COMPARISON OF COLOR AND FABRIC PRESENTATION OPTIONS IN THE DESIGN PROCESS

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(**ABSTRACT)**

The purpose of this research was to assess the current (manual) and future (automated) presentation options for fabric and color in the design process. Current and future presentation options were assessed for viability and identification of relationships between reported sufficiency levels and recommended use responses. This exploration was used to identify new and future technologies for presentation of fabric and color that could potentially aid in increasing product manufacturing competitiveness through time and cost reduction. The study also recorded if the current practices for apparel design were congruent with current available technology and estimated future technology capabilities.

A judgment sample of 20 apparel and interior industry personnel, in three geographical locations (i.e., West Coast, Southeast, Northeast), were mailed a self-administered survey. The survey design employed a structured multi-part questionnaire and four fabric and color presentation options (i.e., fabric swatch, printed swatch card, 2D simulation, 3D simulation). The survey was pilot tested for content validity and instrument reliability. Descriptive statistics (i.e., frequencies, percentages, contingency tables) were used to analyze the data. The response rate was 65% for 13 usable responses.

Exploration and analysis of current (manual) and future (automated) presentation options provided information about the sufficiency of the information provided and for consistencies and inconsistencies in the designer's perception of these options. The fabric swatch format was identified as the current viable manual presentation option. The 2D simulation and 3D simulation presentation option was identified for the automated category. Only the 3D simulation option was found to be viable for use in the design process. The fabric swatch

and 3D simulation successfully conveyed all fabric characteristics effectively. The fabric swatch also conveyed all format attributes effectively and the 3D simulation effectively conveyed familiar, satisfactory results, saves time, and increased productivity.

TO-

Jerome, Benita, and Meshay,
and in loving memory of
Mom, Aunt Willie, and Brittany,

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Chapter One

Introduction

U.S. manufacturing companies have been implementing new technology for competitive advantage for meeting consumer's changing needs (Standard and Poor's, 1996). Research in the industry has shown that apparel manufacturers are adopting new philosophies such as Total Quality Management (TQM), Just-In-Time (JIT), Quick Response (QR), automation, computer technology, and engineering design process (Hammer, 1996; Kincade & Cassill, 1993; Knapton, 1990). Most of this research has focused on production processes or on the link between manufacturing and retailing.

Regan (1997), in a study of the non-competing apparel manufacturers, discussed the importance of management and integration of design with other industrial activities. Regan's initial project was to identify the type of design process, a building block process, used by the designers in her study. Regan also found that the engineering design process could be adapted for application to the apparel design process to improve efficiency. Regan completed research that explored the following areas: (a) identification of the current apparel design process, (b) identification of problems with the current apparel design process, (c) applicability of the engineering design process to the apparel design process, and (d) recommendations for reengineering the current apparel design process. During the completion of areas (a) and (b), Regan identified the color process as the most time and cost consuming area of apparel design. Regan's recommendations included adoption of the engineering design process for improved efficiency, by integrating apparel design with product development through a concurrent design approach. Improved information of the apparel design process, increased use of automated technology, and an understanding of the impact of this technology on the process is needed to achieve the improvements that Regan recommends.

Problem Statement

The use of computers in the fashion industry has expanded to include selection, replication, and production of colors in the design process for apparel items. Companies have begun using 3D imaging for presentation of fabric, color, and print options for marketing purposes. Color is an important element in apparel and accessories because it is generally the first characteristic to which a consumer responds (Eckman, Damhorst, & Kadolph, 1990; Frings, 1999). Eye appeal is also influenced by color (Solinger, 1988). As color may be used to communicate expressive (i.e., values, roles, status) and aesthetic (i.e., human desire for beauty) classifications (Lamb & Kallal, 1992), the magnitude of its importance can not be overestimated. The development of apparel products with color and fabric characteristics desired by the consumer is imperative and dictates the use of the best possible options required to facilitate the process of their development.

Regan (1997) reported the requirement for fabric samples to be as early as one and one-half to two years before the release of a line. This timeline generates large risks for product development. Regan recommended reduced risks by compressing the traditional timeline. Decrease of risks is supplemented by providing samples as close to development and production schedules as possible. Color trends and forecasting are more accurate and predictable closer to the season release time. With the adjustment in time, forecasters are better able to track, explore, analyze, and predict trends for the upcoming season. A shorter timeline will require an adjustment in processes. For example, change in timing of fabric samples may require changes in fabric sample presentations.

Computer technological advancements in the area of fabric simulation, showing promising results, have been conducted. The goal of a cloth or fabric simulation model is to realistically portray varying fabrics in multiple deformation modes (e.g., fabric spread on a table, draped over a chair, on a body). Breen, House, and Wozney (1994) reported previously conducted research demonstrated 3D cloth-like structures for bending, wrinkling, tear, and drape by various researchers (e.g., Dhande, Roa, & Moore, 1993; Feynman, 1986; Haumann & Parent, 1988; Terzopoulos & Fleischer, 1988). Fabric drapeablility, flow, and deformation characteristics are unique for each fabric and each situation. Bending, shear, and tensile properties along with surface roughness and compressibility are also helpful physical/mechanical information characteristics. These information points may be used to establish a body of knowledge, convertible to a queryable database used for the description of physical deformation of cloth. They concluded that these simulations were not amenable for computer queries. A database to support a simulation of hundreds of different fabrics would be very large. These simulation models were also not generalizable due to the use of non-mechanical information required to refine simulation models. Although widely known, this body of knowledge is not readily available.

Breen, Eischen, Kass, Thalmann, and Vecchione (1997) conducted a symposium forum during the 1997 SIGGRAPH Annual Conference that discussed the reasons why fabric and clothing design have not become fully computer automated. Some of the issues discussed included the importance of realism, demands of computer-based manufacturing, resistance to computerization, and cost restrictions.

Purpose Statement and Objectives

The purpose of this research was to assess the current and potential presentation options for fabric and color in the design process. Presentation options vary in the amount and accuracy of fabric and color information that is conveyed to the user. Through the exploration of viable presentation options for fabric and color in the design process, the identification of current technologies that reduce time and cost in the design process may be catalogued. This exploration can also be used to identify new and future technologies for presentation of fabric and color that aid in increasing apparel manufacturing competitiveness through time and cost reduction. This identification will help to record if the current practices for apparel design are congruent with the current available technology and estimated future technology capabilities. Assessment of the fabric and color presentation options will help to record levels of accuracy and information content for apparel designers. Preferences were also recorded for fabric and color presentation option structures and formats.

Sample selection of the study included the use of judgmental sampling technique that was a non-probability sampling technique. A judgmental sample is a sample selected by a researcher based on judgment criteria (Zikmund, 1994). Judgmental sampling criteria is determined to set sampling borders based on the research objectives of the study (Zikmund). An instrument was designed to record preference data and participant data. A portion of the instrument pertained to the review of the four-color and fabric presentation options and was used to record preference data on the presentation option reviewed. The remaining format of the instrument facilitated the collection of data pertaining to the participant's position and job experience, computer experience, company information, demographics, and job satisfaction level (Geissler, 1998; Regan, 1997; Venkataraman, 1992; Wimmer, 1994).

The objectives of this research were to: (a) identify current manual presentation options for fabric and color in the design process, (b) assess viability of current manual presentation options for fabric and color in the design process, (c) identify future automated presentation options for fabric and color in the design process, (d) assess viability of future automated presentation options for fabric and color in the design process, and (e) compare viable manual (current) and automated (future) presentation options for fabric and color in the design process.

Apparel Design and Development Process

Ranked functional activities, from the *as is* environment researched by Regan (1997), are used to identify inputs, controls, outputs, and mechanisms for the apparel product development process (See Figure 1). In the process, Functional Activity A1, Create Apparel Line, is the base for all other apparel product development functional activities and provides inputs for many subsequent activities. Within A1 are the activities of Develop and Design Business Goals, Create Design Objectives: Define Problem, Explore the Problem, Search for Alternatives, Evaluate and Make Decisions, and Specify and Communicate Solutions. Functional Activity A2, Develop Colors and Prints, refers to the implementation of color processes, piece dyeing processes, printing processes, garment dyeing processes, and dyed color sample approval. The apparel manufacturer or external textile suppliers accomplish these activities. This functional activity is driven by decisions in Functional Activity A1, which provides outputs to evaluate and make decisions to begin the color development process. This process was used as the overall framework of the study.

Create Apparel Line	Develop Colors & Prints	Implement Fabric Design & Special Operations	Create Garment & Pattern Prototype	Set Production Specifications	Produce Samples
A1	A2	A3	A4	A5	A6

Figure 1. Apparel design and development process. From Regan (1997).

Significance and Contribution of the Study

Assessment of adoptions for current and proposed future technology in the area of color presentation options will be useful in evaluating the current state of applicable technology. This assessment will also aid in the development of future technology for adoption in the apparel design process. Identification of viable color presentation options, which would reduce time and cost consumption in apparel design and increase consumer responsiveness, would increase global competitiveness in the apparel industry (Dickerson, 1991; Moncarz, 1992; Porter, 1985; Regan, 1997). Contributions to academia include curriculum updates to include future technological advances in the area of color, coordination efforts for consumer qualifying factors, and identification of training requirements. Additional contributions include teamed research between the computer, graphics, and apparel industries for exploration, implementation, and refinement of color technology.

Assumptions

The research assumptions were (a) participants can accurately decipher varying shades and hues, (b) participants have a sufficient level of acuity, phoria, and stereo vision to adequately evaluate 2D and 3D simulation presentation options, (c) participants in the study have similar apparel design development processes, (d) the participants could evaluate the presentation options provided without the benefit of formal training, (e) color is a part of the apparel design and development process as defined by Regan (1997), and (f) surveys completed by selected participants represent accurate information in the order as given in the directions.

Chapter Two
Review of Literature

Introduction

Multiple studies for the production or manufacturing process have been completed for other industries, such as engineering and architecture. General studies that address the production or manufacturing process for most industries usually refer to stages, concepts, and activities of the design process as functions that occur in *the black box*. Limited information is presented to explain what actually occurs during the design process. References to the design function in the literature refer to the generic input of design information. Limited research has been completed that addresses the identification of the design process in the apparel industry in a detailed manner (Regan, 1997).

Regan (1997) discussed the importance of managing the apparel design process due to its impact upon manufacturing activities, product costs, and quality. Regan provided a detailed review of the interrelationships involved in design management (e.g., product design and corporate strategy, design contribution to strategic goals, resource management, design process management). Regan's study emphasizes the need for apparel design research and the importance of managing the design process within a strategic frame that includes an analysis of technology usage.

The apparel design process is a complex process complicated by a unique industry that has anywhere from four to twelve seasons per year, with 50 to 350 styles per season. Regan (1997) reported that a designer is involved in at least 91 functional activities for the development of a single apparel product. Successful completion of these activities can be impeded by reduced process quality. In the area of color, a common rework cycle of three to ten times is usual for each color developed. With the average number of colors developed per season at 35, rework cycles can range from 105 to 350 per season. This problem is compounded because this color decision process occurs continually and overlaps the production and distribution stages of preceding seasons, and continual initiation of the creation and production stages of succeeding seasons in design process management is mandatory. This process or portions of this process have been reviewed or studied in several textbooks and research studies.

Identification of the Design Process

The product development process encompasses the total spectrum of activities and functions required for delivery of a product to the consumer. This process includes internal and external functions, from determination of the strategies to be employed for the conceptualization of a product (e.g., company mission statement) to the transport and distribution strategies for delivery to the retail element (e.g., inventory control, transportation contracts). The apparel design process may be explained as a subset of the product development process (Glock & Kunz, 1995; Regan, 1997). The design process is used to identify needs and develop a product to meet those needs (Regan, Kincade, & Sheldon, 1998; Wilcox, 1987). Navinchandra (1991) defined design as solutions derived from the designers' knowledge, skill, imagination, experience, and problem solving techniques.

Textbooks. Frings (1999) presented an overview of how a line is developed but most of the emphasis was on design elements and principles. Frings' textbook presented the interrelationships of the fashion business from buying supplies, creating and developing new products, to product marketing. The process was presented for three levels in the fashion industry: raw materials, manufacturing, and retailing. Frings discussed the roles of all firms required for apparel production (i.e., fiber, textiles, findings, and trimmings producers; garment manufacturers; wholesale markets; retail stores). Frings also addressed the fur, accessories, and home sewing industries. Main concepts of the textbook included the development of fashion and the industry; fundamental concepts of consumer demand and fashion change; merchandise development, production, and marketing from concept to consumer; industry multi-level interrelationships; and respective explanations.

Determination of the number of groups in a line for the season and establishment of a dollar merchandise plan for identification of projected sales goals for the line are the starting steps in Frings' design process. Development of a merchandising plan follows, to detail the line concept and number of styles and required fabrics. The merchandising plan also included deadline schedules from concept through production. Sketches are produced, followed by sample patterns and sample garments. Sample garments are tested for fit and effect for determination of revisions.

Frings' (1999) design process stages also included external source information (i.e., market research; trend research; economical, technical, social, and political influences; cultural and artistic resources). Additional external resources include color and fabric. These resources are used to develop a design idea based on the designer's unique interpretation.

Kadolph, Langford, Hollen, and Saddler's (1998) textbook presented a basic understanding of the role/impact of textile component products, their production, and performance requirements. The text detailed the interrelationships between apparel components (i.e., fibers, yarns, fabrics, finishes). Career choices and requirements are also presented in the textbook. With the emphasis on the contributive characteristics of each component, serviceability was the basis for discussion.

Terminology in the text incorporated an industry perspective. Discussions included societal, contemporary, and industry concerns along with the impact of technological advances on the textile industry. Kadolph, et al. (1998) also included discussions on furnishings and provided introductory information on industrial products, labeling laws and regulations, and environmental issues. A cursory overview of design career responsibilities and objectives are presented in the textbook. These include "creating ideas or designs for a product" (Kadolph et al., p.380). Areas for design work include yarns, fabrics, print patterns, apparel, rooms, and settings. Designer responsibilities include knowledge of what will sell, satisfy consumers, textile performance, and serviceability through proper selection of appropriate materials. Product knowledge includes legal restrictions through laws, regulations, and codes. Flexibility for various price points and quality levels is also required. Although much information was provided about design, a specific design processes was not identified.

Glock and Kunz (1995) prepared a textbook that presents decision-making aspects of marketing, merchandising, and producing apparel, and within that framework they discuss apparel design. Through the explanation on interrelated management decisions, an explanation of the design factors that determine cost, price, quality, performance, and garment value was provided in the book. This discussion provides support for the importance of the design process to apparel manufacturing. Glock and Kunz considered design as a product and a process, and concur with the earlier work of Davis (1980). An analysis of three apparel products was also presented in the textbook. With the characterization of design as a product, the applicable explanation becomes "a specific or unique version of a style" (Glock & Kunz, p. 151). The new version of a style is called a design until it is assigned a style number or number and adopted into a line.

Glock and Kunz's (1995) exploration of design as a process focused on the design process from the perspective of manufacturing output. The textbook explored the relationship of design to merchandising divisions and product lines to target markets. Glock and Kunz identified the usual location of the design function as in the merchandising division. With line development as a part of a merchandiser's responsibilities, the responsibility for innovation rests with the designer. Discussion was also provided about design technology and the adoption phase utilization. The taxonomy of the apparel merchandising system (TAMS) identifies interactive, concurrent, and sequential components of the merchandising process and explains the process of line development. TAMS is comprised of two strategic planning components (e.g., business planning, marketing planning), three merchandising components (e.g., line planning, line development, line presentation), and three sourcing components (e.g., sourcing strategy, materials sourcing, production sourcing). How this taxonomy relates to product development is unclear.

The three phases, preadoption, adoption, and postadoption, are processes of product development. Also, design and creativity are more directly associated with preadoption and adoption phases (Glock & Kunz, 1995). These processes are classified as merchandising activities for line development. Preadoption is defined by the development of styles by creating original designs, modification of previous season's styles, and knock-offs of other firm's styles. The adoption phase focuses on the analysis of styles for inclusion in a line. The postadoption phase encompasses focussing on perfecting styles for production. An examination of both the design process in different firms and the responsibilities of participants in the process are presented. Although discussed, no single definition of the design process is presented.

Blaich and Blaich (1993) published a management strategy text that included a conceptual framework that combines product design and corporate strategy. The four main components of the framework were: (a) design input for strategic goals, (b) design resource management, (c) design process management, and (d) communication network for information and ideas. According to their framework, consensus between design, marketing, and manufacturing areas is required for an effective design management program. Design resource management requires the efficient use of human, corporate identity, and financial resource areas. Development of an overall design direction that incorporates consistent quality and a structural program is compatible with corporate strategic goals. External and internal idea resources are required to provide diverse information for design areas.

Lewis and Samuel (1989) published an engineering design text that defined the traditional product design process as a process that includes the following stages: (a) problem recognition, (b) problem definition, (c) exploration of the problem, (d) search for alternatives, (e) evaluation and decision making, (f) specification of solution, and (g) communication of solution. The goal of the authors was to describe the theory and practice of engineering design. Lewis and Samuel introduced formal procedures of engineering design, along with techniques for handling open-ended large-scale problems. The authors also discussed divergent phases (e.g., information gathering) and convergent phases (e.g., evaluation and selection among alternatives), generation of formal design reports, economic and human constraints, safety aspects, and failure. Examples are also presented of solved and unsolved engineering design problems.

In summary, Lewis and Samuel (1989) presented a comprehensive outline for the application of the design process for engineering. Formal procedures and techniques were discussed along with the steps required to formally solve design problems and apply design stages identified by the authors. Blaich and Blaich (1993) published a management strategy text that included a conceptual framework that combines product design and corporate strategy. Blaich and Blaich reported that product design could be promoted to the status of a formal activity by integrating the design activities with strategic and operational activities, coordination of design resources, management of the design process, and communication of design relevance. Frings' (1999) explanations and definitions of the interrelationships required in the fashion business, provide a guide to the product development process, which includes marketing, merchandising, and apparel production activities.

Glock and Kunz (1995) do not present a single definition for the design process. The authors presented, instead, a taxonomy for the apparel merchandising system; however, the relationship of design to product development is not clearly explained. Kadolph et al. (1998) presents the contributive characteristics of textile components and their serviceability impact on the end-product.

Research. Gaskill (1992) used a case study analysis format to investigate the functional activities utilized by an international specialty apparel retailer. The apparel retailer selected for study utilized a 100% in-house product development division with the capability to develop multiple apparel lines for varying target audiences. The researcher used interviews, direct observation, and physical evidence for data collection providing a variety of inputs for analysis. Analysis was conducted via single narrative chronological sequencing to identify eight activities during product development: (a) trend analysis, (b) concept evolvement, (c) fabrications selection, (d) palette selection, (e) fabric design, (f) silhouette generation, (g) prototype construction and analysis, and (h) line presentations. A Product Development Model was identified that included internal and external intervening factors during the product development process. Gaskill's use of a case study analysis format and use of interviews, direct observations, and data collection of physical evidence provide detailed information in varied formats to strengthen the Model development. Although product design is implied as part of the model, it is not directly addressed.

Lamb and Kallal (1992) presented an integrated framework for apparel design that incorporated Functional, Expressive, and Aesthetic (FEA) considerations. The framework is a conceptualized model and is a combination of features from design process models by Hanks, Belliston, and Edwards (1977) and Koberg and Bagnall (1981). The core of the model is the target consumer. A culture filter, which influence options for design resolutions, encircles this core. Design criteria such as functional, expressive, and aesthetic classifications are interrelated considerations, which differ for different target consumers.

The functional aspects of the framework can be satisfied through the use color and pattern in addition to physical characteristics without interfering with the interrelationship between expressive and aesthetic classifications. The countenance or expression of color can be utilized to satisfy the interrelations between the expressive and aesthetic classifications. Expressive characteristics that pertain to communicative and symbolic dress aspects include values, roles, status, and self-esteem. Aesthetic characteristics deal with human desire for beauty through: (a) art elements, (b) design principles, and (c) body/garment relationships. For the stages of the design process, the model incorporates Design Problem Identification from the Accept Situation, Analyze, and Define stages of Koberg and Bagnall's (1981) Model. Preliminary Ideas are from Koberg and Bagnall's Ideation stage and Design Refinement from the Select stage. The Prototype Development is adopted from Koberg and Bagnall's Implement stage and Hanks et al. Analysis and Evaluation stages. Implementation is described as the final action after completion of the design process.

Regan (1997) used a purposive discriminate sample of 72 apparel associates from varying product development functional areas during Phase I to develop an apparel design process framework for apparel manufacture. Phase I was a qualitative descriptive study that documented the *as is* environment from design concept through sample production. After documentation and analysis of the *as is* environment, Phase II, a *to be* environment that integrated apparel design with product development, was completed using 34 participants. This research provides detailed information for the application of design as a product (i.e., outputs) and a process with the identification of activities (i.e., inputs).

Phase I research of Regan (1997) yielded six major functional areas for apparel design and preproduction: create apparel line, develop colors and prints, implement fabric design and special operations, create garment pattern and prototype, set production specifications, and produce samples. In Phase II, apparel activities were ranked for early, medium, and late categories in alignment with the seven configuration engineering conceptual statements: design for quality, enabling technology, manufacturability, life cycle-inspectability, life cycle-reliability, life cycle-maintainability, and cost.

Regan, Kincade, and Sheldon (1998) used interpretation analysis qualitative research method to examine line development (i.e., line plan through line release). Data from two large apparel manufacturing companies utilizing 20 participants in the design associate positions were observed and interviewed. Data analysis of the observation field notes and transcribed interviews yielded a detailed identification of the line development process. The identified process was compared to and classified into the engineering design process stages. Regan et al. recommended using the design process theory to provide quantified objective measurements and to teach systematic design process to apparel designers.

LaBat and Sokolowski (1999) reviewed the design process from varying fields, such as architecture and environmental design, engineering, industrial product design, and clothing design. Review of these processes revealed three major common stages in the design process: (a) problem definition and research, (b) creative exploration, and (c) implementation. A textile product development process was proposed. The proposed process was applied to a joint industry-university project for the redesign of an athletic ankle brace. The proposed process provided a structural approach to the project for communication of the working methods of the team participants. The design process was tracked via a chronological structure for design process stages. The problem definition and research stage included the following components: (a) initial problem definition, (b) research and working definition, and (c) working problem definition. The creative exploration stage included (a) preliminary ideas, (b) design refinement, (c) prototype development, and (d) evaluation of prototype. For the implementation stage identified components included (a) production refinement, (b) Phase I: immediate production, and (c) Phase II: improvement/refinement.

Wickett, Gaskill, and Damhorst (1999) completed a study that applied Gaskill's 1992 Retail Product Development Model to a broader range of specialty stores for validation. Wickett et al. interviewed 21 retail employers who supervised the apparel development process in a variety of price lines for men's, women's, and childrenswear specialty stores. Participating stores had a range of 70 to 100% of private label or in-house developed products. During the research effort, Wicket et al. also investigated the following areas: (a) private label practices an motivations, (b) concept of retail product development by participant, (c) product development process stages and decision-making criteria, (d) conversion steps from product to production-ready status, and (e) industry opinion of retail product development trend. During the research, data were collected that supported an expansion of the Retail Product Development Model (Gaskill) beyond line presentation to include the postadoption development stage, as explained by Kunz's 1998 TAMS Model. The explanation provided by Kunz's list the activities for postadoption product development as: (a) styling and fit adjustments, (b) test of materials and assembly methods, (c) style development of style samples, and (d) completion of style and quality specifications. Detailed costing is also conducted along with pattern grading activities.

In summary, aspects of the research reviewed in this section contain only portions of the total product design process as defined by Lewis and Samuel (1989). The exceptions include research completed by Regan (1997) and Regan et al. (1998), which emphasize the total apparel product design process as defined by Lewis and Samuel. Regan (1999) also incorporated the management conceptual framework supplied by Blaich and Blaich (1993) for the elevation of product design to a formal activity. Regan's (1997) research compared the results or benefits of sequential apparel design and product development with concurrent apparel design and product development. Regan presents the most comprehensive, documented apparel design and preproduction process. Phase I of the research incorporated the same stages defined in the traditional product design process as reported by Lewis and Samuel (1989). Regan (1997) recommended that a *to be* environment (Phase II) is suitably applicable for additional research work in the apparel industry. The seven principles outlined for apparel production management, from Phase II are in alignment with the functional activities identified in Phase I, the *as is* environment.

The design process defined by LaBat and Sokolowski (1999) does not identify a separate stage for communication of solution as presented in Lewis and Samuel's (1989) traditional design process text. Gaskill's (1992) Product Development Model, with defined internal and external factors, was expanded by Wicket et al. (1999) to include postadoption activities as defined in Kunz's 1998 TAMS Model. Gaskill's (1992) Model, identified activities for product development, begins with trend analysis and proceeds through line presentations; however, the Model does not proceed beyond the line presentation phase. In comparison to Lewis and Samuel's (1989) defined design process, Gaskill's Model begins with the Search for Alternatives stage, or the fourth stage, and proceeds through the Communication of Solution stage.

Lamb and Kallal (1992) did not directly link an implementation stage to the FEA Model. The FEA Model also did not include a communication stage as defined by Lewis and Samuel (1989). Lamb and Kallal reported that the conceptual framework was applied to several design projects; however, these projects were not adequately referenced to facilitate the review and analysis of the suitability of the Model. Regan's (1997) process can be easily compared to Lamb and Kallal's (1992) Functional, Expressive, and Aesthetic (FEA) model without violating Lewis and Samuel's (1989) traditional design process stages.

Although comprehensive in scope, Regan's (1997) study sample is purposive and precludes immediate generalizability to the entire apparel industry. Wickett et al.'s (1999) research also used a small nonrandom sample size, making the generalizability of the results suspect. Positive participant responses for some of the participants accounted for 4.7% of the responses (n=1), which is weak validation for broader applications of the Gaskill 1992 Model. Gaskill's (1992) research sample population was small and nonrandom. Gaskill's research publication also does not report participation levels of the functional activities recorded. Regan's (1997) study still presents the most comprehensive model in the area of apparel product development with defined activities that support the elevation of the design process to a formal level.

<u>Design Elements</u>

Frings (1999) listed the elements of fashion apparel as the following: (a) color, (b) texture, and (c) style. Frings stated that "usually the first aspect of a garment or accessory to which consumers respond is color" (p.37). Frings also designated that the texture or surface interests of the fabric or style is important to consumers because of its sensuous appeal, and style is defined by the line, silhouette, and details of an item. Design principles included proportion, balance, rhythm, emphasis, and harmony to develop a pleasing design. These principles are guidelines for combining elements (Frings). Solinger (1988) reported that style is based on eye and tactile appeal with eye appeal being influenced by the following: (a) color, (b) silhouette, (c) fabric drape, and (d) fabric surface interest. Perna (1987) identified fashion elements as the (a) silhouette or shape of the garment; (b) fabrication-substance of the item, fiber, texture, weight, and pattern; (c) color; (d) details or adornment; and (e) spirit or special look of the clothes (i.e., nautical, retro). Fiorito (1990) stated that color is a product-specific criteria that is used for qualitative evaluation of apparel products. Color as an evaluation criteria or attribute is used to judge choice alternatives in apparel shopping (Engel, Blackwell, & Miniard, 1993). Kang's 1999 research identified major concerns of retail buyers to be styling, fashionability, color, and product distinctiveness. In a study that explored the perceived risk levels of purchase decision making within specific factors, Kang (1995) reported that product specific criteria included aesthetic aspects, situational usage, performance, and extrinsic criteria, which are in-line with the FEA model proposed by Lamb and Kallal (1992). Color, fabric, and aesthetics are three areas of apparel, which are mentioned by many authors and researchers as important design elements.

Color. Color reported by Frings (1999) has three dimensions - hue, value, and intensity. Solinger (1988) supported these color dimensions in his discussion of fabric. Hue distinguishes one color from another and value refers to the variation of light in a color with varying tints and shades. Intensity refers to the strength (brightness) or weakness (paleness) of a color. Colors may also be classified as warm, cool, or neutral (Frings). Perna (1987) stated that it is mandatory that reports and discussions of color be accurate about value and intensity. Color families may be used year after year, but their tonality will change with each season. Perna thinks that color names also must be accurate but colorful as promoted by the Color Association of the US (CAUS) Standard Color Reference of America. CAUS (1999), considered one of the arbiters of color for over 80 years, prepares seasonal color forecasts for women's, men's, and children's wear and the interior and design industries.

PANTONE, Inc. is a leading developer and marketer of accurate color communication products for varying industries. With a world-renown reputation for accurate communication of color information, PANTONE is well trusted in the color business. PANTONE began as a product developer for color communication in the area of graphic arts (PANTONE, 1999a). Expanding the premise that individuals perceive the color spectrum differently, PANTONE created a matching system with standardized colors on coated and uncoated stock with precise ink formulas for accurate reproduction.

Addressing a need for accurate color communication products in varying industries such as textiles, apparel design, and home furnishings, PANTONE is expanding into other color-conscience industries, including plastics and digital technology (PANTONE, 1999a). Special research and development labs for the company have been structured to support industry requirements. Textile labs have been configured to verify textile production formulas and to prepare cotton fabric color swatch books. With the expansion and initiation of new licensing agreements, PANTONE can facilitate computer access and integration of PANTONE TEXTILE Color System (over 1757 colors) into Computer-Aided Design

(CAD)/Computer-Aided Manufacturing (CAM) systems, fabric Color Swatch Files for textiles, and computer systems and printers with PANTONE color production capability.

In addition to color development and verification labs, PANTONE operates their own printing and bindery operations to ensure quality control of their products (PANTONE, 1999a). The company operates the PANTONE Color Institute, a not-for-profit color research and information center, for distribution of color expertise with industries such as fashion, commercial/industry, contract and interior design, graphic arts, advertising, film, and education. The Institute also studies the influences of color on human thought processes, emotions, and physical reactions.

The PANTONE Textile Color Selector consists of a portable binder with 1757 colors on 100% cotton swatches with numerical reference numbers. The Textile Color Specifier is a color-on-paper fan deck format available for use by designers, merchandisers, or product development managers (PANTONE, 1999b). PANTONE also offers a textile CD-ROM for incorporation of color system colors into Macintosh and Windows based systems.

In 1996, PANTONE's Vice President Richard Herbert discussed the difficulties of consistent and identical device color profile across two platforms (e.g., Macintosh, IBM, UNIX), which makes achieving consistent results difficult on different systems (Herbert, 1996). A partial solution to the problem included implementation of additional software programs to help synchronize color requirements and improve consistency. PANTONE also initiated research and solutions for use of color on the Internet. Color is the most basic aspect of design's visual medium and one of the most difficult to control. PANTONE markets an Internet-specific program for Web publishing color management to facilitate digital product development for purposes of on-line catalogs to maintain the integrity of images of varying monitors (Herbert). With the expertise and resources available PANTONE produces reference swatches on cotton fabric. As cotton is one of the easiest fabrics to dye, transference of the selected colors to other fabrics is suspect for accuracy.

Fabric. Solinger (1988) classified the physical properties of fabric as contributing to surface texture and appeal to the consumer. In addition to color, he also discussed shine and gloss along with matte as dimensions of intensity in reference to brilliance. Solinger defined style characteristics of fabric as changes, which affect emotional appeal of the fabric to the consumer. The author used three subcategories to describe fabric style characteristics: (a) hand, (b) tactile, and (c) visual.

Hand referred to the changes of the fabric plane with the hand to exert tensile, compression, molding, or supporting forces (Solinger, 1988). The following classifications are: (a) thickness compressibility (i.e., soft, lofty, thin), (b) plane compressibility (i.e., hard, springy, bulky), (c) elongation, (d) elasticity (i.e., stretchy), (e) torsion (i.e., sleazy), (f) malleability (i.e., pliable, stiff), (g) flexibility (i.e., drape), (h) resilience (i.e., springy, limp, alive), and (i) gravity – drape, sag, and elongation (i.e., drapeability, flow) (Solinger). These classifications can be physically measured; however, the attributes used to describe the varying levels are subjectively assigned (AATCC Evaluation Procedure 5, 1999).

Tactile characteristics refer to the change in the fabric's surface contour due to a mechanical force (Solinger, 1988). Tactile characteristics may be specified by terms such as soft, coarse, hard, smooth, oily, greasy, sticky, etc. (Solinger). Visual characteristics include the concept of metamerism, which is a change in color due to a change in illumination.

Paek (1985) researched the effects of scaling methods on tactual ratings of apparel and home furnishing fabrics. Seventy-five college textile students evaluated the attributes of stiffness, thickness, roughness, and warmth for 11 varying fabrics. The tactual evaluations were made using a 7-point semantic scale. The tactual scale ratings were then compared to subjective tactual rankings, using a paired-comparison method. Significant results were reported for evaluations of touch alone and by vision and touch. Thickness and roughness were the most consistently rated attributes when touch alone and by vision and touch ratings were analyzed. The highest correlations were found for the attributes of roughness and thickness for touch only ratings.

A variety of dimensions (e.g., hue, value, intensity) are associated with color and require the accurate communication of information for a true portrayal of a color (Frings 1999; Perna, 1987; Solinger, 1988). PANTONE, a leader in color communication products, offers over 1700 colors for computer access and integration. However, PANTONE continues to supplement their automated color communication products with fabric swatches.

<u>Aesthetics.</u> Biaggio and Supplee (1983) completed a study to test the validity of three identified dimensions of aesthetic perception of art from previous research and also to compare aesthetic judgments of art and non-art students. Dimensions tested included hedonic value, arousal, and uncertainty. Biaggio and Supplee discussed the problems of experimental aesthetics in terms of a lack of a suitable system of concepts for classifying artwork and what the benefits of such a system would be. Benefits would include a system to describe art simply and meaningfully, explain relationships between art works, describe similarities and differences and facilitate the objective study of art.

Two groups of participants completed the research, one group was comprised of 20 art majors and the second group was comprised of 26 psychology majors with little or no formal art training. Participants were asked to rate 21 color slides of portraits of similar subjects with limited background stimuli. Participants used twelve seven-point semantic differential scales. Analysis was conducted using principal-component factor analysis on the intercorrelations among mean scores of the semantic scales. The results were the identification of three factors: (a) Hedonic-Interest, (b) Arousal, and (c) Uncertainty. Comparisons between the two groups showed great similarities with high loadings (.50 or greater) on eight of the scales (Biaggio & Supplee, 1983). Three of the scales, for beauty, pleasure, and pleasing, loaded under Hedonic-Interest for the art students and Arousal for the non-art students. The last scale, drowsy-alert, loaded high under Arousal for the art students. The Hedonic-Interest factor included additional values (complexity, powerfulness, alertness, and interestingness) that were not reported in the literature. The Arousal factor did not include high loadings for complexity, powerfulness, and interestingness. The third factor, Uncertainty, was validated (Baggio & Supplee).

Biaggio and Supplee (1983) do not provide clear definitions of the dimensions investigated. The authors state that the dimensions tested were "the same as those developed by Berlyne [1971] and modified by O'Hare and Gordon [1977]", but the modifications were not provided in the text. Hedonic values emphasize judgments of pleasingness, goodness, and beauty, arousal is associated with complexity, uncertainty, interestingness, and uncertainty values emphasize perceived powerfulness, or strength of the stimuli and compositional elements of order, balance, and clarity. These values were similar to identified values identified by Osgood (1976), evaluative, activity, and potency. However, the authors do not provide a reason for selecting Berlyne's values over Osgood's values. The authors' state that Berlyne's values were similar to those identified by Osgood.

Biaggio and Supplee (1983) do not provide a definition for aesthetics. However, a formal definition as supplied by Webster's (1981) is "2: the description and explanation of artistic phenomenon and aesthetic experience by means of other sciences (as psychology, sociology, ethnology, or history" (p.19).

<u>Fabric aesthetics.</u> Hatch's (1993) textbook has a discussion of the aesthetic appeal properties of fabric and defines them as the pleasantness of fabric to four human sensory mechanisms, sight, touch, hearing, and smell. Hatch stated that fabric aesthetic appeal was the main consideration in many consumer purchase decisions. Hatch also explained that the aesthetic appeal of an apparel product may outweigh other considerations, such as durability or care requirements, which was rarely the case with industrial products.

Sight sensory aesthetic properties or appearance aesthetics refers to the perceived effects of light interaction with fabric and includes translucence/opacity, luster, dullness, pattern and texture, color, and drapeability. The translucence or opacity of a fabric is dependent on the amount of light that is transmitted through the fabric. Hatch 91993) discussed degrees of translucence (i.e., solid, dark, cloudy) and opacity (i.e., sheer, gauzy, gossamer, pale). Luster and dullness refer to level of light reflection from the fabric due to surface contour. Smoother surface contours reflect higher amounts of light (i.e., sheen) while diffuse light is reflected from rough surfaces. Light reflectance may also be controlled through the application of delustrants to fabric surfaces, yarns, during man-made fiber production, and natural fiber preparations (Hatch; Kadolph et al., 1998; Solinger, 1988). Pattern can impact light reflection and texture.

A combination of surface appearance, which is visually detected by the eye, is detected as variations in light reflection across the fabric surface. Hatch (1993) discussed the aesthetic appeal of color through perception, as “the most pleasurable visual sensation” (p.48). Color for fabric is the light reflected from the surface (i.e., fabric) as per the selective reflectance of light wavelengths not absorbed by colorants (i.e., dyes and pigments). Hatch mentioned the complexity of fabric color and its perception, which involves light source, colorants, dyeing/printing, and the observer, but did not provide detailed information in the textbook, as it is an introductory text. Drapeability or fall of fabric over a three-dimensional form is visible due to differing light reflections at the tops and valleys of the formed folds. Hatch reported that weight and stiffness are the most important determinants of fabric drapeability. Fabric weight causes the fabric to fall and stiffness opposes gravity. These distinctive characteristics produce unique drape formations. Shear resistance also plays a part in the drape of a fabric and refers to the internal friction between yarns and fibers in the fabric during deformation. The appearance aesthetics of a fabric are created by a complex integration of characteristics that influence the behavior and perception of the fabric.

Hand or touch sensory aesthetic properties include feel, which involves the sense of touch and refers to the body of a fabric or sense of limpness of springiness of a fabric. Hand is a complex concept involving the total sensation experienced when fabric is manipulated by the fingers. The feel or hand aspect of fabric texture is detected through the friction between the fingers and the surface contour of the fabric (Hatch, 1993). Hand “is often the fundamental aspect that determines the success or failure of a textile product” (Hatch, p. 53). Quantitative measurements of hand have been developed using the Kawabata

Evaluation System (KES) and used to record tensile and shear measurements, thickness and compression, bending, and surface roughness under low loads (Merkel, 1991).

Sound sensory aesthetic properties include discernible sounds when the fabric is worn which may have a positive or negative influence for apparel selection (e.g., rustling of taffeta, rubbing of corduroy). Smell sensory properties are related generally to absorption and retention of odors during manufacture; and after wear, care, and with age. A discussion is also presented in the textbook concerning appearance retention, which refers to fabric durability properties but affects aesthetics.

Brand (1964) completed research that explored the measurement of fabric aesthetics. Brand described the main problem of the research as how to ask the right questions to obtain meaningful answers. Brand proposed that if the data were collected correctly there are techniques and methods for converting the answers to useful numerical forms. Objectives of the research included: (a) development of a definition of fabric aesthetics using common words, (b) suggestion of a system for rating scales, and (c) demonstration of valid conversion of basic (subjective) data into numerical definitions of an aesthetic property.

Brand's (1964) paper presented clear definitions and guidance for the selection and use of industry related jargon for collection of subjective data. An explanation was also presented for the classification of related words and provides an understanding of the use of frames of reference for clarification. Brand (1964) used a list of approximately 80-industry words used for discussion of fabric aesthetics. These words were classified into physical and psychological contexts to facilitate use.

In the study, 11 participants judged six commercial fabrics of three styles with a variety of quality and cost. Each style was judged twice by each participant, requiring the use of fifteen paired comparisons of test fabrics. Participants judged each set (2) using a single polar-pair word scale, tied ratings were not allowed. Statistical component analysis was utilized to obtain the minimum number of independent factors. The author reported that subjective factors for fabric aesthetics that can be evaluated with objective tests can successfully be converted to numerical factors for mathematical evaluations. Detailed information of the component analysis results was not provided in the reviewed research.

Hoffman (1965) completed research that measured the aesthetic appeal of fabrics. Hoffman defined fabrics with good aesthetics as fabrics that were pleasing to the eye and hand. Hoffman also asked the question of whether technical instruments can measure physical properties responsible for fabric aesthetics favored by people. The response was positive, with the requirement to identify likes and dislikes of people. Hoffman presented an array of components that contribute to the aesthetics of an object. These components were complex stimuli that can be arranged in a circular formation in dichotomous order (e.g., good-bad, order-disorder, variety-monotony). A true measurement of aesthetics requires the measurement of opinions-psychometry. The use of psychometry dictates the accurate measurement of attitudes and preferences and can be applied to diverse areas, such as color, clothing, and handwriting. Accepted methods in the area of psychometry include "paired comparisons, disguised replication, scaling, depth interviewing, semantic differential, factor analysis, similarity testing, and proximity maps" (Hoffman, p. 429).

In the study, 75 participants were presented with descriptive words for clothing (e.g., snug, revealing, prudent, modest, delicate, graceful, convenient) and asked to identify how often she would wear such items. The responses were used to build a perceptual map. While none of the responses were exactly alike, there were enough high degree similarities to identify segments suitable for marketing exploration. This paper presented a strong argument for the use of psychosemetric research in the area of fabric aesthetics.

Hatch's (1993) textbook provided comprehensive information on the aesthetic appeal of fabric and human sensory impact. Brand (1964) successfully used common words to define fabric aesthetics and develop a rating scale for these words. Brand was also able to demonstrate the valid conversion of subjective data into numeric definitions for comparative analysis purposes. Hoffman (1965) was also able to build a strong case for the use of psychometric research in the area of fabric aesthetics.

Apparel aesthetics. Textbook and research sources have been completed that explore the definition and measurement of apparel aesthetics. Kaiser (1990) published a textbook that discussed the social psychology of clothing. In the section on personal color analysis, Kaiser discussed the impact of color folklore on consumer behavior and the formalization of color *systems* developed in the 1970s, which became a large business. Kaiser calls for research that explores and explains the personal perceptions and peer perceptions of apparel color choices along with external influences for these choices.

Kaiser (1990) discussed the subjectivity of the psychology of color and many external influences on the choice of color. Adams and Osgood (1973) mentioned the cultural impact of color choice and acceptance. Adams and Osgood (1973) advised that color research needs to be cross-cultural to explain color perception and its affective meanings as cited in Kaiser. Biaggio and Supplee (1983) explained dimensions of aesthetic perceptions in terms of art. However, the observations recorded by Biaggio and Supplee differ somewhat from previous aesthetic research (e.g., Beryne, 1971; Osgood, 1976) in terms of underlying components for the factors identified.

Color Research

Radeloff (1991) conducted a study to determine affects of color attributes on preferences and if color preferences were affected by psychological type. Participants for the study (n=111) were college age females that were enrolled in undergraduate fashion and design classes. Participants completed The Myers-Briggs Type Indicator (MBTI) Form F to identify their psychological type. Participants then completed the compiled instrument, which contained fabric samples organized by seasonal hue categories, value categories, and chroma categories. Samples contained solids, neutral solids and patterned fabrics. Participants were asked to rate samples in terms of personal preference. The researcher used Tukey's honestly significant difference (HSD) to identify differences in the color preference categories of the fabrics. Analysis of variance (ANOVA) was used to identify significant differences between all psychological types, except introverted thinkers, and seasonal color preferences. Data analysis revealed that summer and winter hues were preferred over autumn seasonal hues, and spring seasonal hues were preferred to autumn seasonal hues. Medium values were the most favored followed by dark and light values. These values were all significantly different from each other. Participants identified as extroverted dominant psychological types identified seasonal colors more than other psychological types. Thinking, feeling, and intuitive extroverts preferred dull chromas.

The researcher used standardized methods proposed by American Society for Testing and Materials (ASTM), Intersociety Color Counsel (ISCC), and National Institute of Standards and Technology (NIST), formerly known as National Bureau of Standards (NSB) for the designation of hue and color. However, standardized methods were not used during the data collection phase. Preference data were collected in natural light from a window ledge during the hours of 11am to 2pm without viewing time limits. This data collection process ensured that multiple days were used for data collections, which raises the question of consistent weather patterns during data collection and the effects of light source variation.

Hilliker and Rogers (1988) conducted a study to analyze the impact of personal color analysis on the marketplace. The authors described the use of color analysis within the organizations observed and documented display uses in specialty and department stores. Additional objectives included identification of types of color analysis classes offered (12%), documentation of changing level of importance of color analysis to organizations. Forty-one participants from specialty and department stores, from the four geographical areas of the US completed self-administered questionnaires. Hilliker and Rogers reported that 61% of the specialty store participants and 53% of the department store participants related that they used color guidance to arrange displays and merchandise. In contrast, the researchers documented that 23% of specialty stores and 40% of department stores did not use personal color analysis information in their organization. The authors also reported an increase in the perceived level of importance of personal color analysis by participants for years 1983, 1986, and 1989, by organization. For specialty stores, there was an increase for very important rating from the 7%, reported in 1983 to 33% by 1989 and, for department stores, an increase to 33% in 1989 from 4% in 1983.

Offerjost and Terry (1987) completed a project to develop a microcomputer-assisted instruction (MCAI) lesson for teaching color concepts. The authors also evaluated the MCAI lesson's effectiveness and identified relationships between achievement and attributes or preferred learning styles. Sixty-three participants with limited microcomputer exposure were given the MCAI, self-paced, color concept lesson. Analysis techniques used during the project included paired comparison t-test of pretest and posttest scores and paired comparison t-test for effectiveness of increased student knowledge. No significant difference was identified between retention for pretest and midterm scores. Regression analysis was used to identify significant relationships between achievement and attitudes (R^2=.47, $p<.0002$). Offerjost and Terry's research also documented the effectiveness of using microcomputers as learning tools by allowing immediate feedback to participants, and facilitation of independent learning.

Limited research into the apparel area of color perception research addresses issues of color perception and use. The research that is reported has limitations. Radeloff (1991) used a partially standardized method for the collection of data. Hilliker and Rogers (1988) did not report the identity of the personal color analysis philosophies used by the participants. Offerjost and Terry (1987) did not provide information on the color concepts presented in the MCAI lesson. The reported research however, does show the importance and complexity of color acceptance and perception.

Decision Making

Various research has been conducted to analyze the decision making process both in general and with specific applications to apparel choices. Dewey (1910) proposed problem solving as the explanation for conceptualization of the behavior in the decision process. In apparel design, for example, Lamb and Kallal (1992) developed an integrated framework that combines FEA considerations, and incorporated creative thinking development as proposed by Watkins (1995).

The identification of the decision-making process employed in the area of apparel product development and selection is distinct. Kang's (1999) research identified a unique approach for decision-making by apparel buyers. Kang completed a study that developed an assortment-planning model for women's wear retail buyers. Development of an assortment plan requires the forecast and selection of styles, colors, and sizes with decisions about dollar amounts spent and units purchased. Kang's 1995 research identified an applicable description for an assortment plan decision model as the individual decision-making process model, which was incorporated in the later (1999) study. Kang investigated the identified steps for the assortment-planning process: (a) problem recognition, (b) information-search activities, (c) qualitative-evaluation activities, (d) quantitative evaluation activities, (e) product selection forecasting activities, and (f) sales forecasting activities. The goal was to identify decision process or the inputs, functions, mechanisms, constraints, outputs, and interrelationships of activities. The researcher built a practical-use assortment-planning model through taped and transcribed interviews. Validation of the practical-use model was accomplished with follow-up interviews. Kang reported that, when making decisions, retail buyers are more concerned with styling, fashionability, color, and product distinctiveness. Additional research proposed by a participant in the study included studies to explore the differences among buyers and other decision-makers in style, color, and size of apparel choices.

Kang (1999) found that differences existed between the defined conceptual model and the practical-use model. Kang discovered that organization and ease of use, facilitated by classifying the model into functional activities, streamlined the model and made it more acceptable to participants in her study. Participants in the study also suggested the removal from the model of information search activities that were conceptually feasible but too time consuming for actual implementation. The researcher identified that merchandising concepts, evaluation concepts, and opinions were regarded as valid qualitative evaluations used during decision-making by apparel buyers; however, no formal evaluation form was used by buyers to record this information. Kang recorded a limited use of quantitative analysis methods for sales forecasting data during the decision-making process (e.g., decomposing and regression analysis). Kang's 1999 research supported her earlier research (1995) that during product selection a psychological conjunctive selection rule was employed. In this decision making process, a first set of parameters was identified followed by additional parameters (e.g., First: identify merchandising concepts, key items, price and quality range, Second: eliminate alternative products and select best products per evaluation results).

Computer Usage in Apparel Industry

Collier and Collier (1990) completed a study that reviewed the rapid developments of CAD, CAM, and Computer-Aided Engineering (CAE) and their potential application in the apparel industry. Collier and Collier discussed the earlier use of 3D representations of draped fabric based on 2D CAD systems. The discussion contained individual reviews of the three areas and provided information of the linkages possible and those in place, using the technology. Collier and Collier provided a discussion of the implications of these developments on clothing and textiles education areas (i.e., curriculum development) along with recommendations for additional and future research. The recommendations and applications discussed by the authors were of a generic nature and did not specifically apply to the area of apparel design process with reference to the selection of fabrics or the application of color.

Venkataraman (1992) completed a study of 40 companies of varying size that identified the utilization of CAD graphics in the textile and apparel product development process. The areas of design and marketing were the main focus of the study. Venkataraman also determined the effects of CAD graphics systems on the textile and apparel industry. Implementation of Kaufman's problem solving process for needs assessment was assumed by the researcher in terms of the *best fit* for individual company requirements (Kaufman & English, 1979; Venkataraman). Venkataraman found that some departments in companies, in the study, utilized different CAD graphics systems, indicating that there was no one solution for the varied requirements in this area. She hypothesized that use of differing CAD graphics systems would also indicate evaluation of performance effectiveness based on special department requirements. Venkataraman identified textile design, colorations, and sketch colorations as the major uses for CAD graphics due to the cost and time requirements for these areas in the apparel product development process. Future needs and requirements for CAD graphics systems were identified as systems that improved color control, provided better matching and selection, and enhanced printer resolution, along with increased speed and printer capabilities. Additional research was recommended to compare CAD systems, training outcomes, and CAD graphics interface applications. Venkataraman also recommended the completion of longitudinal studies for CAD utilities in the industry.

Bean (1994) investigated job satisfaction of 102 US textile and apparel designers with CAD technology. The study also explored the relationships between: (a) personal demographics, (b) job features, (c) CAD use, (d) employer characteristics, and (e) designer attitudes towards CAD in the fashion industry with job satisfaction levels. Participants were selected from Fabricad Update subscription lists. Data were collected using self-administered mail questionnaires. Bean found that statistically significant relationships existed between job satisfaction levels and personal demographics, job features, and attitudes. However, a statistically significant relationship was not found to exist between job satisfaction and CAD use or employer characteristics (Bean). Regression analysis was used to identify and quantify contributions to job satisfaction. Though job satisfaction levels were slightly above average, general satisfaction levels and attitudes contributed more to job satisfaction levels than personal demographics. Future recommendations included studies to determine correlations between job satisfaction and job performance and effects of CAD usage on job satisfaction. Additional research is also recommended to identify the thought processes, tasks, and skills required for designer/patternmaking positions and industry environments.

Wimmer (1995) completed an exploratory study using qualitative and quantitative techniques. Wimmer compared the efficiency levels of AutoCAD/ApparelCAD and Lectra systems available in the apparel design curriculum for a particular university. Research was conducted on student participant attitudes and preferences towards CAD AutoCAD/ ApparelCAD and Lectra system. The researcher also investigated the current use of CAD systems at other universities with apparel design programs. Lectra was found to be the preferred system by students, and most universities preferred microcomputers versus CAD systems due to cost constraints. Participant satisfaction levels, attitudes, experience, and demographic data were collected for analysis, and participants were found to have positive attitudes towards CAD computer usage for apparel design and production. Wimmer also collected data on implementation and integration challenges and procedures. Wimmer recommended additional research be conducted to measure efficiency levels of CAD systems in other disciplines for comparative purposes. She also recommended studies that explore transfer of knowledge from AutoCAD to educational programs and industry CAD systems and comparison studies of supplemental design software with AutoCAD and industrial CAD systems for apparel manufacturers.

Color and Fabric Presentation Options

Swatch cards are used by most apparel designers to select fabrics; however, due to the small size of the swatch cards, designers must also order short cuts (3 to 5 yards) to make test garments (Frings, 1999). Swatch cards contain a collection of current available fabrics in the potentially available colors and patterns for a particular season. Peltz (1980) stated that bi-yearly production of swatch cards by textile fabric mills is the norm for distribution to potential consumers (e.g., apparel designers). These cards are used as projections for the new trends in the upcoming seasons based on voluminous amounts of research (Frings). Not every color on a swatch card is changed for every season. Some colors are recycled and are used as a base for the next season.

Fabric simulation. Breen, House, and Wozney (1994) reported that previously conducted research demonstrated 3D cloth-like structures for depicting bending, wrinkling, tear, and drape. Various researchers, such as Dhande, Roa, and Moore (1993), Feynman (1986), Haumann and Parent (1988), and Terzopoulos and Fleischer (1988) conducted this type of research. However, the previous research for drape behavior of fabric was not based on actual physical units of fabric properties (e.g., weight, flexibility). Mechanical information about fabric properties was not available in the computer database for queries; therefore, the necessary fabric property information was not readily available for incorporation into previous simulation models. Without this refinement of the models, the simulations were not acceptable for simulation of large-scale fabric samples nor generalizable for generic fabric sample simulation production.

Breen et al. (1994) completed research that explored the prediction of woven fabric drape using computer simulation. The process involved the use of KES for the collection of empirical mechanical data from actual fabric samples. Kawabata bending and shear data for fabric samples were used to develop energy equations for the model. Validity of the model was verified by the comparison of simulation of the sample drapes to actual sample drapes. Comparisons were made through a review of photographs for actual sample drapes and computer visualizations of simulated sample drapes. Camera angles for the photographs were selected for best presentation of unique draping characteristics of each sample. The Kawabata shear and bending test results were recreated through simulation.

Breen et al.'s (1994) research only provided a model for simulating large-scale draping behavior for specific types of fabric. Due to the unique outcome of fabric drape for each repetition, the exact replication of all possible fabric drape combinations is almost impossible. A change in a single fabric property would require recalculation of all inputs.

Examples include the impact of fabric with high electrostatic propensity, when two areas of the fabric are close enough together to interact. Another example is the change of drape due to the flexibility of the fabric in areas of bias (true diagonal) orientations in relationship to viewing angle and perspective. However, a simulation of draping tendency was possible. The current model produced soft folds instead of the sharp creases and edges generally seen in simulated draped fabric. Time constraints for the model included a general run-time of 1-CPU week, which was an indication of the massive amount of time required to run such large programs. Most software programs use CPU time measured in minutes, seconds, or parts of a second. Also a more objective comparison of the simulation and actual results needs to be completed using drape coefficients for the samples. Drape coefficients are calculated based on the ratio of the area of the draped fabric's shadow to the area of shadow if the fabric is rigid (Merkel, 1991). This quantitative comparison would be more objective than the visual comparisons made in the study.

Volvino, Courchesne, and Thalmann (1995) conducted research to test a simulation model that effectively and efficiently reproduced a number of deformation situations. These situations included crumpling, high deformations, wrinkling, friction, and motion. The authors developed a model that allowed the integration of various sources for motion animation development. Random wrinkling and deformation was accomplished using collision detection algorithms which validates the model and verifies numerical stability. Streamlined fabric assembly and simulation was accomplished by the use of 3D mechanical simulation of imported 2D panels. This research supports and portrays the current capabilities for generation of simulated apparel products shown in motion on a simulated body. The successful assembly and simulation of imported 2D panels demonstrates the possibility of using flat pattern pieces to portray 3D renditions of the same item on a stationary form. That form can also be shown in motion for more realistic demonstration of apparel product fabric simulations and their interaction and reactions on a human form.

According to earlier studies, the necessary technology has been developed for the computer automation of the apparel product design process. Breen, Eischen, Kass, Thalmann, and Vecchione (1997) conducted a symposium forum during the 1997 SIGGRAPH Annual Conference. Participants discussed the reasons why fabric and apparel design has not become fully computer automated. A primary issue, related to the topic of discussion, included fundamental technological barriers (e.g., CPU run-time requirements for simulation processing) for deployment of computer technology in areas of product development. Additional related issues included requirement for better user interfaces, importance of realism, demands of computer-based manufacturing, resistance to computerization, and cost restrictions.

Perceptions of 2D and 3D communications. At the time of Miller's (1994) research, he reported that guidelines for 3D displays were not fully developed. These guidelines were for structuring 3D displays to achieve the most effective communication possible. Miller's research focus was the investigation of whether 3D viewing of information were task specific. Twenty-four university students, 12 female and 12 male, between the age of 17 and 25, were paid $5.00 per hour for participation in the study. Participants were screened for acuity, phoria (e.g., ability to fuse multiple retinal images), and stereo vision prior to final selection for participation in the study. Miller provided twelve component tasks in 2D and 3D formats. The twelve tasks were structured to measure detection, discrimination, recognition, and perception of the six basic components of visual space perception. Those components were: (a) perception of distances between objects, (b) prediction of future object positions based on past positions over time, (c) perception of object dimensions, (d) perception of absolute distances between two objects or object and viewer, (e) perception of relative distances between two objects, and (f) identification and discrimination of objects based on shape and orientation. Performance data were collected for viewing time, accuracy percentages, and generic mental effort for completion of exercise. Miller also found that the use of 3D viewing could improve perception and communication of 3D information and that use of 3D viewing is task specific. Miller found that in his study object tracking prediction and object recognition were not improved by the use of 3D viewing, and participants showed a significant decrement in observation.

Miller's (1994) study can have implications for the use of 3D imaging in the apparel industry. Currently potential color specialists are tested in areas of color perception prior to hiring. The use of 3D imaging also requires additional tests in terms of acuity, phoria, and stereo vision perception to effectively work in color simulation and management positions (personal communication, Dan Randall, October 13, 1999; Roland L. Connelly, Sr., October 14, 1999). Many of the detailed explorations of the visual and perceptual requirements for 3D viewing and imaging of fabrics and apparel products have been conducted to identify thresholds for accurate portrayal of colors on varying fabric components and trimmings (e.g., sewing threads, embellishment threads, zippers, buttons, linings).

Geissler (1998) explored the communication effectiveness of the World Wide Web (WWW) as an advertising medium. Geissler investigated which design elements and combinations contribute to the perceived complexity of WWW home pages and the relationship between perceived complexity of WWW home pages and communication effectiveness. Focus groups were used to support development of hypothesis and propositions and a pilot test were used to refine and update the questionnaire and stimuli design. Telephone interviews were used to identify key factors in Web site complexity, design, and effectiveness. The researcher found that home page size, number of graphics, links, and motion influence home page complexity through the identification and analysis of WWW home page attributes. The research also identified that perceived complexity of home pages increase with an increase in the number of links and that there is significant interaction between home page size and the number of graphics (Geissler). Experimental research was conducted to test Berlyne's Theory of Stimulus Complexity. Results were that communication effectiveness was higher for home pages with perceived moderate ranges of complexity than for less complex or more complex home pages through the exploration of attributes and computer experience (Geissler).

Costs and benefits. Gilbert (1995) prepared a special report outlining the benefits of automating the design process through the use of CAD systems. Participants were 15 manufacturers that had recently automated the design process. The participants were questioned about the benefits of CAD systems and were asked to provide recommendations for successful implementation of the technology. The results included specific information about fabric development and fabric choices. Benefits recorded included reduction in time requirements, enhancement of creativity, perfect presentation, and improvements in quality. Gilbert also reported timesavings through the use of illustrations of concept lines without sample generation. This streamlining promoted early numbers for key account forecasting, which facilitated reduction in lead times and overruns. Reduction of the conceptual design phase along with merchandising and sales graphic presentations for fabric styling and colorways also reduces lead times. Line or product color changes were reported in record time, minutes instead of hours or days. Participants reported that the automated process also facilitates multiple updates and quick changes for line or product color. Participants in the study also reported that enhanced creativity levels were achieved by increasing drawing and rendering capabilities over manual preparations of the same products.

Gilbert (1995) also stated that cost cutting benefits were possible due to a reduction in artwork costs. With the advent of current technology, production of realistic renderings for presentations and marketing purposes is possible through development of the full product concept and technical illustrations. Gilbert reported that quality benefits include increased precision and more control over designs. Providing additional control during the design phase is important in the area of prints and yarn dyes because these decisions are made early in the production process. Participants also reported the bonus of creating textile concepts and specifications for printing and dyeing guidelines by mills. Implementation recommendations provided by participants in the study included: (a) tailoring to consumer needs, (b) following vendor specifications, (c) selection of the best operator, and (d) adequate training.

The study conducted by Gilbert (1995) was restrictive in the numer of participants and therefore is not generalizable.The study may also contain inherent bias in the area of CAD implementation because the researcher was a vendor and the study may have included a restrictive sample of only consumers with no problems or complaints. Validity and reliability justifictions were not reported but may have been in place for the study. However, the provision of implementation recommendations is helpful especially from the perspective of industry operations that have completed implementation of this technology and for the enumeration of potential benefits for technology implementation.

In summary, Moreland (1997) provided an overview of CAD technology presented at the 1997 Bobbin Show. The Bobbin Show sponsors a forum for the exchange of business and technology issues and advances in the apparel and sewn products industry (Black, 1998). Technological advances in the area of CAD integration in production and merchandising were reported. Moreland reported that systems are available to coordinate from the overseas production process to virtual store layouts and 3D concept to merchandising planning along with networking data management systems for the design process and the creation of virtual collections and catalogues. In the area of color and texture, Moreland reported new developments in productivity and color capabilities and texture applications with enhanced gradation capabilities. Patternmaking advances were also showcased at the 1997 Bobbin Show. These advances included use of 2D drawing systems for critical pattern measurement data communication and the automatic generation of patterns from measurement tables.

Although computerized methods for some aspects of the design process are available, manual color and fabric presentation options are still the preferred method for the communication of information as reported by Frings (1999) and Peltz (1980). However, costs and time constraints are pressing designers, manufacturers, and retailers to find more efficient ways to develop products. With Paek’s (1985) findings that the effect of vision perception of textiles was insignificant, weight is added to the concept of using automation for communication of color and fabric presentations. Research to identify presentation methods that would convey the preferred information required by designers is generally supported by Breen et al. (1994, 1997) and Volvino et al. (1995). Results of these explorations can be used to define and refine guidelines for viable use of 3D capabilities in the apparel industry as reported by Breen et al. (1994, 1997) and Volvino et al. (1995). A major deterrent to the adoption of computer automation of the apparel product design process, as noted by Breen et al. (1994, 1997), is cost constraints. Computerization of color and fabric choices is proposed as acceptable to designers if the method for automated communication had reasonable cost requirements, was technologically compatibility with industry automation/computer capabilities, and was user friendly (Gilbert, 1995; Moreland, 1997). This study examined current and future technology for color and fabric presentation options with presentation methods that are easy to use and relatively low cost. Manual and automated color presentation options were included in the study for evaluation.

Chapter Three
Methods

Introduction

The purpose of this research was to assess the current and future options for fabric and color in the design process. This identification will help to record if the current practices for apparel design are congruent with the current available technology and estimated future technology capabilities, and to extend the knowledge of the tools used and decisions made in the apparel design process.

Color and fabric selections in the apparel design process can occur as early as two years prior to product release date. Reduction in the development and production time frames would facilitate initiation of the apparel product line development process closer to product release dates and be a major contribution to the apparel product development process. Shorter creation and production time frames reduce risks for estimation of consumer requirements. Promotion of teamed research efforts for exploration, implementation, and refinement of color technology are beneficial to the computer, graphics, and apparel industries. Exploration of future technological advances in the area of color for coordination efforts for consumer qualifying factors and identification of training requirements for curriculum updates area are a major contribution to academia.

The objectives of this research were to: (a) identify current manual presentation options for fabric and color in the design process, (b) assess viability of current manual presentation options for fabric and color in the design process, (c) identify future automated presentation options for fabric and color in the design process, (d) assess viability of future automated presentation options for fabric and color in the design process, and (e) compare viable manual (current) and automated (future) presentation options for fabric and color in the design process.

This chapter describes the research design, operationalized variables, sample characteristics, scenario, instrumentation, data collection method, and data analysis used in the study.

Research Design

This study used a preexperimental research design. The design was modified to include a treatment, with four levels, which was administered to the participants, and qualitative analysis was used as a methodology for obtaining valuable information from the identified industry experts and facilitated the collection of information from the perspective of industry persons directly responsible for the selection and implementation of color in the design process. All four color and fabric presentation options were administered to all participants. A preexperimental research design does not require a control group for the comparison of the results obtained from participants (Cresswell, 1994).

Qualitative research is well suited to explore problems where the results will increase knowledge and understanding by identifying a range of behavior. Ely, Anzul, Friedman, Garner, and Steinmetz (1991) provided a guide for conducting qualitative research, which was used in this study. The publication is formatted as an integrated flow process that highlights the research process and deals with *how people feel and what they learn* as they explore the process of qualitative research. This information is communicated by documenting the procedures for teaching qualitative methodologies. Individual chapters deal with the following steps in qualitative research: (a) starting, (b) doing, (c) feeling, (d) interpreting, and (e) reflecting, which suggest a step-wise procedure for research.

Qualitative research is generally partitioned into two main categories: interpretational analysis and structural analysis (Tesch, 1990). A researcher uses a structural analysis research focus to accomplish problem solving; therefore, this qualitative analysis was used as the methodology for collecting data from the identified industry experts. The treatment, which included four levels, was administered to all participants in the study. Collection of information from the perspective of industry persons directly responsible for the selection and implementation of color in the design process is important for a structural analysis. The participants viewed color and fabric presentation options. Questionnaires were employed to collect research data pertaining to participant response. A generated scenario was also developed to provide boundaries for the application of the color and fabric presentation options in the study. The purpose of the scenario was to provide a standard frame of reference for the review of the provided color and fabric presentation options. The instrument and scenario were pilot tested to provide face validity of the instrument and scenario and to refine the instrument and the scenario (Creswell, 1994).

Sample

Sample selection of the study included the use of judgmental sampling technique that was a non-probability sampling technique. A judgmental sample is a sample selected by a researcher based on judgment criteria (Zikmund, 1994). The goal of the research was to collect information on the use of color and fabric presentation options, both manual and automated, from the perspective of those responsible for making color and fabric decisions in the apparel product development process. For this reason, only specific industry personnel were selected; therefore, judgment-sampling criteria was justified. Judgmental sampling criteria was determined to set sampling borders based on the research objectives to understand phenomena about select cases (Vass & Kincade, 1999; Zikmund, 1994).

Malhotra (1999) defines judgmental sampling as a form of convenience sampling where population elements are selected based on the judgment of the researcher. To offset the problem of sampling validity due to sample size and purposive selection, judgmental sampling criteria are set in terms of the research objectives for this study. Judgmental sampling may be used when the selected elements are representative of the population of interest. Kang (1999) detailed judgmental sampling criteria parameters by the research objectives to increase sampling validity. Stanforth and Lennon (1997) used a sample of female participants with an average age of 24, enrolled in human ecology programs, from 2 midwestern universities. This population was selected because the researchers believed that the sample was: (a) a significant market segment, (b) very concerned with clothing, and (c) spends more money as a group than it saves. The focus of the study was the effects of consumer expectations and store policies on retail salesperson service satisfaction and patronage levels. Vass and Kincade (1999) also reported that the use of judgmental sampling criteria is justified when the goal is to understand phenomena about select cases. Workman and Johnson (1993) used a judgmental sampling technique to select a college student population. The authors believed that college students would exhibit many characteristics associated with fashion leaders and fashion innovators. The study identified the relationships between the need for variety and consumer groups (i.e., fashion opinion leaders, fashion innovators, innovative communicators, and fashion followers). Caldwell and Workman (1993) used fabric retailers as the sample population for a study to test the concept of customized patterns. This population was selected due to their interest in customized patterns and support capabilities.

The qualitative judgment criteria established for this study was based on apparel industry research conducted by Kang (1999), Regan, Kincade, & Sheldon (1998), and Vass and Kincade (1999). Judgment selection criteria selected for this study included: (a) company type to focus on select industry areas responsible for product development; (b) computer access of participants to identify and partition active technology levels; (c) participant's responsibility in product design process to concentrate on participant's responsible for color and fabric selection decisions; and (d) participant's job experience to identify areas of expertise in color and fabric selection decisions.

Company type for participation in the study was designated as manufacturers of the following merchandise types: (a) apparel, (b) fashion accessories, (c) textiles, (d) interior fashions, or (e) other components for production of products. Vass and Kincade (1999) used a wide array of textile products to provide contrasts represented in the industry. Computer access by the participants was required for participation in the study to allow for the evaluation of the automated color and fabric presentation options included in the study. The minimum computer access requirements included the following: (a) PC or MAC based system, (b) SVG color monitor, (c) 16M RAM, and (d) 3.5" disk capacity as recorded by Geissler (1998).

To ensure that the participants' job responsibilities were inclusive of activities within the study's parameters, selected job titles were used. Participants eligible to participate in the study included one of the following job descriptions: (a) design director, (b) designer, (c) assistant designer, (d) product developer, (e) colorist, (f) stylist, (g) illustrator, (h) merchandiser, (I) CAD operator, (j) CAD manager/coordinator, or (k) other position description that includes the responsibility of selecting color during the apparel design process (Bean, 1997; Regan, Kincade, & Sheldon, 1998). A minimum baseline for level of expertise and understanding of the company's policies and procedures during the apparel product development process was implemented. This criteria was used by Kang (1999) and was noted by her as important to have knowledgeable participants. Participant's job experience was restricted to those employees that have a minimum of 3 months job experience at the current employer to support increased knowledge of the employer's design process. A major assumption in the research was that participants had sufficient visual, acuity, and phoria skills to participate in the study. This assumption was presupposed based on the participant's job experience and required skills. Final selection for participation in the study was based on the following characteristics: (a) companies' willingness to participate in the study and (b) satisfaction of the minimum computer access requirements.

<u>Selection Method.</u> Identification of companies for potential participation in the study was accomplished through the following procedure (a) background information search and (b) phone communication with apparel companies. The researcher conducted background information searches by reviewing the most recent American Association of Textile Chemists and Colorists (AATCC) Directory, the Bobbin directory listing for top apparel manufacturers, and Virginia Polytechnic Institute and State University, Department of Near

Environments Alumni Directory for industry contacts. The researcher contacted key executives identified through the directories and listings using telephone, mail, and email communications to ascertain their willingness to participate in the study. Communication with the key executives included an explanation of the purpose, scope, and research objectives of the study. Top management was contacted for identification of employees who were involved in the apparel design process with regards to the identification and determination of color for an apparel line. Owens (1992) and Vass and Kincade (1999) used this selection method with excellent participant return rates. Confirmation of the researcher's status at Virginia Polytechnic Institute and State University was also provided to participants, along with a University approved application from the Institutional Review Board for Research Involving Human Subjects (IRB).

Owens' (1992) method/format for documenting the process for presentation of response rate information is useful. The original population profile was presented with identification of selection criteria and context methods used for selection. Adjusted population information was presented, followed by the adjusted sample response rates and the results of communication efforts (i.e., nonreachable, wrong number) employed. Owens used membership lists of academic, trade, and industry sources to provide a comprehensive list of internationally involved textile and apparel companies. The level of international involvement was verified through telephone communication. Qualified companies, based on the level of international involvement and number of expatriate employees, received questionnaires. The response rate for the study was 93% and was attributed to the use of prenotification correspondence, questionnaire distribution, follow-up telephone communications, and callbacks by the researcher.

Size. The sample size for the study was dictated by the number of positive responses received after initial contact for participation to facilitate completion of research in a timely manner and to allow for the completion and analysis of the detailed questionnaire (see Table 1). Timeliness was important because of the rapid change in technology The study contained 13 participants. Some potential participants were eliminated because they lacked the necessary hardware and software. Although the lists used were current some of the sample population were non-reachable, after repeated calls and/or emails.

Table 1

Presentation of Population Adjustments and Final Sample Size

	Number	Total Eligible
Sample Population	---	61
Not Qualified	---	11
Hardware/Software Deficiencies	1	---
Experience Deficiencies	10	---
Non-Reachable	---	27
Wrong Address & Number	11	---
No Answer	16	---
Adjusted Population	---	23
Time Constraints	3	---
Adjusted Sample Size	---	20
Non-Response	7	---
Total Response	13	---

Operationalize Variables

Apparel design process - Regan's (1997) Phase I, *as is* environment model: (a) create apparel line, (b) develop colors and prints, (c) implement fabric design and special operations, (d) create garment pattern and prototype, (e) set production specifications, and (f) produce samples.

Automated color and fabric presentation options - 2D simulation swatch sample and 3D simulation swatch sample with animation

Decision making - Evaluation of alternatives by an individual using a complex cognitive process to select a course of action (Kang, 1999; Sanders & McCormick, 1993)

Design - A process change through a defined process that satisfies a want or need (Blaich & Blaich, 1993; Lewis & Samuel, 1989)

Manual color and fabric presentation options - Fabric swatch and printed swatch card (Frings, 1999)

Scenario

Kang (1995, 1999) documented the use of the conjunctive selection rule by apparel buyers for decision-making in the apparel buying process. The conjunctive selection rule utilizes a stepwise or building block approach to decision-making. The first level parameters are identified and used for decision-making; succeeding levels are identified with additional parameters, continuing until the final decision level is reached. The decision-making levels used in this study included: (a) design process model selection, (b) product selection, (c) identification of product details and costs, (d) scenario development, (e) scenario communication and presentation, and (f) fabric presentation option selection. Parameter level tasks (a) through (e) are the responsibility of the researcher, and the final parameter level is the responsibility of the participant. In this research, the final decision level (level f) was the selection of fabric for the use in a design product.

For the present study, the researcher reviewed current research literature for the product design process. The researcher used a synthesis of the apparel design process models reported by Regan, Kincade, & Sheldon (1998), Kang (1999), and LaBat and Sokolowski (1999) to develop a design scenario. Exact design details and costs were based on discussions with current product designers and researcher's experience.

This design scenario was presented to the study participants to supply a context (or parameters) for the evaluation of color presentation options. The design process model presented in the development of the scenario was *descriptive*. Participants were expected and encouraged to use their previous experiences and current knowledge for the application of a solution to the proposed scenario. Cross (1984) identified most clothing design process models as *prescriptive* as opposed to *descriptive*. Prescriptive models are used to explore and encourage development of better working methods. Prescriptive models subscribe to thorough investigation during the early stages. These models place solution adoption at the end of the process. Descriptive models use previous experience, general guidelines, and rules of thumb. This approach generally leads designers in the right direction but do not promise guaranteed success (Cross, 1989). Descriptive models are harmonious with the conjunctive selection rule.

The participants were required to evaluate color and fabric characteristics information and fabric sample attributes from the provided presentation options in the study. Two scenarios, apparel and interior industry focused, were developed for distribution with the instrument. The apparel product scenario was distributed to apparel industry participants and the interior scenario was distributed to interior design industry participants. The apparel product was a Misses front button blouse, with ¾-length sleeves, front and back princess darts, with scoop neckline (see Appendix A1). The apparel product was based on a review of 10 Ws, a noted fashion publication. The retail cost for this item was $35.00. Style features and cost were based on average production products for a Moderate line of Misses apparel.

The interior product was an accent pillow, 19” square with a 3” flange, polyester fill, spot clean care, and had a retail price of $19.00 (see Appendix A2). The interior product was based on the standard styles and features for an average Moderate line interior product. The interior product was based on a review of 12 Internet Home Page locations for home accessories. Line drawings of the respective products were provided for participant review. When the participants received the package, the colors and fabric had not been selected for the product. This task was the remaining design decision in the design process and the focus of this study for participants. Based on the presentation options, the participants were to make selection decisions for use of this fabric for the prescribed product.

<u>Presentation Options</u>

Color and fabric presentation options included the following: (a) fabric swatch, (b) printed swatch card, (c) 2D simulation swatch sample, and (d) 3D simulation swatch sample with animation. This range of options included two current presentation formats, most commonly used in the apparel industry, and two future presentation options, as proposed by fabric providers. Fabric samples are the presentation options preferred by designers, followed by printed swatch cards, because of the wealth of information that they convey. Fabric samples provide the opportunity to review the weight, drape, thickness, compressibility and recovery, along with fabric stiffness information. Printed swatch cards provide detailed color and pattern information. Future technologists promoting simulation presentation options, claim that designers can obtain in-depth information from a simulated sample that is adequate for the selection of fabrics for incorporation into apparel production lines (Roland L. Connelly, Sr., October 14, 1999).

Pettersson (1989) defines visuals as icons that resemble what they represent. The goal for the visual in this study was to convey information via a representation of a particular fabric presentation option. With a visual, the participant should have been able to obtain a reasonable and usable representation of reality (Pettersson). Estimated reasonable and usable representations of the selected fabric were provided to the participants as 2D simulation swatch samples, 3D simulation swatch samples with animation, and printed swatch cards. Simulation samples of 2D presentation options were created by the researcher using color imaging scanning hardware and software, and enhanced using PhotoShop software. For the swatch card, the scanned image was printed to photographic quality paper using an Espon Stylus Color 600 Printer. The scanned image was recorded on CDs for distribution. Simulation samples of 3D presentation options were compiled by the researcher using digital videotapes of the sample fabric and converted to movie format with QuickTime software. The video image was recorded on CDs for distribution. All participants viewed the presentation options in the following order: (a) 2D simulation swatch sample, (b) 3D simulation swatch sample with animation, (c) printed swatch card, and (d) fabric swatch.

The manual presentation options were formats (i.e., printed swatch card and fabric swatch) that did not require hardware or software augmentation or interaction for use. Fabric sample presentation options were constructed using sample fabric. Samples were labeled with fabric name, weave, content, width, pattern repeat, weight, thickness, stiffness, and drape information. Printed swatch cards were generated using scanned files of the selected fabric that were manipulated using PhotoShop software for retention of true color and printed on photographic quality paper for distribution. Automated presentation options consisted of 2D and 3D simulations of sample fabric. The 2D simulations were compiled using scanned files of sample fabric and recorded on CD-ROM. The 3D simulations were compiled using a digital video camera files and recorded on CD-ROM for distribution.

All presentation options were prepared from an identical control fabric. Fabric characteristics were provided to the participants when they reviewed the manual presentation options. The following characteristics for the sample fabric will be provided on the presentation options: (a) fabric construction, (b) fiber content, (c) width, (d) pattern repeat length, (e) weight, (f) thickness, (g) drape coefficient, and (h) fabric stiffness. These characteristics are typically provided by textile manufacturers to apparel designers.

The selected control fabric was a woven, 70%/30% Dacron®/polyester blend with a slub. Selection of fabric with the above listed characteristics was similar to the standard fabrics used in the apparel industry for the selected apparel product. The length of the fabric was provided, along with the cut width parameters and the pattern repeat length. Fabric weight for the control fabric was provided in mg/cm^2 in compliance with ASTM D3776-85, Standard Test Method for Mass Per Unit Area (Weight) of Woven Fabric. Fabric thickness was calculated in compliance with ASTM D1777-96. The drape coefficient as an indication of the capability of the yarns to readjust position under stress was calculated for a 10"x10" sample. Fabric stiffness was calculated using the cantilever test in compliance with ASTM D1388-96, Option A. These tests helped to identify the functional aspects of the Functional, Expressive, and Aesthetic (FEA) framework developed by Lamb and Kallal (1992) for the explanation of the design process. By identifying physical characteristics of the fabric that will affect the end products' use and performance, risks are reduced during the selection/rejection process for suitable fabrics for the proposed product.

Instrumentation

The instrumentation used to collect data consisted of a two-part questionnaire and the color and fabric presentation options. The questionnaire was used to record information on the current manual and automated presentation options for fabric and color in the design process (see Appendix B3). Questions, pertaining to the review of the four color and fabric presentation options, were used to record previous experience, evaluation and preference data on the presentation option reviewed along with a design process model. Additional questions were used to collect data pertaining to the participant's position and job experience, computer experience, company information, demographics, and job satisfaction level. The instruments of Wimmer (1995), Vass and Kincade (1999), and Venkataraman (1992) used to collect data from CAD operators and supervisory personnel using computers for apparel design and production provided guidance for compilation and structure of this study's instrument. An overview of the variables in the research is provided in Table 2.

Presentation option review questions. This portion of the questionnaire was used to collect data on the participant's experience with each presentation option, information conveyed, evaluation of presentation format attributes, presentation option preference, along with discontinuation ratings. Guidance for collection of past experience variable structure was adapted from variables used in a study conducted by Bean (1997). Nominal and ratio measures were used to record this information (see Table 3).

The variable used to record conveyance of presentation option characteristics information was structured utilizing a five-point Likert-type scale. This variable was used to record ratings for conveyance of color (i.e., hue), shade (i.e., light variations, tints, values), and brightness (i.e., intensity, paleness), along with fabric aesthetic terms adapted from Bean's (1997) research (see Table 4). This variable was used to record how well the presentation option presents usable data. Usable data was defined by previous research data that is necessary for decision-making during the design process (Bean; Regan, Kincade, & Sheldon, 1998).

A Likert-type scale was used to collect attribute data evaluation on the presentation option (see Table 4). The attribute terms and scaling were adapted from an instrument used by Geissler (1998). Geissler completed research that identified WWW home page attributes for analysis of complexity levels and best-fit characteristics for marketing purposes. Apparel industry words that describe physical and psychological characteristics of fabrics were used

Table 2

Overview of Variables in the Research

Variable Area	Source	Variable Number
Presentation Option Reviews 1, 2, 3, and 4		
Previous Experience	Bean 1997	1, 2a-d
Information Conveyed and Attributes Evaluation	Brand, 1964; Geissler, 1998	3a-j, 4a-j
Color Verification	Brand, 1964; Geissler, 1998	5,6
Sufficient Decision Information	Geissler, 1998	7a-b
Preference and Discontinuation	Geissler, 1998; Kang, 1999; Sanders & McCormick, 1993	8, 9a-d
Color & Fabric Time Requirements	Regan, Kincade, & Sheldon, 1998	10, 11
Apparel Design Process Model	Kang, 1999; Regan, Kincade, & Sheldon, 1998	12a-c
Work & Personal Demographics		
Section A – Job Information	Bean, 1997; Kang, 1999; Regan, Kincade, & Sheldon, 1998; Venkataraman, 1992; Wimmer, 1995	1, 2a-b, 3, 4, 5, 6a-b, 7
Section B – Computer and CAD Experience	Bean, 1997; Geissler, 1998; Venkataraman, 1992; Wimmer, 1995	1, 2a-j, 3, 4, 5a-g, 6, 7, 8, 9a-l, 10a-j, 11a-aa, 12a-b, 13a-p, 14, 15, 16
Section C – Computer Equipment	Geissler, 1998	1, 2, 3, 4
Section D – Company Information	Bean, 1997; Venkataraman, 1992; Wimmer, 1995	1, 2, 3, 4, 5a-c
Section E – Demographics	Bean, 1997; Geissler, 1998; Venkataraman, 1992; Wimmer, 1995	1, 2, 3, 4, 5

Table 3

Previous Experience Variables for Presentation Option Review 1,2,3, and 4

Variable	Source	#	Measures
Presentation Option Review 1, 2, 3, and 4			
Presentation Option Experience	Bean, 1997	1	Nominal
Presentation Option Past Use		2a-d	Ratio

Table 4

Information Conveyed Variables for Presentation Option Review 1,2,3, and 4

Variable	Source	#	Measures
Presentation Option Review 1, 2, 3, and 4			
Presentation Option Information Conveyance	Brand, 1964	3a-j	Ordinal
Presentation Option Attributes Evaluation	Geissler, 1998	4a-j	Ordinal

to measure participant perceptions of information conveyed by the presentation options, using a five-point Likert-type scale (Brand, 1964). Participant perceptions of the color and shade designations for the individual presentation options were also recorded to compare participant color and shade identification capabilities (see Table 5).

Table 5

Color Verification Variables for Presentation Option Review 1, 2 ,3, and 4

Variable	Source	#	Measures
Presentation Option Review 1, 2, 3, and 4			
Color	Brand, 1964, Geissler, 1998	5	Ordinal
Shade		6	Ordinal

Geissler (1998) also identified key factors needed for home pages in Web site complexity, design, and effectiveness. Geissler recorded preference data for effectiveness during the study, facilitating comparisons of complexity and design attributes. Other authors have also used participant perceived preference ratings for the recording of effectiveness levels in terms of complexity and applicability of models (Kang, 1999; Sanders & McCormick, 1993). A four-point Likert-type scale was used to record preference data.

Nominal measures were used to record sufficiency of decision information provided and discontinuance justification information on the presentation option reviewed (see Table 6). Participants were also asked to record comments for decision information.

Table 6

Decision Information, Preference, and Discontinuation Variables for Presentation Option Review 1,2,3, and 4

Variable	Source	#	Measures
Presentation Option Review 1, 2, 3, and 4			
Sufficient Decision Information	Geissler, 1998; Kang, 1999; Sanders & McCormick, 1993	7a-b	Nominal
Current Presentation Option Preference		8	Ordinal
Option Discontinuance Justification		9a-d	Nominal

The variables used to record the standard or usual time designated by participants for color and fabric selection activities were structured based on Regan's (1997) research (see Table 7). Regan reported that an average of 35 colors might be developed per season in the apparel industry with a potential rework requirement of 105 to 350 per season.

Table 7

Standard Time Requirement Variables for Presentation Option Review 1,2,3, and 4

Variable	Source	#	Measures
Presentation Option Review 1, 2, 3, and 4			
Color Selection	Regan, Kincade, & Sheldon, 1998	10	Ratio
Fabric Selection		11	Ratio

Participants were asked to indicate at which decision-making point they would use the current color presentation option under review (see Table 8). This variable was included to collect data on the earliest and latest point for application of the presentation option. Participants used a modified apparel product process diagram adapted from Regan's 1997 research (see Appendix B). Participants were also asked to record any comments they had pertaining to the design process model provided. Kang (1999) documented that activities used during the decision-making process were dependent upon time constraints. These activities were affected by the degree of similarity to other activities at earlier settings during the decision-making process.

Table 8

Design Process Model Variable for Presentation Option Review 1,2,3, and 4

Variable	Source	#	Measures
Presentation Option Review 1, 2, 3, and 4			
Application During Decision–Making Process	Kang, 1999; Regan, Kincade, & Sheldon, 1998	12a-c	Nominal

Employment, experience, and personal demographics information. Sections, A through E, included variables to collect data on job information, computer and CAD experience, computer equipment, company information, and demographics (see Appendix B3).

Section A was used to collect data pertaining to the participant's position and job experience (see Table 9). The variable for current position was included to document the participant's current job parameters. Data were collected on the supervisory experience of the participants, along with the number of employees supervised. Industry and position experience information, including time at current position were also recorded to document the level of expertise of the participant for decision-making in the design process for presentation options. Previous experience data along with time at previous position information and textile and fabric experience were recorded to document previous knowledge that may affect evaluation and use of presentation options (Bean, 1997; Kang, 1999; Regan, Kincade, & Sheldon, 1998; Venkataraman, 1992; Wimmer, 1995).

Table 9

Section A - Job Information Variables for Participants

Variable	Source	#	Measures
Current Position	Bean, 1997; Kang, 1999; Regan, Kincade, & Sheldon, 1998; Venkataraman, 1992; Wimmer, 1995	1	Nominal
Supervisory Experience		2a	Nominal
Supervised Employees		2b	Ratio
Industry Experience		3	Ratio
Position Experience		4	Ratio
Time at Current Position		5	Ratio
Previous Position Experience		6a	Nominal
Time at Previous Position		6b	Ratio
Textile & Fabric Experience		7	Ratio

Section B was used to record data on the participant's computer and CAD experience (see Table 10). Computer experience, type of computer experience, and amount of computer experience were recorded to identify the effect of computer experience on the evaluation and use of the automated presentation options. CAD experience, training, and use data were recorded for the same reasons. Data were recorded for the current CAD responsibilities, and CAD utilization levels were also recorded to identify usage levels of CAD on a daily basis. The purpose was to document if there was an increase in the use CAD technology in the design process. The participants were asked to record the areas in which CAD was used for apparel design and for textile design. Information was also recorded for the type of CAD system utilized, computer software being used, along with type of software (e.g., industry specific; off-the-shelf). Industry specific CAD systems are available along with off-the-shelf software packages, which may be adapted for use in the design process. Data for CAD use history, including the number of CAD stations and number of trained employees were documented to determine prevalence of CAD use in the company. Previous research that reviewed computer and CAD implementation in the apparel process determined that the level of computer and CAD experience and training affected the evaluations and outcomes of research that documented participant preference information (Bean, 1997; Geissler, 1998; Venkataraman, 1992; Wimmer, 1995).

Table 10

Section - B Computer and CAD Experience Variables for Participants

Variable	Source	#	Measures
Computer Experience	Bean, 1997; Geissler, 1998; Venkataraman, 1992; Wimmer, 1995	1	Nominal
Type of Computer Experience		2a-i	Nominal
Amount of Computer Experience		3	Ratio
Total CAD Experience		4	Ratio
CAD Training		5a-g	Nominal
CAD Use		6	Nominal
Current CAD Responsibilities		7	Nominal
CAD Daily Utilization		8	Interval
CAD for Apparel Design		9a-l	Nominal
CAD for Textile Design		10a-j	Nominal
CAD System Utilized		11a-aa	Nominal
Computer Software Use		12	Nominal
Type of Computer Software		13a-p	Ordinal
Company CAD Design Use		14	Ratio
Company CAD Stations		15	Ratio
Company CAD Employees		16	Ratio

Section C was used to record computer equipment data using questions adapted from research conducted by Geissler (1998) (see Table 11). Variables included for this section include computer hardware information such as computer type, memory capability, monitor type, and age of computer equipment. During the study, Geissler found that computer hardware configurations affected the capability of participants to thoroughly and effectively evaluate information conveyed using the computer.

Section D was used to record data on the participant’s company through the use of nominal and ratio measures (see Table 12). The purpose of Section D was to document company information, designer counts, years in business, and manufacturing classification (e.g., US, 807, offshore). Bean (1997), Venkataraman (1992), and Wimmer (1995) documented the impact of company information on participants’ perceived preferences and research outcomes.

Table 11

<u>Section C - Computer Equipment Variables for Participants</u>

Variable	Source	#	Measures
Computer Type	Geissler, 1998	1	Nominal
Memory Capability		2	Interval
Monitor Type		3	Nominal
Age of Computer Equipment		4	Ratio

Table 12

<u>Section D - Company Information Variables for Participants</u>

Variable	Source	#	Measures
Company Merchandise	Bean, 1997; Venkataraman, 1992; Wimmer, 1995	1	Nominal
Total Employees		2	Nominal
Company Designers		3	Ratio
Years in Business		4	Ratio
Company Manufacturing Classification		5a-c	Nominal

Section E (see Table 13) was used to record demographic information of participants (e.g., age, gender, education level). Ratio, nominal, and interval measures were used for these variables (Bean, 1997; Geissler, 1998; Venkataraman, 1992; Wimmer, 1995). Venkataraman found that job satisfaction levels had an impact on the reported perceived preferences reported in her study. Job satisfaction level using a five-point Likert-type scale. Participants were also asked to indicate desire for research results of the completed study.

Selection of these questions was based on demographic questions used in previous research found to be significant factors in operator decisions (Bean, 1997; Geissler, 1998; Venkataraman, 1992; Wimmer, 1995). Bean's (1997) research investigated job satisfaction of US textile and apparel designers with CAD technology. Relationships between (a) personal demographics, (b) job features, (c) CAD use, (d) employer characteristics, and (e) designer attitudes towards CAD in the fashion industry with job satisfaction levels were also explored and detailed in Bean's instrument. Sections A, C, D and E also used factors from previous industry studies (Bean, 1997; Giessler, 1998; Venkataraman, 1992; Wimmer, 1995).

Table 13

<u>Section E - Demographic Variables for Participants</u>

Variable	Source	#	Measures
Age	Bean, 1997; Geissler, 1998; Venkataraman, 1992; Wimmer, 1995	1	Ratio
Gender		2	Nominal
Education Level		3	Interval
Job Satisfaction Level		4	Ordinal
Results Interests		5	Nominal

<u>Validity.</u> The following constructs and procedures addressed the issue of validity, which deals with whether a measure (test) has the ability to measure what it is intended to measure (Zikmund, 1994). Content validity verifies that a scale logically reflects what is intended to be measured (Zikmund). Content validity was improved with direct questions that provided adequate coverage of the following concepts: evaluation of color and fabric presentation options, position and job experience, computer experience, company information, demographics, and job satisfaction levels. These questions were based on wording and structure of previous research on this industry. Criterion validity is the correlation of other measures of the same construct (Zikmund) and whether the measurement scales perform as expected in relationship to selected criteria from previous studies (Malhotra, 1999). Criterion validity was improved through the use of Likert-type scales to record format attribute levels and identify satisfaction levels. Nominal, ordinal, and ratio measures were used to record experience, preference, education, and demographic data. Concurrent validity was accomplished by the collection of all data during the same scheduled timeframe and is a classification of criterion validity in reference to time sequence of data collection (Malhotra; Zikmund). Construct validity was accomplished by the use of a questionnaire based on previous industry research (Bean, 1997; Kang, 1999; Regan, Kincade, & Sheldon, 1998; Vass and Kincade, 1999; Venkataraman, 1992; Wimmer, 1995).

<u>Reliability.</u> Reliability was verified through the use of an instrument package. An instruction package assists the research and researcher with consistent measures that yield consistent results (Zikmund, 1994). All participants in the study received the same presentation options and questions to answer and the order and structure of the package.

<u>Limits.</u> The design and development process model used in this study was an adaptation of the Phase I *as is* Model from Regan's 1997 research. The design and development process model was used in reference to the first functional activity (A1-Create

Apparel Line) identified in Regan's Phase I *as is* environment, with particular regard to the contributing activities for color selection and application during the creation of an apparel product. The focus of this research was the selection of fabric and color by designers during the design process. Research of the development of colors and prints for the production stage, the next functional activity, were not explored (Phase I, Functional Activity A2).

Pilot testing. The instrument and scenario were pilot tested to further improve content validity of the instrument and scenario. Pilot testing is used to refine the instrumentation package to ensure that it adequately measures what it is intended to measure and is compiled in a useable format and structure (Creswell, 1994). Pilot testing was conducted by the distribution of the instrumentation packet to identified apparel designers (n=6) not selected as final participants in the study. Changes were made prior to distribution to the research sample based on the responses and comments received during pilot testing. Instructions were reworded to provide better directions on how to answer the survey. A few questions were reworded according to pilot test feedback.

Data Collection

Methods. In an effort to collect unbiased data from the participants, participants reviewed the 2D-presentation option followed by the 3D-presentation option, then the printed fabric card, and finally the fabric sample option. The order of the presentation options for review was based on the premise that all of the information required to make a fabric selection was provided in each fabric presentation option. As the manual presentation options were more prevalent, review of the automated presentation options occurred before the review of the manual presentation options in order to reduce learned bias. Each presentation option contained sufficient information for the participant to review and evaluate the use of the presentation option in terms of the provided scenario. Each manual presentation option was enclosed in a separate interior envelope labeled to open after completion of the automated presentation options to preclude advance review of the material.

Procedure. Data collection followed the steps listed: (a) instrumentation packet distributed to participants via mail, (b) participants complete review of presentation options, (c) participants complete experience, company information, demographics, and job satisfaction, and (d) participants return questionnaire to researcher using self-addressed, stamped envelope provided.

Time schedule. Table 14 contains the time schedule for the completion of the study.

Table 14

Estimated Time Schedule for Completion of Apparel Product Color and Fabric Presentation Options Study

Researcher	Schedule
Pilot Testing	Two weeks
Identify potential participants	Two weeks
Contact and coordinate participant data collection	Two weeks
Collect data	Two weeks
Analyze data	Two weeks
Total	Eight weeks
Participant	Schedule
Completion of presentation options review Completion of experience, company info, demographics, and job satisfaction	1 hour and 10 minutes
Return of instrument	10 minutes
Total	1 hour 20 minutes

Data Analysis

As the goal of this study was to explore current and future color presentation options, a *descriptive* process were used to analyze and evaluate the color presentation options provided during the study. Descriptive processes can provide information for computing needs assessments (Malhotra, 1999).

Frequency distributions were used to describe and summarize the data collected from the sample, specifically for objectives a, b, c, and d. Frequency distributions indicate the number of occurrences for the variables and define the proportion of each occurrence within the sample (Zikmund, 1994). Frequency distributions also provided the mode (i.e., value occurring most often) and were used to document what had been found. Frequency contingency tables can be used to organize data by groups or categories for comparisons of frequency distributions in two or more variables (Zikmund, 1994). The data were analyzed to identify similarities and designate groups. Descriptive statistics and frequency contingency tables were used to complete the objectives of the study. Specific information for each variable is provided for each objective:

(A) identify current manual presentation options for fabric and color in the design process,

The qualifier for this objective was ***Yes*** for Presentation Option Experience variable. When participants responded yes, frequency distributions were used to document what was found for Presentation Option Past Use, Sufficient Decision Information, Presentation Option Preference, and Option Discontinuance Justification (see Table 15).

Table 15

Variables Used to Document Identified Usage for Current Manual and Automated Presentation Options

Technique:	Descriptive Statistics
Qualifiers:	**If variable for Presentation Option Experience (1) = Yes**
Data Location	
Variable Number	Measure
2a-d	Ratio
7a	Nominal
8	Ordinal
9a-d	Nominal

(B) assess viability of current manual presentation options for fabric and color in the design process,

The qualifier for this objective was ***Yes*** for Presentation Option Experience variable. Frequency distributions were used to document what was found for Presentation Option Information Conveyance and Presentation Option Attributes Evaluation (see Table 16).

Table 16

Variables Used to Document Identified Usage for Viable Current Manual and Automated Presentation Options

Technique:	Descriptive Statistics
Qualifiers:	**If variable for Presentation Option Experience (1) = Yes**
Data Location	
Variable Number	Measure
3a-j	Ordinal
4a-j	Ordinal

(C) Identify future automated presentation options for fabric and color in the design process.

The qualifier for this objective was ***No*** for Presentation Option Experience variable. Frequency distributions were used to document what was found for Sufficient Decision Information, Presentation Option Preference, and Option Discontinuance Justification (see Table 17).

(D) assess viability of future automated presentation options for fabric and color in the design process,

The qualifier for this objective was ***No*** for Presentation Option Experience variable. Frequency distributions were used to document what was found for Presentation Option Information Conveyance and Presentation Option Attributes Evaluation (see Table 18).

Table 17

Variables Used to Document Identified Usage for Future Manual and Automated Presentation Options

Technique:	Descriptive Statistics
Qualifiers:	**If variable for Presentation Option Experience (1) = No**
Data Location	
Variable Number	Measure
7a	Nominal
8	Ratio
9a-d	Nominal

Table 18

Variables Used to Document Identified Usage for Viable Future Manual and Automated Presentation Options

Technique:	Descriptive Statistics
Qualifiers:	**If variable for Presentation Option Experience (1) = No**
Data Location	
Variable Number	Measure
3a-j	Ordinal
4a-j	Ordinal

(E) compare viable manual (current) and automated (future) presentation options for fabric and color in the design process.

Research questions and variable comparisons from previous research (e.g., Bean, 1997; Geissler, 1998; Venkataraman, 1992; Wimmer, 1995) were reviewed for applicability to the current study. The following comparisons were used for this study:

(1) Relationship between Presentation Option Preference, Sufficient Decision Information, Presentation Information Conveyance, and Presentation Option Attributes Evaluation.

Contingency tables were compiled to identify any tendencies that may have been present in the study for the effect or influences on the ratings by characteristics information conveyed and format attributes information by each viable presentation option format. (see Table 19).

Table 19

Variables Used to Compare Viable Current (Manual) and Future (Automated) Presentation Options Research Objective E1

Comparison:	**Presentation Option Preference**
	Sufficient Decision Information, Presentation Information Conveyance, and Presentation Option Attributes Evaluation.
Data Location	
Variable Number	Measure
8	**Ratio**
7a	Nominal
3a-j	Ordinal
4a-j	Ordinal

(2) Relationship between Presentation Option Preference and Current Position, Industry Experience, Position Experience, Time at Current Position, Previous Position Experience, Time at Previous Position, and Computer Experience.

Contingency tables were compiled to identify tendencies that may have been present in the study for the effect or influences on the ratings by presentation option preference levels and current position, industry experience, position experience. Possible influences were also explored between presentation option preference levels and time at current position, previous position experience, time at previous position, and computer experience by each viable presentation option format (see Table 20).

(3) Relationship between Presentation Option Preference and Type of Computer Experience, Amount of Computer Experience, Total CAD Experience, CAD Training, CAD Use, and CAD Daily Utilization.

Contingency tables were compiled to explore presentation option preference and type of computer experience, amount of computer experience, total CAD experience, CAD training, CAD use, and CAD daily utilization by each viable presentation option format (see Table 21).

Table 20

Variables Used to Compare Viable Current (Manual) and Future (Automated) Presentation Options Research Objective E2

Comparison :	**Presentation Option Preference**
	Current Position, Industry Experience, Position Experience, Time at Current Position, Previous Position Experience, Time at Previous Position, and Computer Experience.
Data Location	
Variable Number	Measure
8	**Ratio**
Section A – 1	Nominal
Section A – 3	Ratio
Section A – 4	Ratio
Section A – 5	Ratio
Section A – 6a,b	Nominal, Ratio
Section A – 7	Nominal

(4) Relationship between Presentation Option Preference and CAD for Apparel Design, CAD for Textile Design, Company CAD Design Use, Company CAD Stations, and Company CAD Employees.

The impact or influence of presentation option preference and CAD for apparel design, cad for textile design, company CAD design use, company CAD stations, and company CAD employees each viable presentation option was investigated using contingency tables (see Table 22).

(5) Relationship between Presentation Option Preference and Job Satisfaction.

Contingency tables were compiled to compare responses presentation option preference and job satisfaction levels (see Table 23).

Table 21

Variables Used to Compare Viable Current (Manual) and Future (Automated) Presentation Options Research Objective E3

Comparison:	**Presentation Option Preference**
	Type of Computer Experience, Amount of Computer Experience, Total CAD Experience, CAD Training, CAD Use, and CAD Daily Utilization.
Data Location	
Variable Number	Measure
8	**Ratio**
Section B – 2a-j	Nominal
Section B – 3	Nominal
Section B – 4	Nominal
Section B – 5a-g	Ordinal
Section B – 6	Ratio
Section B – 8	Interval

Participants were asked to indicate, on the provided Design Process Model, the earliest and latest points for the use of the currently reviewed presentation option during the design process (Variables 12a and b). The purpose was to identify potential use areas for each particular presentation option format during the design process.

Content analysis can be used to provide systematic, objective analysis of participant communication (Zikmund, 1994). Content analysis was used to assess comments provided by the participants. Information was recorded for level of sufficiency of information for individual presentation options (Variable 7b). Content analysis was used to assess the comments provided in regards to the Design Process Model (Variable 12c) for the earliest and the latest use of each individual presentation option format.

Table 22

Variables Used to Compare Viable Current (Manual) and Future (Automated) Presentation Options Research Objective E4

Comparison:	**Presentation Option Preference**
	CAD for Apparel Design, CAD for Textile Design, Company CAD Design Use, Company CAD Stations, and Company CAD Employees.
Data Location	
Variable Number	Measure
8	**Ratio**
Section B – 8	Interval
Section B – 9a-l	Nominal
Section B – 10a-j	Nominal
Section B – 14	Ratio
Section B – 15	Ratio
Section B – 16	Ratio

Table 23

Variables Used to Compare Viable Current (Manual) and Future (Automated) Presentation Options Research Objective E5

Comparison:	**Presentation Option Preference**
	Job Satisfaction
Data Location	
Variable Number	Measure
Section A – 1	**Nominal**
1	Nominal
2a-d	Ratio

Chapter Four
Results

The purpose of this research was to assess the current and future presentation options for fabric and color in the design process. A modified preexperimental research design with four treatment levels was used. A convenience sample filtered by judgment selection criteria, which was based on previous research by Kang (1999), Regan, Kincade and Sheldon (1998), and Vass and Kincade (1999), was used. Participants in the sample met the criteria of (a) worked for a company focused on apparel or interior product development, (b) had computer access, (c) had responsibility in the design process for color and fabric selection decisions, and (d) had adequate job experience to identify areas of expertise in color and fabric selection decisions.

A total of 13 participants out of an initial sample of 61 participated in the study. Participants in the study were from various geographical locations: (a) West Coast, (b) Southeast, and (c) Northeast. Participants worked for large and small firms and included apparel and interiors industry personnel. Participants had various titles and job descriptions. They represented an average industry experience of 3.9 years. To participate, they met the minimum requirements of memory and monitor capabilities, and had access to a CD ROM.

This chapter reports on the profile for the participants, the presentation options profile, and the results according to the five research objectives.

Participant Profile Variables

<u>Participant's Job</u>

Participants were asked to record their current title position. Position titles were investigated to identify any trends that may be present for industry employment areas. Participants also recorded supervisory responsibilities and number of supervised employee information. These numbers were used to track management levels for industry experience in the apparel, textiles, and interior areas. History information was collected for individual participant levels of current employee position level. Participants were also asked to provide information on prior experience at the current employment position and to indicate number of years. This information provides additional insight into experience levels for the participants in the study for the current position that is held. A total for textile and fabric experience was also recorded for the participants to provide a baseline for overall experience levels of the participants in the study (see Table 24).

Table 24

Survey Participant Profile Overview

Section A – Job Experience		Section D – Company Information	
30.8%	Designers	81.8%	Apparel Products
23.1%	Product Developers	18.2%	Textile & Fashion Accessories
15.4%	Supervise Up to 5 Employees	36.6%	1 to 5 Designers
7.8 Years	Avg. Exp. in App/Inter Industry	45.5%	Up to 20 Years in Business
3.9 Years	Avg. Exp. with Present Employer	27.3%	21 to 30 Years in Business
5 Years	Avg. in Current Position	Classifications	
13.6 Years	Avg. Exp. with Textiles & Fabrics	77.8%	Manufacture in US
Sections B & C – Computer & CAD Experience		22.2%	Manufacture Not in US
100%	Computer Exp.	66.7%	Manufacture Offshore
11.3 Years	Avg. Computer Exp.	11.1%	Manufacture 807
100%	Word Processing Exp.	Section E – Demographics	
92.3%	Spreadsheet Exp.	33.7 Years	Avg. Age
76.9%	CAD, Games	92.3%	Female
5.2 Years	Avg. CAD Exp.	69.2%	Post Graduate Study
60%	With CAD Exp., Currently in Use	Job Satisfaction	
50%	Avg. Daily Use of CAD (< 25% of time)	46.2%	Somewhat Satisfied
66.7%	Colorization, Line Drawings, Logos/Labels/Hangtags	38.5%	Satisfied
50%	Rendering/Illustration	15.3%	Very Satisfied
7	S/W Packages Used	Color & Fabric Process	
6	Off-The-Shelf S/W Packages Used	17.2 Days	Avg. Time to Complete Color Process
3 Part.	10 Years of Design Use w/CAD	22.5 Days	Avg. Time to Complete Fabric Selection Process
5+ Avg.	CAD Stations In-House		
Up to 5	Trained CAD Employees In-House		

Among the 12 participants, four were designers (30.8%), and the next most popular position title recorded in the study was product developer (23.1%, n=3). Of the total number of participants, 15.4% (n=2) supervised 5 or less employees. The average number of years that the participants had worked in the apparel, textile, or interior industry was 7.8. The data for this variable ranged from 3 years to 25 years in the industry areas. The average number of years that the participants in the study were with their present employees was 3.9 years. The largest group of the participants (23.1%, n=3) had been employed with their present employers 3 years, 53.9 % (n=10) had up to 7 years experience with their present employer, and 5 years for 15.4% (n=2). The longest time reported at the current employer was 14 years, with the average time spent at the current position 5 years. For the variable, length of time at the current position, 60.8% of the participants had up to 7 years experience. In terms of experience at the present position, 30.8% (n=4) of the participants held the same position at a prior job. Of these four participants, 23.1% held the same position at a previous employer, up to 9 years. The average number of years recorded by the participants for textile and fabric experience/knowledge was 13.6 years. The participants in the study had an established length of job history to allow them to participate in the study and provided the requested data for presentation option evaluation and company-related information (see Appendix D1).

<u>Participant's Computer and CAD Experience</u>

Computer experience information was recorded to identify personal technology capabilities and familiarity. All of the participants (n=13) had computer experience and the average experience level was 11.3 years. Participants reported a number of computer experience areas. All of the participants (n=13) had word processing computer experience. The second most common form of computer experience recorded was spreadheet experience by 92.3% (n=12) of the participants. The next most common areas of computer experience included CAD, games, and statistics at 76.9% (n=10) for each of the listed areas (see Appendix D1).

For the 76.9% (n=10) of participants that reported CAD experience, the average number of years of experience was 5.2 years. These 10 participants reported that CAD training was obtained through the following methods: (a) college or university (46.2%, n=6), (b) previous job training by an employee (23.1%, n=3), and (c) current job training by employee and continuing education program at 7.7%, n=1 each. While 30.8% of the ten participants with CAD experience reported that they had no CAD training, none of the participants had formal CAD manufacturer training (see Appendix D1).

Of the ten participants with CAD experience, six (60%) are currently using CAD systems at work. Of these participants, 83.3%, (n=5) reported that CAD job responsibilities were a part of their initial job description when hired. The remaining participant had job responsibilities added after being hired (see Appendix D1).

The six current CAD users in the study were asked to record their average daily CAD use. A Likert-type scale was used to record usage levels. Levels reported by the participants that indicated CAD usage were 50% (n=3) at less than 25%, 33.3% (n=2) for 76% to 100%, and 16.7% (n=1) at 25 to 50%. There were no recordings for usage levels of 26% to 50% (see Appendix D1).

Participants were asked to provide information for CAD use areas in apparel/interior design, and for textile design. The majority of the tasks where CAD is utilized are colorization, line development, and logos/labeling/hang tags with usage levels of 66.7% (n=4) each (see Table 25). CAD programs are also being used in the industry for 3D rendering and illustration (50%, n=3). This data provides a check point for CAD and computer use in the design area and also provides data on the use of computers in the design area with regards to color responsibilities (see Appendix D1).

Data were also collected about the industry-specific CAD system used for design work by participants. Participants, who indicated CAD use identified, seven particular software packages. AVL Looms is used exclusively by one of the participants. AVL Looms is also used 70% of the time along with Infomax Systems (28% of the time), and Monarch design Systems (2% of the time) by another participant. One participant indicated Lectra Systems is used in conjunction with Microdynamics System with usage levels of 25% and 50% respectively. Data indicates that the Lectra System is also used in conjunction with Symmetry System and AutoCAD System (33% respectively) by another participant (see Appendix D1).

Participants were asked to indicate usage of off-the-shelf software programs for design work by recording percentage of use. Five participants (83.3%) used these software programs. Adobe Illustrator is used by one participant, 90% of the time in conjunction with PhotoShop for the remaining 10% of the time. Adobe illustrator is also used by another participant (50%/50%) equally with PhotoShop and one participant used a combination of 1% Adobe Illustrator and 1% PhotoShop. One participant reported that they used a combination of off-the-shelf programs, AutoCAD 3D Vision (90%), CorelDraw (5%), and

PhotoShop (5%). The Symmetry program was used by a participant 25% of the time and while another participant reported that they used AutoCAD exclusively (100%) (see Appendix D1).

Table 25

Apparel/Interior and Textile Design CAD Utilization

Tasks	Percentage
Apparel/Interior Design	
Colorization	66.7
Line Development	66.7
Logos/Labeling/Hang Tags	66.7
3D Rendering	50
Illustration	50
Styling	33.3
Catalog/Advertising	33.3
Merchandise Presentation	33.3
Print Fabric Colorways	33.3
Print Fabric Design	33.3
Textile Design	
Logos/Labeling/Hang Tags	33.3
Print Fabric Colorization	33.3
Print Design	33.3
Print Fabric Recolorization	33.3
Woven Fabric Structure	33.3
Catalog/Advertising	16.7
Line Planning/Development	16.7
Merchandise Presentation	16.7

Additional information collected included length of time that the participant's company has used CAD for design, the number of CAD stations, along with the number of trained CAD employees. Time information reported for CAD use in design included 10 years for 3 participants in the study, 9 years for 2 participants, and 5 years and 15 yeas for one participant each. Half of the participants (50%) had up to 5 CAD stations at their companies.

The remaining participants (n=3) who identified CAD use had 6, 18, and 50 CAD stations each. The majority of the participants (83.3%, n=5) had up to 5 trained CAD employees. The remaining participant had 100 trained CAD employees (see Appendix D1).

Participant's Computer Equipment

Participants were asked to provide information on computer equipment including type (PC or MAC), memory capability (RAM), monitor type, and length of time for owning computer equipment. Geissler (1998) provided guidelines for technology parameters for in relation to World Wide Web (WWW) use and enhanced graphics displays. Technology parameters below certain levels hinder adequate use of enhanced graphics features and may decrease performance. All participants were screened for the following minimum requirements for PCs: (a) 200 MHz Pentium MMX, (b) 32M RAM, (c) 640x480 monitor with16-bit color capability, and (d) 8xCD-ROM. Minimum requirements for MACs included: (a) 200 MHz 603e, 32M RAM, (c) 640x480 monitor with16-bit color capability, and (d) 8xCD-ROM. The majority of the participants (76.9%) in the study used PCs to complete the survey and 15.4% used MACs. One participant did not report their computer type in the study. Of the participants (38.5%, n=5) that recorded memory or RAM levels, all exceeded the minimum RAM criteria of 32M, required to participate in the study. However, 61.5% of the participants did not report RAM levels. None of the participants reported the requested monitor information beyond providing the monitor manufacturer. The purpose of this question was to get an indication of the color projection capabilities of the monitors to assess potential effect and influence on performance of the automated presentation options. By recording the age of the computer equipment used for the survey, an indication of the technology levels is possible. Participants used computers that were two years old or less (63.6, n=6%), 18.2% (n=2) of the computers were five years old, and 18.2% (n=2) of the computers were either three years old or ten years old (see Appendix D1).

Participant's Company

Company data requested included information on merchandise type, company size, number of designers employed, length of time in business, and manufacturing classification for goods. This information gives a broader indication of company structuring. The dominant merchandise type produced by participating companies was apparel producer at 81.8% (n=9). Textile and fashion accessory producers accounted for 18.2% (n=2) of the participating companies and the remaining participants did not report merchandise type information. The majority of the participants (36.3%, n=4) worked for companies that had more than 1000 employees. The second major size was comprised of companies with less than 21 employees (27.3%, n=3). Employee levels were reported as 18.2% (n=1) for companies with 21 to 50 employees and 101 to 500 employees. The number of designers employed in these companies range from one to five designers (63.6%, n=7). One participant reported that the company employed 40 designers (see Appendix D1).

The range of years in business, for the company, as reported by participants spanned from eight years to 50 years. A number of the participating companies in business for up to 20 years (45.5%, n=5), for 21 to 30 years (27.3%, n=3), and one company each at 35, 47, and 50 years. Manufacturing classifications indicate level of international involvement and are catalogued as made in US, Under 807, and offshore (not 807). Companies can operate under multiple manufacturing classifications. Data recorded in the study indicated that 77.8% (n=7) of the participating companies manufacture in the US, 22.2% (n=2) do not manufacture in the US. For offshore manufacturing the amount is 66.7% (n=6) and for 807 manufacturing, 11.1% (n=1) of the companies manufacture in trade protected locations (see Appendix D1).

Participant's Demographics

Demographic information asked of participants included age, gender, education levels, and job satisfaction rating. The age span for participants in the study was 23 years to 55 years with 33.7 years as the average age. The majority of the participants were female (92.3%). Education levels for the participants were that 69.2% had completed postgraduate study and the remaining participants had bachelor degrees. A six-point Likert-type scale was used to record job satisfaction ratings. Venkataraman's (1992) research reported that job satisfaction levels affected participant response for job information and change evaluations. The scale included ratings for extremely satisfied, satisfied, somewhat satisfied, extremely dissatisfied, dissatisfied, and somewhat dissatisfied. The majority of participants (46.2%) reported a rating for somewhat satisfied, 38.5% were satisfied, and the remaining two participants were extremely satisfied with their jobs. Job satisfaction levels were high and should have a positive effect on participant responses (see Appendix D1).

Participants were asked to provide ratio data for the normal amount of time spent on the color selection process and the fabric selection process. The participants on average spent 17.2 days on color selection. The average time spent by the participants on fabric selection was 22.5 days. The time information reported spanned a very wide range. Some participants recorded making color and fabric decisions in a matter of hours. Other participants recorded using as many as 30 to 130 days for the selection process (see Appendix D1).

Profile of Presentation Options

Participants were asked a variety of questions about each of the four presentation options. Participants were asked to indicate their previous use of the fabric swatch presentation option. Recordings were also made for the number of times a participant may have used the presentation option in the past season, within the past three seasons, and within the past year. The participants were also asked to record how many seasons there are per year in their company. Participants were asked to provide ratio data for the normal amount of time spent on the color selection process and the fabric selection process.

Regardless of the usage participants were asked to review each and were asked to record color and shade information (i.e., color verification) for each presentation option. The purpose was to collect comparison information for identification of individual acuity and phoria data. The true color of the presentation option is light blue/blue-violet with a shade designation of medium.

Regardless of previous use, participants were asked to examine the presentation option and rate how well the option conveys fabric characteristics and format attribute information. The fabric characteristics information was rated on the following 10 variables: (a) color, (b) shade, (c) brightness, (d) fuzzy, (e) soft, (f) smooth, (g) opaque, (h) body, (i) bounce, and (j) drape. These fabric characteristics included both texture and motion aspects of the fabric. These information variables were selected based on previous research that recorded the importance of these variables to design decisions. A five-point Likert-type scale was used to record the levels of information conveyed by the option, level 1 (does not describe at all) to level 5 (describes very well).

Participants also recorded ratings for how well format attributes were conveyed through the fabric swatch presentation option. The list included: (a) familiarity, (b) commonly used, (c) convenient, (d) satisfactory results, (e) low risk, (f) increase productivity, (g) increase creativity, (h) saves time, (i) improves quality, (j) requires training. These attributes evaluated issues of use for the design function and for the designer, and were rated on the same five-point scale as fabric characteristics.

Participants were asked to indicate if they felt that the fabric swatch presentation option supplied sufficient information to make the requested decision for the selection of fabric and color based on the apparel or interior scenario provided. Participants were also asked to provide comments concerning the level of sufficiency for information of the fabric swatch presentation option. Participants were also required to provide preference for future use of the presentation option. A four-point modified Likert-type scale was used to rank preference. The rankings included discontinue use, decrease use, continue use, and increase use. A modified Likert-type scale was used to record deterrent data that would influence a discontinue recording for future use.

As a summary for each option, the participants were asked to identify where along the design process model they would recommend the use of this option. A process design model was provided to the study participants. The model was adapted from Regan's (1997) research, which presents the most comprehensive, documented apparel design and preproduction process (see Appendix B3). The goal was to have the participants indicate on the model the earliest and latest points for potential use for the presentation option. Usability may be influenced by the location on the model or time constraints imposed by company time lines for product development.

Fabric Swatch Presentation Option

The fabric sample presentation option was constructed using sample fabric. The sample was labeled with the fabric name, weave, fiber content, width, pattern repeat, weight, thickness, stiffness, and drape information. This option is the one that is traditionally used by designers in the apparel and interiors industries (Frings, 1999).

Participant history. Participants were asked to indicate their previous use of the fabric swatch presentation option. The majority of the participants (76.9%, n=10) had used the option. Participants in the study indicated that this option format had been used an average of 222.75 times in the past season. The range for format use was 10 uses per season for one participant to 600 uses for another participant. Only four participants provided data for past seasons and past three seasons. Several participants provided use data for the past year. When these numbers about previous use were compared, a slight increase in use was observed. Participants commented that the format was familiar and commonly used (see Appendix D1).

Color verification. Participants were also asked to record color and shade information for the presentation option. Light blue/blue-violet was the closest any participant came to the original color designation. Light blue/violet and blue were two colors that were each mentioned by 23.1% of the participants. These two colors were the only colors chosen by more than one person. One participant each recorded one of the following colors: bright sky blue, pale blue, lavender, and medium blue (see Appendix D1).

Fabric characteristics information. When they observed the fabric swatch, participants were asked to rate how well the fabric swatch presentation option conveyed fabric characteristics information. All of the participants rated the fabric characteristics at level 4 or level 5. Although there was not agreement across the participants for the name of the color, for the fabric swatch, participants recorded that color and shade information were adequately presented (see Appendix D1).

Option format attributes. The fabric swatch format was rated on all format attributes as acceptable or highly acceptable (levels 4 or 5) by the majority of the participants. In summary, participants also felt that the format did increase productivity, enhance creativity, and improve quality. They thought that the fabric swatch format was convenient and did save time. This concept of time was measured by the actual time used in viewing the option. The designers did not include the time needed to order the swatch and to wait for delivery of the swatch (see Appendix D1).

Selection for use. The majority of the participants (92.3%) indicated that the fabric swatch presentation option supplied sufficient information to make the requested decision for the selection of fabric and color based on the apparel or interior scenario provided. Content analysis was used on the comments that were recorded about sufficiency levels of the fabric swatch presentation option. Two comments were consistently noted: best presentation format and request for a larger sized swatch. Participants were also required to record preference for future use of the presentation option. For the fabric swatch presentation option, all of the participants chose continue or increase use and recorded no deterrents for use of this presentation option (see Appendix D1).

Design Process Model. A large percentage of the participants (45.5%, n=5) indicated that they would begin using the fabric swatch format at activity 121 (Define New Season Line) (see Appendix B3). The next most popular activity level selected by participants was level 124 (Maintain Basic Line (Core Items)) (18.2%, n=2) and 125 (ID Fabric Type) (18.2%, n=2). Activities 12 (Define Problem) and 142 (Merchandise the Line) were selected by one participant each. For the use that was the latest in the design process, a number of participants (30%, n=3) selected levels 164 (Communicate Seasonal Plan) and 165 (Present Line and Best Styles). Participants selected levels 153 (Finalize Fabric Prints and Texture) (20%, n=2) and 10% (n=1) each for 134 (Evaluate Fabric Type and Style) and 161 (Decide Optimum Product Solution) (see Appendix D1).

Swatch Card Presentation Option

The swatch card presentation option is a manual version of a fabric swatch and was compiled by scanning the fabric sample and augmenting the files using PhotoShop. The results were recorded by printing on coated photographic paper for distribution. The card was labeled with the fabric name, weave, fiber content, width, pattern repeat, weight, thickness, stiffness, and drape information. This information was the same as that which was provided for the fabric swatch.

Participant history. Participants were asked to indicate their previous use of the swatch card presentation option. Few participants (23.1%, n=3) had used the option. One participant in the study indicated that a swatch card presentation option format had been used once in the past season for the selection of the fabric and color in the design process. Another participant recorded that the swatch card format had only been used 150 times in the past three seasons. Only one participant provided seasonal use history precluding identification of any trends for the use of this option (see Appendix D1).

Color verification. Participants were also asked to record color and shade information for the presentation option. Light blue/blue-violet was the closest any participant (n=1) came to the original color designation. The majority of the participants (23.1%, n=3) designated the color of the presentation option as purple, which was the most common response. The remaining colors recorded, each by one participant, were blue, bluish purple, French blue, violet, lavender, and lilac. The color was judged by the researcher to be different from the original fabric swatch but was the best color match that could be made with available equipment (see Appendix D1).

Fabric characteristics information. When they observed the swatch card, participants were asked to rate how well the swatch card presentation option conveyed fabric characteristics information. Participants (61.6%) recorded that the swatch card format was rated at level 4 or 5 for the color of the fabric. For the conveyance of the shade characteristic information, 61.5% of the participants selected level 4 or 5 for the swatch card format, with 30.8% of the participants recording a rating level of 2 (somewhat does not describe). For the conveyance of brightness characteristic information, 61.5 % of the participants recorded level 4 or 5. The remaining participants rated the presentation option as level 2 (23.1%) (somewhat does not describe) and level 3 for neutral for brightness characteristic information. Some participants (46.2%) rated fuzzy information at level 4 or 5 for fabric characteristics information conveyance. Also, for the fuzzy characteristic information, 46.2% of participants rated the swatch card format at level 2 and level 1. For the conveyance of soft category information, 23.1% of the participants recorded a rating level for 3 (neutral) and level 2, respectively, and 38.5% at level 1. One participant did not provide the requested information. Conveyance of smoothness characteristic information was rated at levels 4 or 5 by 53.9% of the participants, and 38.5% rated this variable at levels 1 or 2. The opaqueness information level was rated at levels 4 or 5 by 53.9% of the participants and 92.3. Many participants (53.9% and 71.6%, respectively) rated body and bounce, two key movement characteristics at levels 1 or 2, indicating that the format did not provide information of this type (see Appendix D1).

In summary, for the swatch card format, participants generally found that color and shade information were adequately presented. Information categorized for texture hand and body/bounce/drape were unfavorably presented in terms of the participant's description/expectation of the provided sample.

<u>Option format attributes.</u> The majority of the participants (46.2%) found that the swatch card format was not a familiar presentation option for fabric and color (rating levels 2 or 1). For the swatch card, 30.8% of the participants found that the swatch card format somewhat described (level 4) a presentation option that was similar in comparison to the format that they commonly used (see Appendix D1).

The swatch card format was rated at levels 1 or 2 by 69.2% of the participants for the category of convenient. The remaining participants rated the swatch card format as not generally equal (levels 4 or 5) to the baseline of general fabric swatch (30.8%). For the attribute of satisfactory results, 23.1% of participants found that the swatch card somewhat describes (level 4) in comparison to a general fabric swatch. The remaining participants rated this presentation format as somewhat does not describe (38.5%) and does not describe very well at all (23.1%) (see Appendix D1).

In terms of low risk for using the 2D presentation format, a total of 30.8% of participants rated the attribute at levels 5 or 4. However, a large percentage of the participants 61.6% believed low risks did not describe the presentation option (levels 2 or 1). The remaining participants (7.7%) were neutral (see Appendix D1).

For the increase productivity variable, ratings were 53.9% for levels 1 or 2 and 38.5% of the participants were neutral. For the attribute enhances creativity, 53.9% of the participants rated the swatch card format at levels 2 or 1 for somewhat does not describe (level 2) and does not describe at all (level 1). A number of the participants (38.5%) were neutral for enhance creativity for the swatch card format and 7.7% indicated they rated the format as level 4 on enhance creativity. The remaining participants 38.5% were neutral on the question of enhance creativity (see Appendix D1).

Participants (61.6%) rated the swatch card format for saves time at levels 1 or 2 and 30.8% of the participants rated the swatch card as neutral. The remaining 7.7% of the participants rated the format at a level 4 for saves time (see Appendix D1).

Participants reviewed the attribute improves quality. The majority of the participants (61.6%) rated this attribute at level 2 and level 1. The second highest group of participants 30.8% was neutral on this attribute, and the remaining participants (7.4%) selected levels 4. In terms of training requirements for the swatch card format, 46.2% of the participants recommended that training was necessary to use this option, and 38.5% did not believe that training was necessary for use. All other participants (15.4%) rated training as neutral (see Appendix D1).

In summary, the attribute trends as recorded by participants, were that the swatch card format was not familiar and was not commonly used. Did not provide satisfactory results did not involve low risks, and required training to use. Participants also felt that the format did not increase productivity, enhance creativity, or improve quality. Participants, however, did feel that the swatch card format was convenient and did save time.

Selection for use. Participants were also asked to indicate if they felt that the swatch card presentation option supplied sufficient information to make the requested decision for the selection of fabric and color based on the apparel or interior scenario provided. A few participants (23.1%) indicated that the swatch card presentation option provided sufficient information to make the requested decision for fabric and color. Participants were also asked to provide comments concerning the level of sufficiency for information of the swatch card presentation option (see Appendix D1).

Content analysis of the comments that recorded variables pertained to sufficiency levels of the swatch card presentation option revealed that participants felt the need to feel and touch the fabric. Other comments included the suggestion that this option be used for decisions relative to carryover fabric from previous seasons, initial decision selection process, and order for swatches. Participants were not comfortable using this presentation format to make final fabric and color choice/decisions.

Participants were also required to record preference for future use of the presentation option. For the swatch card presentation option, 30.8% of the participants indicated decrease use, and 30.8% recommended discontinue use. The remaining participants (38.5%) recommended continuing use of the option. Validations or reasons for recommending discontinue use were for the following reasons: capability (23.1%), training requirements (7.7%), and equipment requirements (7.7%) (see Appendix D1).

Design Process Model. A large percentage of the participants (60.0%, n=6) indicated that they would begin using the swatch card format at activity 121 (Define New Season Line) (see Appendix B3). The next most popular activity level selected by participants was level 124 (Maintain Basic Line (Core Items)) (20.0%). The remaining other levels included: 12 (Define Problem) and 142 (Merchandise the Line) (10.0% each). For the latest activities (i.e., those closest to the finalization of the product), two participants selected 134 (Evaluate Fabric Type and Style). The remaining activities selected were 124 (Maintain Basic Line (Core Items)), 125 (ID Fabric Type), and 132 (Determine Strategy for Directional Fashion Items). Additional activities that were selected were 141 (Select Carryover and Reorderable Products), 142 (Merchandise the Line), 153 (Finalize Color Palette), 164 (Communicate Seasonal Plan), and 165 (Present line and Best Styles). A wider range of activities were selected by the participants for the latest point to use this presentation option. When identifying use for this option, participants were selecting possible activities that would use the swatch card as a color sample chip. Use was also noted where the presentation option could be used with other materials collected, used in activities prior to making a final decision, or used during product development when fabrics had already been viewed and selected (see Appendix D1).

2D Simulation Presentation Option

The 2D simulation presentation option is an automated version of a fabric swatch and was compiled by scanning the fabric sample and augmenting the files using PhotoShop. The results were recorded using CD ROM. Additional text information was not provided with this option.

Participant history. Participants were asked to indicate their previous use of the 2D simulation presentation option. Few participants (15%, n=2) had used the option. One participant in the study indicated that a 2D simulation presentation option format had been used approximately 100 times in the past season for the selection of the fabric and color in the design process. Another participant recorded that the 2D simulation format had only been used twice in the past season. When these numbers were compared to previous seasons, a definite trend in the use of 2D simulation for fabric and color presentations could not be identified (see Appendix D1).

Color verification. Participants were also asked to record color and shade information for the presentation option. Light blue/blue-violet was the closest any participant (n=1) came to the original color designation. The majority of the participants (23.1%, n=3) designated the color of the presentation option as blue. This was the most common response. This large category was followed by 15.4% each for Carolina Blue and bright sky blue. The remaining colors recorded, each by one participant, were turquoise blue, the light blue/blue-violet, royal, and medium blue (see Appendix D1).

Fabric characteristics information. When they observed the 2D simulation, participants were asked to rate how well the 2D simulation presentation option conveyed fabric characteristics information. Participants (76.9%) recorded that the 2D simulation format was rated at level 4 (somewhat describes) the color of the fabric in the option and 15.4% of the participants marked a level 5 rating, describes very well. For the conveyance of the shade characteristic information, 61.5% of the participants selected level 4 for the 2D simulation format. Also in shade information, 15.4% of the participants indicated level 5; however, 15.4% of the participants recorded rating levels of 3 for neutral. For the conveyance of brightness characteristic information, 53.8% of the participants recorded level 4. The remaining participants were evenly distributed across level 5 for describes very well, level 3 for neutral, and level 2 for somewhat does not describe brightness information. Fuzzy information was rated at level 4 for fabric characteristics information conveyance by some participants (38.5%). Also, for the fuzzy characteristic information, 46.2% of participants rated the 2D simulation format at level 2 and level 1. For the conveyance of soft category information, 30.8% of the participants recorded a rating level of 3 (neutral), 30.8% at level 2, and 23.1% at level 1. Conveyance of smoothness characteristic information was rated at levels 2 or 1 by 69.3% of the participants. The opaqueness information level was evenly rated at levels 4, 3, 2, and 1 by equal numbers of the participants and 92.3% of the participants rated body, bounce, and drape information conveyance at level 3 (neutral), 2 (somewhat does not describe), and 1 (does not describe at all) (see Appendix D1).

In summary, for the 2D simulation format, participants generally found that color and shade information were adequately presented. Information categorized for texture hand and body/bounce/drape were unfavorably presented in terms of the participant's description/expectation of the provided sample.

Option format attributes. The majority of the participants (61.6%) found that the 2D simulation format was not a familiar presentation option for fabric and color (rating levels 2 or 1). When compared to the format that was commonly used, 30.8% of the participants found that the 2D simulation format somewhat described (level 4) a presentation option that was similar to the commonly used format (see Appendix D1).

The 2D simulation format was rated as acceptable by 46.2% of the participants for the category of convenient. The remaining participants rated the 2D simulation format as not generally equal (levels 2 or 1) to the baseline of general fabric swatch (23.1%) or were neutral (level 3, 30.8%). For the attribute of satisfactory results, 23.1% of participants found that the 2D simulation somewhat describes in comparison to a general fabric swatch. The remaining participants rated this presentation format as somewhat does not describe (30.8%) and does not describe very well at all (23.1%) (see Appendix D1).

In terms of low risk for using the 2D presentation format, a total of 30.8% of participants rated the attribute at levels 5 or 4. However, a large percentage of the participants 46.2% believed low risks did not describe the presentation option (levels 2 or 1). The remaining participants (23.1%) were neutral (see Appendix D1).

Increase productivity ratings included 46.2% for levels 1 or 2 and 46.2% for level 3 (neutral). For the attribute enhances creativity, 46.2% of the participants rated the 2D simulation format at levels 2 or 1 for somewhat does not describe (level 2) and does not describe at all (level 1). A number of the participants felt the 2D simulation format somewhat describes (level 4, 15.4%) and describes very well (level 5, 15.4%) for enhance creativity. The remaining participants 38.5% were neutral on the question of enhance creativity (see Appendix D1).

Participants (53.9%) rated the 2D simulation format for saves time at levels 5 or 4. However, 23.1% of the participants rated the saves time attribute in comparison to the baseline (general fabric swatch) at rating levels 2 or 1. The remaining participants (23.1%) were neutral on this attribute (see Appendix D1).

Participants reviewed the attribute, improves quality. The majority of the participants (53.9%) rated this attribute at level 2 and level 1. The second highest group of participants 30.8%, was neutral on this attribute, and the remaining participants (15.4%) selected levels 5 or 4. In terms of training requirements for the 2D simulation format, 61.5% of the participants selected levels 5 or 4. All other participants (38.5%) rated training as neutral (see Appendix D1).

In summary, the attribute trends as recorded by participants, were that the 2D simulation format was not familiar, was not commonly used, did not provide satisfactory results did not involve low risks, and required training to use. Participants also felt that the format did not increase productivity, enhance creativity, or improve quality. Participants, however, did feel that the 2D simulation format was convenient and did save time.

Selection for use. Participants were also asked to indicate if they felt that the 2D simulation presentation option supplied sufficient information to make the requested decision for the selection of fabric and color based on the apparel or interior scenario provided. A few participants (15.4%) indicated that the 2D simulation presentation option provided sufficient information to make the requested decision for fabric and color. Participants were also asked to provide comments concerning the level of sufficiency for information of the 2D simulation presentation option (see Appendix D1). Content analysis of the recorded comments that pertained to sufficiency levels of the 2D simulation presentation option revealed that participants requested more information for drape, swatch size, background and content information (33%). Requests were also recorded for opportunities to feel and touch sample (17%). Participants reported that the monitor affected the shade and image was out of focus (25%). Content analysis revealed that the 2D simulation format was useful (25%).

Participants were also required to record preference for future use of the presentation option. For the 2D simulation presentation option, 46.2% of the participants indicated decrease use of the 2D simulation presentation option, and 30.8% recommended discontinue use. Validations or reasons for recommending discontinue use were for the following reasons: capability (15.4%), training requirements (23.1%), and equipment requirements (30.8%). For the deterrent of adequate process in-place, 7.7% (n=1) indicated Yes. This variable may have been interpreted incorrectly by the participants. A positive or yes response to the questions indicates that continued use of the 2D simulation format would be unnecessary because there was a presentation option currently in use that was adequate, which was true for most participants (see Appendix D1).

Design Process Model. A large percentage of the participants (54.5%, n=6) indicated that they would begin using the 2D simulation format at activity 121 (Define New Season Line) (see Appendix B3). The next most popular activity level selected by participants was level 124 (Maintain Basic Line (Core Items)) (18.2%). Other levels included 125 (ID Fabric Type), 142 (Merchandise the Line), and 164 (Communicate Seasonal Plan) (18.2%, n=2 each). The remaining activities were 124 (Maintain Basic Line (Core Items)), 132 (Determine Strategy for Directional Fashion Items), 153 (Finalize Fabric Prints & Texture), 154 (Create Concept Boards), and 165 (Present Line & Best Styles). Each of the preceding activities was selected by one participant (see Appendix D1).

3D Simulation Presentation Option

The 3D simulation presentation option is an automated version of a fabric swatch and was compiled by filming the manipulation of the fabric with a digital camera and transferring the video file to CD ROM. Additional text information was not provided with this option. This option has been proposed by textile producers as the fabric swatch method for the future (personal communication, Dan Randall, October 13, 1999; Roland L. Connelly, Sr., October 14, 1999).

Participant history. Participants were asked to indicate their previous use of the 3D simulation presentation option. No participants had used the option (see Appendix D1).

Color verification. Participants were also asked to record color and shade information for the presentation option. Light blue/blue-violet was the closest any of the participants (15.4%, n=2) came to the original color designation. The majority of the participants designated the color of the presentation option as white/gray or blue participants (23.1%, n=3, respectively). The remaining colors recorded, each by one participant, were pale blue and baby blue (see Appendix D1).

Fabric characteristics information. When they observed the 3D simulation, participants were asked to rate how well the 3D simulation presentation option conveyed fabric characteristics information. Two of the 10 fabric characteristics (i.e., color and opaque) were each rated at levels of 4 or 5 by 92.3% of the participants. The remaining eight fabric characteristics (i.e., brightness, shade, fuzzy, soft, smooth, body, bounce, drape) were rated, each, at levels of 4 or 5 by 84.6% of the participants (see Appendix D1). In summary, for the 3D simulation format, participants found that all of the fabric characteristic variables were adequately presented.

Option format attributes. The majority of the participants (53.9%) found that the 3D simulation format was a familiar presentation option for fabric and color (rating levels 4 or 5). When comparing the format to the commonly used format, 38.5% of the participants found that the 3D simulation format does not describe at all (level 1) or somewhat does not described (level 2) a presentation option that is similar to the commonly used format (see Appendix D1).

The 3D simulation format was rated as acceptable by 38.5% of the participants for the category of convenient (levels 4 or 5). The remaining participants rated the 3D simulation format as not generally equal (levels 2 or 1) to the baseline of a general fabric swatch (38.5%), or were neutral (23.4%). For the attribute of satisfactory results, 69.3% of participants found that the 3D simulation somewhat describes or describes very well the fabric in comparison to a general fabric swatch. The remaining participants rated this presentation format as somewhat does not describe (15.4%) and neutral (15.4%), as comparative to an actual fabric (see Appendix D1).

In terms of low risk for using the 3D presentation format, a total of 46.2% of participants rated the attribute at levels 5 or 4. However, a large percentage of the participants 15.4% believed low risks did not describe the presentation option (levels 2 or 1). The remaining participants (38.5%) were neutral (see Appendix D1).

For enhancement of productivity, 46.2% of the participants rated the 3D simulation at levels of 4 or 5. For the attribute enhances creativity, 46.2% of the participants rated the 3D simulation format at levels 4 or 5 and 38.6% of the participants rated it at levels 1 or 2. Participants (61.6%) rated the 3D simulation format for saves time at levels 5 or 4; however, 15.4% of the participants rated the saves time attribute in comparison to the baseline (general fabric swatch) at rating levels 2 or 1, and the remaining participants (38.5%) were neutral on this attribute (see Appendix D1).

Participants reviewed the attribute, improves quality. A selection of the participants (38.5%) rated this attribute as neutral, and the remaining participants were equally split between levels 1 or 2 and levels 4 or 5 at 30.8% respectively. In summary, the format attribute trends, as recorded by participants, were that the 3D simulation format was familiar, provided satisfactory results, had low risks, increased productivity, enhanced creativity and saves time. The 3D presentation option was not commonly used, and participants thought that users would require training. Participants, however, were neutral or equally split on the convenience of the presentation option and its capability to improve quality (see Appendix D1).

<u>Selection for use.</u> Participants were also asked to indicate if they felt that the 3D simulation presentation option supplied sufficient information to make the requested decision for the selection of fabric and color based on the apparel or interior scenario provided. A slight majority of participants (53.8%) indicated that the 3D simulation presentation option provided sufficient information to make the requested decision for fabric and color. Participants were also asked to provide comments concerning the level of sufficiency for information of the 3D simulation presentation option (see Appendix D1).

Content analysis of the comments recorded, which pertained to sufficiency levels of the 3D simulation presentation option, revealed that participants requested more information for drape, swatch size, and background. Participants needed to touch and feel the fabric. The presentation option was useful in the beginning of the design process and for providing information to order fabric samples. Additional comments included participants concern about the time requirements for the set up of the presentation option and the technical requirements for use of the option. One set of comments stressed that the weave was not visible in this option, and another set of comments pertained to excellence of fabric, texture and hand information presented by the presentation option. Content analysis revealed that in general the 3D simulation format was useful.

Participants were also required to record preference for future use of the presentation option. The largest percentage of the participants (46.2%) for the future use question were neutral about the future use of the 3D simulation presentation option. For this option, 15.4% of the participants recommended discontinue use, and 23.1% indicated decrease use of the 3D simulation presentation option. Validations or reasons for recommending discontinue use were for the following reasons: training requirements, equipment requirements, and adequate process in-place (15.4% each) (see Appendix D1).

Design Process Model. A large percentage of the participants (45.5%, n=5) indicated that they would begin using the 3D simulation format at activity 121 (Define New Season Line) (see Appendix B3). The next most popular activity level selected by participants was level 124 (Maintain Basic Line (Core Items)) (18.2%). Other levels included: 12 (Define Problem), 125 (ID Fabric Type), 142 (Merchandise the Line), and 161 (Decide Optimum Product Solution) (9%, n=1 each). The latest activities selected for use with this presentation option included: 164 (Communicate Seasonal Plan) by 27.3% (n=3) of the participants followed by 134 (Evaluate Fabric Type and Style) by 18.2% (n=2) of the participants. Additional activities from the design process model that were noted as potential activities for use of the option included: 141 (Select Carryover and Reorderable Products), 142 (Merchandise the Line), 153 (Finalize Fabric Prints and Texture), 161 (Decide Optimum Product Solution), and 165 (Present Line and Best Styles) (9.0% each) (see Appendix D1).

Research Objective A

Identify current manual presentation options for fabric and color in the design process

This research objective identified the current manual presentation options. Based on literature, research experience, and pilot tests, current options were expected to be the manual presentation options of the fabric swatch and the printed fabric card. This assumption was substantiated by the usage of the participants. Automated options were not expected to be in current use; however, two participants had experience with this option.

Their current usage was very limited, and could not complete the questions in this section. For this reason, the prediction of manual options as fabric swatch and swatch card was continued in this study.

The research objective was satisfied by comparing the response data for past use of the presentation option being reviewed with the response data for the past use history of the option. Participants were asked to record past use history for the past season, for the past three seasons, and within the past year. Information for the number of product development seasons in a year was also recorded. This series of questions was asked to identify if there was a developing trend in the use of the current presentation option. Contingency table comparisons were completed using variables for adequacy of decision making information (i.e., sufficiency), future use, and discontinuance (i.e., deterrents) areas. The variables in the contingency tables were examined to explore consistency levels between presentation options for continuance and discontinuance of use (see Appendix D2).

For the fabric swatch presentation option (manual), 76.9% of the participants (n=10) had used the format. Use rate for this format within the past season ranged from 10 to 600, with an average use rate of 222.8. For the past three seasons, the use rate ranged from 6 to 2000, with an average use rate of 516.5. Four seasons were recorded by 30.8% of the participants and 7.7% recorded for five and two seasons respectively. For one company, the fabric swatch presentation format was used 3000 times in the past year (see Appendix D2).

Printed swatch cards (manual) were not a familiar presentation option for study participants. Only 23.1% (n=3) had used this presentation option in the past. The information provided by the participants who had used printed swatch cards in the past was limited. Of the participants who had used this presentation method, 66.7% (n=2) did not provide numbers for past season use of the presentation format. None of the users provided information for the past 3 seasons. Yearly counts for presentation formats use were 1 and 150. Limited information was provided for the number of times this presentation option was used in the past 3 seasons, the past year, and the number of seasons (see Appendix D2).

In summary, the most familiar current presentation option was fabric swatch format. The printed swatch cards, although available in the industry, were in extremely limited use by these participants. According to the participants, the fabric sample presentation option format was the most widely used presentation option format because of the wealth of information that is conveyed.

Research Objective B

Assess viability of current manual presentation options for fabric and color in the design process.

This research objective assessed the viability of the current manual presentation options identified in research objective A as current presentation formats (i.e., fabric swatch, printed swatch card). Viability of presentation options was assessed using variables for fabric characteristics information and presentation format attributes. The scale for these variables was a five-point Likert-type scale that ranged from level 1 (i.e., does not describe at all) to level 5 (i.e., describes very well). The characteristics rated included the following: (a) color, (b) shade, (c) brightness, (d) fuzzy, (e) soft, (f) smooth, (g) opaque, (h) body, (i) bounce, and (h) drape. These information criteria were selected based on previous research that recorded fabric aesthetics using common words (Brand, 1964). To be considered a viable presentation option, the option must have at least seven fabric characteristics and seven format attributes with rating levels of 4 (i.e., somewhat describes) or above.

Fabric swatch (manual) fabric characteristics variable results were consistently rated at level 4 or 5 by all ten participants for all ten variables. For the presentation format attributes, all of the participants who used fabric swatches (n=10) rated the following characteristics: familiar, satisfactory results, and commonly used, at levels 4 or 5. Eight participants (80%) rated convenience, enhance creativity and increase quality at a 4 or 5 (see Table 26) (see Appendix D3).

For the fabric swatch option, 60% (n=6) of the participants indicated that no training was needed to use this option. Among the other participants who had used this option, two participants thought that extensive training would be necessary, and one participant did not complete the question (see Appendix D3).

Participants were asked to rate the overall viability of the option for future or continued use. For fabric swatches, every participant indicated that this option should continue to be used. In fact, 38.5 % indicated that they would like to see an increased use of this option. This response is contrary to what the fabric producers are predicting for their future sample distribution methods (see Appendix D3).

For the printed swatch cards (manual), three participants indicated past use of this option. This option is in common practice among fabric companies and is used in the industry when fabric companies provide multiple versions of a fabric. The finding of limited usage is in contrast to the expectations of the researcher. No explanation was given by any

Table 26

Viability Assessment of Fabric Characteristics and Presentation Option Format Attributes for Fabric Swatches

Fabric Characteristics					
Viable			Non-Viable		
Variable	n	Percentages	Variable	n	Percentages
Color	10	100.0	---	---	---
Shade	10	100.0	---	---	---
Brightness	10	100.0	---	---	---
Fuzzy	10	100.0	---	---	---
Soft	10	100.0	---	---	---
Smooth	10	100.0	---	---	---
Opaque	10	100.0	---	---	---
Body	10	100.0	---	---	---
Bounce	10	100.0	---	---	---
Drape	10	100.0	---	---	---
Option Attributes					
Familiar	10	100.0	Saves Time	5	50.0
Commonly Used	10	100.0	---	---	---
Convenient	8	80.0	---	---	---
Satisfactory Results	10	100.0	---	---	---
Low Risk	9	90.0	---	---	---
Increase Productivity	7	70.0	---	---	---
Enhance Creativity	8	80.0	---	---	---
Increase Quality	8	80.0	---	---	---
No Training Needed	6	60.0	---	---	---

Note: Percentages indicate the percentage of participants that on that variable rated the option at a 4 or 5.

of the nonuser participants. Of the fabric characteristics variables, five variables were assessed as viable (i.e., levels 4 or 5, n=2 each). The variables included color, shade, brightness, smooth, and opaque (see Table 27). Assessment of the format attributes information revealed that the only viable variables were familiarity, convenience, saves time, and no training needed (see Appendix D3).

Table 27

Viability Assessment of Fabric Characteristics and Presentation Option Format Attributes for Printed Swatch Cards

Fabric Characteristics					
Viable			Non-Viable		
Variable	n	Percentages	Variable	n	Percentages
Color	2	66.7	Fuzzy	2	66.7
Shade	2	66.7	Soft	2	66.7
Brightness	2	66.7	Body	2	66.7
Smooth	2	66.7	Bounce	2	66.7
Opaque	2	66.7	Drape	2	66.7
Format Attributes					
Familiar	2	66.7	Commonly Used	2	66.7
Convenient	2	66.7	Satisfactory Results	2	66.7
Saves Time	2	66.7	Low Risk	2	66.7
No Training Needed	2	66.7	Increase Productivity	2	66.7
---	---	---	Enhance Creativity	2	66.7
---	---	---	Improves Quality	2	66.7

Note: Percentages indicate the percentage of participants that on that variable rated the option at a 4 or 5.

Participants were asked about their preference for continued or future use of this manual option. Among the swatch card users, only one user (33.3%) recommended continued use of the cards. The other two participants (66.7%) recommended discontinued usage. No one recommended an increase in the use of this option. This response is consistent with the participants' responses about the lack of viability of this option (see Appendix D3). Comments from these participants indicated that they were provided this option from the fabric companies when basic or staple fabrics were used on a reorder basis. Training requirements and adequate process in place were reasons given to substantiate their preference for discontinued use.

In summary, the fabric swatch presentation option is the most viable presentation option format. Participants consistently rated the fabric characteristics and format attributes at levels 4 or 5 for color. Participants thought that the fabric option was viable for fabric characteristics such as texture (i.e., fuzzy, soft, smooth, opaque), and movement (i.e., body, bounce, drape). As judged by the format attributes, participants also found this option to be easy to use. The printed swatch card is not a viable presentation option format in terms of fabric characteristic information, specifically variables that related to texture and movement. The printed swatch card was also not viable because participants thought that it did not provide satisfactory results, had a high risk when used in a design decision, and reduces creativity and quality.

Research Objective C

Identify future automated presentation options for fabric and color in the design process.

This research objective identified the future automated presentation options. Future was defined as options that were automated versions of fabric and utilized computer simulations to convey fabric characteristics. No participants had used the 3D simulation. Only two participants had any experience with 2D simulation, and this experience was extremely limited. One participant commented that she had used the 2D simulation so infrequently that she could not report any of the current use information about this option. The assumption that the automated options, or computer simulations, were the future options was supported by the findings (see Appendix D4). Although participants were not currently using the method, industry reports indicate that these are the future formats for the industry (personal communication, Dan Randall, October 13, 1999; Roland L. Connelly, Sr., October 14, 1999).

Research Objective D

Assess viability of future manual and automated presentation options for fabric and color in the design process.

This research objective assessed the viability of the future presentation options identified in research objective C as future presentation formats (i.e., 2D and 3D simulation). Viability of a presentation options was assessed using variables for fabric characteristics information and presentation format attributes. The scale for these variables was a five-point Likert-type scale that ranged from level 1 (i.e., does not describe at all) to level 5 (i.e., describes very well) was used. The characteristics rated included the following: (a) color, (b) shade, (c) brightness, (d) fuzzy, (e) soft, (f) smooth, (g) opaque, (h) body, (i) bounce, and (h) drape. These information criteria were selected based on previous research that recorded fabric aesthetics using common words (Brand, 1964). To be considered a viable presentation option they must have at least seven characteristics and seven attributes with predominant ratings with levels of 4 (i.e., somewhat describes) or above. Responses for these automated options were gathered from all participants because as a future option potential use as available to all designs.

For the 2D simulation, participants, in general, did not like this presentation option (see Table 28). Texture variables split with responses between viable and nonviable. Viable variables for fabric characteristics included only: color, shade, and brightness. Participants thought that the movement variables of the fabric characteristics were nonviable. For the format option attributes, the only viable variable was saves time. The remaining variables for the format attributes were not viable. More than one-half of the participants thought that extensive training would be necessary to use this option (see Appendix D5).

When asked for their preference for future use, participants (30.8%) recommended that the option be discontinued, and 46.2% recommended decreased use of this option. Only 15.4% recommended continued use of the option, and one participant did not report a future use preference. This finding is consistent with the viability ratings. No fabric movement variables were rated as viable, and only one format variable was considered viable. Participants noted that the equipment requirements for this option were high and were not justified considering the amount and quality of information that was obtained from the option (see Appendix D5).

For the 3D simulation, all of the fabric characteristic information variables were rated at levels 4 or 5 by all participants (see Table 29). For format attributes variables, only three of the attributes had ratings of 4 or higher by more than 50% of the participants. Those were satisfactory results (69.3%, n=9), saves time (61.6%, n=8), and familiar (53.9%, n=7) (see Table 28). Three other attributes (i.e., low risk, increase productivity, enhance creativity) had few participant level 4 or 5 recordings (46.2%, n=6). Five of the participants (38.5%) in the study recorded level 3 or neutral ratings on the variables low risk and increase productivity with 15.4% (n=2) of the participants giving recordings of levels 1 or 2. The enhance creativity variable had two recordings for level 3 and the remaining recordings (38.5%, n=5) were for levels 1 or 2 (see Appendix D5).

Table 28

Viability Assessment of Fabric Characteristics and Presentation Option Format Attributes for 2D Simulation

Fabric Characteristics					
Viable			Non-Viable		
Variable	n	Percentages	Variable	n	Percentages
Color	12	92.3	Fuzzy	5	38.5
Shade	10	76.9	Soft	2	15.4
Brightness	9	69.2	Smooth	3	23.1
---	---	---	Opaque	3	23.1
---	---	---	Body	1	7.7
---	---	---	Bounce	1	7.7
---	---	---	Drape[a]	---	---
Option Attributes					
Saves Time	7	53.9	Familiar	5	38.5
---	---	---	Commonly Used	3	23.1
---	---	---	Convenient	6	46.2
---	---	---	Satisfactory Results	3	23.1
---	---	---	Low Risk	4	30.8
---	---	---	Increase Productivity	1	7.7
---	---	---	Enhance Creativity	2	15.4
---	---	---	Increase Quality	2	15.4
---	---	---	Training Needed	8	61.6

Note: Percentages indicate the percentage of participants that on that variable rated the option at a 4 or 5. [a] No participant reported a 4 or a 5 for this variable.

Table 29

Viability Assessment of Fabric Characteristics and Presentation Option Format Attributes for 3D Simulation

Fabric Characteristics					
Viable			Non-Viable		
Variable	n	Percentages	Variable	n	Percentages
Color	12	92.3	---	---	---
Shade	11	84.6	---	---	---
Brightness	11	84.6	---	---	---
Smooth	11	84.6	---	---	---
Fuzzy	11	84.6	---	---	---
Soft	11	84.6	---	---	---
Opaque	12	92.4	---	---	---
Body	12	92.4	---	---	---
Bounce	12	92.4	---	---	---
Drape	11	84.6	---	---	---
Option Attributes					
Familiar	7	53.9	Commonly Used	2	15.4
Satisfactory Results	9	69.3	Convenient	5	38.5
Saves Time	5	61.6	Low Risk	6	46.2
---	---	---	Increase Productivity	6	46.2
---	---	---	Enhance Creativity	6	46.2
---	---	---	Improves Quality	4	30.8
---	---	---	Training Needed	10	77.0

Note: Percentages indicate the percentage of participants that on that variable rated the option at a 4 or 5.

Findings for this research objective about the future options were that the 3D simulation presentation option was viable for communication of fabric characteristics information; however, format attributes were not viable for increasing productivity, creativity, and quality, or for reducing risks. The 3D simulation format was also not recorded by participants as convenient or low risk. In addition, participants thought that this option would require additional training prior to use. Training needed was given as a deterrent in the comment section. The participants also thought that the option would restrict their creativity and productivity (see Appendix D5).

For 3D simulation, 46.2% of the participants recommended continued use of the option, and 7.7% recommended increased use. Discontinued and decreased use was selected by 38.5% of the participants. One participant omitted this question. This finding is in contrast to the variable viability ratings for fabric because most participants rated this option high for all fabric information. They rated many of the format variables as nonviable. The problems with usage may have discouraged some participants. Reasons for discontinuing use included training requirements, high equipment requirements, and adequate process already in place (see Appendix D5).

In summary, the 2D simulation was rated by participants as nonviable in format and only partially viable in fabric information characteristics. For this reason, the 2D simulation is considered to be a nonviable future option. The 3D simulation was rated by the participants as viable on 100% of the fabric information characteristics. More than one-half of the participants rated the 3D simulation as saving time, and reported that the option would provide satisfactory results when used in their job. For this reason, the 3D simulation is considered to be a viable future option.

Research Objective E

Compare viable manual (current) and automated (future) presentation options for fabric and color in the design process.

The purpose of research objective E is to compare, through the use of contingency tables, participants' recordings for preference of use. The fabric swatch option was rated overall as the viable manual or current option. The 3D simulation was rated overall as the viable automated or future option. Comparisons were made between these two options

Research objective E1. ***Relationship between presentation option preference, sufficient decision information, presentation information conveyance, and presentation option attributes evaluation.***

The purpose of research objective E1 was to provide an overview of the comparison between the viable options and to investigate the consistencies between reported presentation option preference levels and the selection for use variables (i.e., sufficient decision information, presentation fabric characteristics, conveyance, option attribute information). Contingency tables were used to examine these variables (see Appendix D6). Sufficient information was evaluated by the participants by responding to whether the option provided enough information to make a decision. Most participants rated the fabric swatch as providing sufficient information (see Table 30). Five of the participants rated the 3D simulation as providing sufficient information. When rating the information that was by the provided options for fabric characteristics, the participants gave both options equal ratings. The 3D simulation was equivalent to the fabric swatch in terms of specific fabric variables. With this equivalency of fabric information ratings, the researcher would assume that the rating would be higher for the overall evaluation of sufficient information; however, the manual option was rated much higher than that automated option. According to comments from participants, the difference between the two options was the inability to touch the fabric in the 3D simulation (see Appendix D6).

Table 30

Comparison of Viable Options for Sufficient Information, Fabric Characteristics Information and Format Attributes

	Fabric Swatch (Manual)	3D Simulation (Automated)
Percentage of Participants		
Sufficient Information	92.3%	53.8%
Percentage of Viable Variables		
Fabric Characteristics Information	100.0%	100.0%
Format Attributes	90.0%	30%

The future manual presentation option identified in this study was the fabric sample format. A large percentage of the participants indicated that the fabric swatch format provided sufficient information for decision making. With this finding, recommendations for future use were explored. Recommendations for future use included continue use (50%) and increase use (50%). None of the participants identified deterrents to the use of this presentation format. With these designers, the fabric swatch presentation format appears to be well established and identified for continued use in the future (see Appendix D6).

The future automated presentation option identified by participants in the study was the 3D simulation presentation format. For the variable, sufficient information provided by the format, a slight majority of the participants reported that the 3D simulation format was acceptable for decision making. With this acceptance, the preference for use was examined. While 46.2% of the participants recommended continue use of the presentation format and

7.7% recommended increase use of the presentation format, a few participants selected decrease or discontinuance of this option (40%, n=2). For the five participants that selected decrease or discontinuance use, they indicated the deterrents of training requirements, equipment requirements, and adequate process in-place (see Appendix D6).

Research objective E2. ***Relationship between presentation option preference and current position, industry experience, position experience, time at current position, previous position experience, time at previous position, and computer experience.***

Contingency tables were compiled to compare job information variables and presentation option experience. Job information variables used included: (a) current position, (b) industry experience, (c) position experience, (d) time at current position, (e) previous position experience, (f) time at previous experience, and (g) textile and fabric experience/knowledge amounts. These comparisons were completed to evaluate or identify any effect job experience, position, and expertise levels would have on evaluation of presentation option (Bean, 1997; Kang, 1999; Regan, Kincade, & Sheldon, 1998; Venkataraman, 1992; Wimmer, 1995). Presentation option formats reviewed in this research objective included: (a) fabric swatch and (b) 3D simulation. Presentation preference option was measured by the question of preference to continue or increase use of the option.

For the fabric swatch option, all participants gave ratings for preference to continue or increase use (see Appendix D6). Job characteristics, such as position and time in that position had no relationship to this rating for fabric swatch. Regardless of position (merchandising or design), 100% of the participants recommended continued or increased use of the fabric swatch. For participants who supported the viability of the 3D simulation, 40% had positions in the merchandising function of their company and 60% were in the design function of the company (see Appendix D6). In comparison to the fabric swatch, which was rated as viable by all participants, participants with design positions rather than merchandising positions tended to be more favorable to the 3D simulation.

Of the seven participants who rated that the 3D simulation should be continued or increased, number of years in the industry appeared to have no relationship to their preference. Participants with few years of experience and those with many years of experience were among those with preference to continue to use or increase this option. The additional job experience variables of time in the current or other industry experience had similar disbursement of participants (see Appendix D6). No relationship was observed between industry experience, current or otherwise, and ratings for the use of 3D simulation.

Amount of computer experience showed some relationship with preference for the 3D simulation (see Appendix D6). Participants with fewer years of computer experience were more inclined to recommend continued or increase use of this option than participants with more years of computer experience.

Research objective E3. ***Relationship between presentation option preference and type of computer experience, amount of computer experience, total CAD experience, CAD training, CAD use, and CAD daily utilization.***

Contingency tables were used to compare computer and CAD experience variables to presentation option preferences. The purpose was to investigate if participants that recommended decrease or discontinue use had low levels of computer experience, CAD experience, and CAD training, and CAD application. Variables reviewed included: (a) type of computer experience, (b) amount of computer experience, (c) CAD experience total, (d) CAD training, (e) current use of CAD, and (f) percentage of daily CAD use.

The fabric swatch was rated by 100% of the participants to be recommended for continued or increased use (see Appendix D6). Preference for this option had no relationship to computer usage. Everyone wanted to use fabric swatches. For this objective, only the automated or computer related option was further evaluated for relationships with other variables. Literature indicates that lack of computer use can be a deterrent to adoption of new computer technologies (Wimmer, 1994). For this reason, the objective was explored relative to participants who rated the 3D simulation for decreased or discontinued use.

The type of computer experience that was recorded most frequently for participants that recommended decrease use or discontinue use of the presentation formats was word processing (100%) for 3D simulation (see Appendix D6). The next most common computer experience as reported by those who wanted to reduce usage was spreadsheet experience (see Appendix D6). Preference for the 3D simulation appeared to be low when the type of computer experience was primarily word processing.

The participants appeared to have adequate amounts of computer and CAD experience for a practical review and evaluation of the automated (3D simulation) presentation option formats. In terms of computer experience, participants were not asked to provide information on when they received their computer training and on what types of systems, so a comparison on how advanced their computer training was cannot be addressed. For CAD experience total, the more experienced CAD user did not prefer the 3D simulation in comparison to the less experienced CAD users. CAD training was generally the same for all participants; therefore, no assessment could be made for the impact of this variable on preference ratings. Current use of CAD and daily CAD usage had no relationship with preference level for 3D simulation (see Appendix D6).

In summary, lack of graphic type computer experience (i.e., no CAD experience or primarily word processing experience) was related to a negative response to the question on preference for the 3D simulation. Specific CAD experience, although varied among the participants, was not directly related to preference ratings. Having extensive CAD experience did not make a participant an avid fan of the 3D simulation.

Research objective E4. ***Relationship between presentation option preference and CAD for apparel or interior design, CAD for textile design, company CAD design use, company CAD stations, and company CAD employees.***

Contingency tables were used to compare presentation option preference with specific industry application of CAD. The purpose was to investigate if participants that had CAD application experience that would have transferable skills for the use of the automated presentation option format. Variables reviewed included: (a) CAD application areas in apparel/interior design, (b) CAD application areas in textile design, (c) company CAD use, (d) CAD stations, and (e) CAD employees. The numbers in these comparisons are too small, often one per comparison, to make meaningful comparisons (see Appendix D6).

Research objective E5. ***Relationship between presentation option preference and job satisfaction.***

This objective was designed to measure the relationship between the ratings on presentation options and participants' job satisfaction. All participants rated their jobs at same level of satisfaction. Lack of variance in the responses precluded additional analysis.

In summary for research objective E, inclusion of fabric characteristic information variables and format attribute variables allowed for the comparison of viable and nonviable presentation formats. This comparison was also augmented by a decision making variable, which allowed for a review of consistencies and inconsistencies for presentation format for future use. Preferences for the two viable options were equivalent for fabric characteristics information. For format attributes, some differences were noted, and differences were found in the ability of the options to provide sufficient information. These differences were further investigated through the relationship between preference for an option and a variety of personal work experience variables. The preference ratings for the fabric swatch option were consistently high; therefore, no relationship between work experience variable and the preference for the fabric swatch could be determined. Preference for the 3D simulation did vary across the participants. The researcher, in the analysis of research objectives E2-E5, sought an explanation of the variance in the preference ratings for the 3D simulation. Type of computer experience and amount of computer experience had some relationship with the preference ratings on the 3D simulation (see Appendix D6).

Chapter Five

Summary, Conclusion, Limitations, and Suggestions for Future Research

Using new technology is proposed as a competitive advantage strategy for manufacturers who struggle to meet consumer's changing needs. Regan (1997) discussed the importance of management of the design function and the need to improve decision making in design. Increased information about the design process and the integration of automated technology in the apparel design process is needed to achieve the improvements that Regan recommends. The purpose of this study strives to meet these recommendations by Regan and to provide information for the apparel industry and the academic researchers and teachers who study and teach design.

Companies in many industries have begun using automated or 3D simulations for presentation of fabric, color and print options. These options are used frequently in marketing functions and have potential for design functions. Limited information is available about the use of presentation options that are an alternative to the traditional fabric swatch. Although trade shows and industry literature have reported successful usage of automated presentation options, information is needed about the practical use of these options for the design process within an industry setting.

The purpose of this research was to assess the current and potential presentation options for fabric and color in the design process. Presentation options can vary in the amount and accuracy of the information that is conveyed to the user. Exploration of current and future presentation options can provide information about the sufficiency of the information provided and for a review of consistencies and inconsistencies in the designer's perception of these options.

Summary

This study assessed current and potential presentation options for fabric and color in the design process. This exploration was used to identify new and future technologies for presentation of fabric and color that could potentially aid in increasing apparel manufacturing competitiveness through time and cost reduction. This identification helped to record if the current practices for apparel design were congruent with the current available technology and estimated future technology capabilities. Assessments of the fabric and color presentation options were used to help record levels of accuracy and information content delivered by these options for product designers. Preferences were also recorded for fabric and color presentation option structures and formats.

The completed study was a modified preexperimental research design. Four treatment levels, but no control sample, were used. Selection criteria guided the researcher in identifying 61 designers who could potentially participate in the research. Of this sample, 13 designers met all of the criteria and participated in the study. Data were collected with a self-administered survey package that was mailed to the participants. The package contained a multi-part questionnaire and the four presentation options for viewing. The four presentation options were fabric swatch, swatch card, 2D simulation, and 3D simulation. The questionnaire asked the participants for ratings of each presentation option according to fabric characteristics information and format attributes. The questionnaire also contained questions about work experience, company demographics and computer experience.

Research objective A. Research objective A identified current manual presentation options that were satisfied by the comparison of response data for past use of the presentation option. A series of questions, which included past season and yearly use, was reviewed to identify any trends in the use of the presentation option. The most familiar manual presentation option or the presentation option in most current use, as identified by the participants, was the fabric sample. This finding is in alignment with the expected results (Frings, 1999; Peltz, 1980). The fabric sample format is currently the most used presentation format. Although known to be used by fabric producers, very few participants had used or were currently using swatch cards.

Research objective B. Research objective B assessed the viability of the current manual presentation option by assessing participant ratings for conveyance of fabric characteristics information. This variable included: (a) color, (b) shade, (c) brightness, (d) fuzzy, (e) soft, (f) smooth, (g) opaque, (h) body, (i) bounce, and (j) drape. Participants also recorded ratings for how well the following list of format attributes were conveyed through the presentation options. The list included attributes such as, (a) familiarity, (b) commonly used, (c) convenient, (d) satisfactory results, (e) low risk, (f) increase productivity, (g) increase creativity, (h) saves time, (i) improves quality, and (j) requires training. The selected fabric characteristics and information attributes were adapted from research conducted by Brand (1964) and Geissler (1998). A five-point Likert-type scale that includes the following levels, does not describe at all (1) to describes very well (5), was used.

The fabric sample presentation option was consistently rated as the viable presentation option for conveyance of fabric characteristics and attribute information.

Contingency tables were used to compare rated adequacy levels of decision making information (i.e., sufficiency of information) for future use and discontinuance (i.e., deterrents) areas. Examination of these variables also helped to verify consistencies or inconsistencies between continuance and discontinuance of use information. Most participants had experienced using this presentation option. Participants liked the fabric sample for the fabric characteristics information and the format attributes that this option provided. This option satisfied the participants' desire to touch and feel the texture of the fabric.

Viability analysis for the printed swatch card presentation format was also conducted. The study found that this format did not adequately convey texture and movement information. The participants thought that this format would not contribute to a satisfactory result and was a high risk format.

Research objective C. Research objective C assessed the future automated presentation options by analyzing past use data. The 2D simulation option had been used by a few participants; however, the frequency of use was so small that seasonal use data was not reported. No participants reported use of the 3D simulation format. These findings were in alignment with the assumption that the automated presentation options were future presentation options. Previous research in the area of fabric simulation and 2D and 3D communications also support these findings. Previous studies reported that the necessary technology is available for automation of the apparel product design process (Breen, et al., 1997).

Research objective D. Research objective D was completed by assessing the viability of the automated presentation options. Fabric characteristics and attribute format information was judged using the context of comparison to general fabric swatch formats. According to the participants, the 2D simulation format presented color and shade information adequately; however, the diversity of responses on the color verification question indicates that the true color may not be accurately determined by this method. Participants did not feel that the format effectively conveyed texture and movement information. The ratings for discontinue use of the 2D simulation format were not consistent with the variable sufficient information supplied by the presentation option. While most of the participants felt that the 2D simulation format did not provide sufficient information, only a few participants recommended discontinue use, and less than one-half of the participants recommended decrease use. Because of the lack of viable fabric information this option was judged to be nonviable.

The 3D simulation presentation was rated as a viable presentation option. All of the fabric characteristics had viable ratings. The format attributes were viable for time saver and satisfactory results. The amount of training and the equipment needs for this option were the primary deterrents to its use.

Research objective E. Research objective E compared, through the use of contingency tables preferences for use to a variety of work experience variables. The fabric swatch option was rated as the overall viable manual option. The 3D simulation was rated as the overall viable automated option. Variations in preference for use were reviewed for these options.

Preferences for the two viable presentation options were equal for fabric characteristics information. There was some variance in the format attributes in providing sufficient levels of information. All participants, regardless of demographics, computer experiences or company information, rated the fabric swatch as a viable option. For the 3D simulation, differences were noted between the computer type experience and the presentation option preference use rating. Differences were noted between the personal work experience and the presentation option use preference. Comparisons completed for research objectives E2-E5 identified computer experience, types and level, as having a relationship on the preference for use ratings of the 3D simulation format.

Use of the presentation simulations. A process design model was provided to the study participants. The model was adapted from Regan's (1997) research, which presents a comprehensive, documented apparel design and preproduction process. The goal was to have the participants indicate on the model the earliest and latest points for potential use for the presentation option. Usability may be influenced by the location on the model or time constraints imposed by company time lines for product development. In the responses, the higher the ratings for information conveyance, the wider the range of activities that were included for use with the presentation option.

The swatch card was identified by the participants as having very limited usage, and basically a nonviable format for any decisions except reorder and tentative or temporary decisions. The 2D simulation was also judged to be nonviable as a presentation option to evaluating fabric type and style and decide optimum product solution. These are critical design decisions that must be made to move to the next decision point, and are noted by the participants as needing to be made with the fabric swatch. The swatch card or 2D simulation option could be used as supplementary information for fabric sample requests, carryover colors and styles, and reorders. These are design decisions that use previous information and are making minor changes to established decisions.

A wide range of design decision activities was listed for the fabric sample presentation option. The 3D simulation option had a list that was similar to the activities list for the fabric swatch of both critical decision activities and reorder type activities. This finding is in support of the research reports that the 3D simulation is an effective communication option for colors and images for specific tasks (Miller, 1994), and is most effective for conveyance of particular types of information.

Conclusions

Technology requirements were of concern for the participants in the study. They indicated that the technology requirements were a deterrent for the future use of the 2D simulation. The same equipment requirements are present for the 3D simulation format; however, that variable was not selected at a comparable level as a deterrent for use of that presentation format. The participants consistently rated the 3D simulation format at higher viability levels than the 2D simulation for characteristic information and format attributes. Training was noted as needed for the automated formats. Participants with computer experience of a more advanced format were inclined to show a preference for the continued or increased use of the 3D option.

Viability of the presentation options appeared to be task specific. When asked where in the design process that the option would be useful, participants' responses variety with the presentation option. This finding is in support of information from Miller (1994) that automated processes are successful in conveying information for specific tasks. Future use of these options may be task specific.

Industry personnel and limited research report that automated presentation options are not viable; however, the findings in this study indicate that the 3D automated presentation option is viable. More than one-half of the participants reported that this option could be used in the future. Although the participants reported that the 3D simulation was viable, the fabric swatch remained the option with the strongest support. The 3D simulation was rated viable for all visual fabric characteristics; however, in the comments, participants said that this option did not satisfy their desire for tactile information about the fabric. They repeated that they wanted the tactile information, but many participants did agree that the 3D simulation would provide them with the information needed to make many decisions in the design process.

Limitations and Suggestions for Future Research

Limitations for this research, as with any qualitative research project, impacted the results of this study. Guidance for future research is based on the consideration of the limitations and the results from the study. Areas of consideration include generalizability of the results, sample size, sample diversity, and variable analysis.

Use of a judgement (convenience) sample limited the generalizability of the study. A larger and more random sample size would facilitate the use of more stringent data analysis techniques for examination of the data. A more diverse sample would allow for generalizability or the inference of data results to product development areas beyond the ones viewed in this study.

A number of the variables used in the study had limited previous use, or were drawn from industry studies or studies in non-fabric related fields. A future qualitative study of fabric and color presentation options is needed to reveal more of the underlying factors that may have influenced the variables in the study, (i.e., conveyed information for presentation options, presentation option attributes, sufficient decision information, discontinuation of use of presentation option). Further refinement of variable analysis is needed to allow weighting of the variables in a quantitative study. With weighting of the variables, more accurate measures of association for a truer identification of significant relationships can be recorded and improve inference to other samples.

Position in the company and type of computer experience showed a relationship to the viability of the option. Future study should investigate this relationship.

This study was based on the apparel design process as defined by Regan (1994). This foundation limits the generalizability of the findings to design processes that might vary from Regan's model. A review and validation of the apparel design process used in the study would promote more accurate baseline information for the development of a general applicable design process model.

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