ABSTRACT

HATCHER, LESLEY. An Integrated Printed Textile Design and Apparel Product Development Process. (Under the direction of Dr. Traci May-Plumlee (Chair) and Professor Nancy Powell (Co-Chair))

The purpose of this study was to acquire information about the textile print design process as it is executed at apparel companies who design and develop printed fabrics internally for their seasonal lines. Technologies used by apparel companies in the textile print design process were also surveyed.

The sample consisted of nine companies who design and develop printed fabrics internally to be used in their seasonal apparel lines. Using a case study approach, company representatives were interviewed via the telephone. The data from each respondent company was organized by process steps and technologies used, and translated into a graphical representation. The graphical representations from all companies were compared for similarities and differences and consolidated into a graphical representation. The graphic representation of the textile print design process at an apparel company was then integrated into the No-interval Coherently Phased Product Development Process for Apparel by May-Plumlee and Little (1998). The result was a framework that serves as a theoretical foundation for academic research in the integration of the apparel design and textile print design processes, and a model for practitioners.
AN INTEGRATED PRINTED TEXTILE DESIGN AND APPAREL PRODUCT DEVELOPMENT PROCESS

By

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A thesis submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the Degree of Master of Science

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DEDICATION

This research is dedicated to Lexus and Charlie.
BIOGRAPHY

The author, Lesley Nicole Hatcher, was born in Raleigh, NC on September 16, 1980. Her parents are Terry and Marsha Hatcher and she has a younger sister, Terri Morgan Hatcher.

Lesley was raised in Raleigh, NC and graduated from Athens Drive Senior High School in 1998. She received her Bachelor of Science Degree in Textile Technology with a concentration in Textile Design from North Carolina State University in 2002. She then continued at North Carolina State University to pursue her Master of Science Degree in Textile Technology and Management under the New Product Development Concentration with a minor in Design.
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CHAPTER I

INTRODUCTION

The apparel industry has been faced with greater competition, shorter cycle times, and highly sophisticated consumers as it has evolved over the past decade (Wickett, Gaskill and Damhorst, 1999). As a result the academic world continues to research the ever-evolving apparel product development process. With an increasing amount of competition in the market place and sophisticated target markets, the design and development of apparel products becomes an increasingly important phase in apparel production. Effective design and development is essential in order to create products that will be successful at retail. It is important that apparel manufacturers not only consistently develop up-to-date silhouettes, but also pay close attention to the color and print direction of the fabrics that are produced, as these are major factors in an end-consumer’s decision to purchase. Apparel product development models clearly outline fabric and color selection, but those models, whether sequential or concurrent in nature, do not clearly establish how the printed fabrics used in the garments are developed. Using the No-Interval Coherently Phased Product Development Model for Apparel (NICPPD) by May-Plumlee and Little (1998) as a foundation, this thesis addresses the development of internally produced fabrics. This process is found in Phase 3 of their model (See Figure 5), Design Development and Style Selection.
Purpose of the Study

The purpose of this research is to conduct an in-depth analysis to identify how printed textiles are designed in U.S. apparel manufacturing firms and how this process can be integrated into the NICPPD Model for Apparel proposed by May-Plumlee and Little. There are 2 primary goals of this research:

1. To develop an industry-focused process for the integration of the textile print design and apparel design processes
2. To determine what technologies and systems are used in the processes, at which stages these technologies are used, and how these technologies can be used to integrate the overall textile print design process into the apparel design process.

A case study methodology was used in this research to collect qualitative data. The individuals targeted for this research were those who are involved in the development of an apparel company's printed fabric and it's seasonal apparel lines.

Research Objectives

There are five primary research objectives. They are as follows:

1. Identify the phases and the design process involved in the development of a printed fabric designed internally by an apparel company.
2. Identify how the development of a printed fabric integrates into the overall apparel product development process.
3. Determine what types of technologies and systems are used in the design and development of printed fabrics at an apparel company.

4. Identify any of the technologies that are used in both the printed fabric design process and the apparel development process.

5. Determine the interaction points and scope of the interactions between the apparel and print development functions.

Significance of the Study

The study will provide further insight into the apparel development process through the expansion of the NICPPD Model for Apparel proposed by May-Plumlee and Little (1998). This will be done by incorporating a model framing the design and development process for printed fabrics created internally at apparel companies into the NICPPD model.
Definition of Terms and Abbreviations

**Coverage**- The printed area of a fabric.

**Grain**- The direction of the warp yarns (woven fabric) or wales (knitted fabric) in a fabric.

**Lab dips**- Fabric swatches which are dyed in efforts to match a color standard that has been set by a company.

**Pattern grading**- “Taking the production pattern pieces made in the sample size for a style and creating a set of pattern pieces for each of the sizes listed on the garment spec sheet.” (Burns and Bryant, 430).

**Registration**-“The alignment of colors to each other on the fabric during the printing process (Fisher and Wolfthal, 206).

**Sourcing**- “Decision process for determining how and where textile and apparel products or their components will be produced” (Burns and Bryant, 432).

**Strike-off**- “Sample prints on fabric for pattern or color approval” (Wilson, 144).

**Trim**- “materials used to ornament or enhance garments” (Glock and Kunz, 524).
CHAPTER II

REVIEW OF LITERATURE

Apparel Product Development Models

When developing any new product, there is a series of steps which typically occur to facilitate the product creation. The process typically begins when there is a need for a new product or product range. Initiating factors that can facilitate the need for new product development are “financial goals, sales growth, competitive position, product life cycle, technology, globalization, regulation, material costs, inventions, demographics, lifestyle changes, customer requests, supplier initiatives and alliances” (Urban and Hauser, 1993, p. 6). In terms of printed apparel, new products are typically created as components of a product range, also known as a line or collection, as opposed to independently as individual products.

Several apparel product development models that describe the process used in developing seasonal apparel lines can be found in the literature. The steps typically found in these models are as follows (Burns and Bryant, 1997):

1. Research
2. Design
3. Design Development and Style Selection
4. Marketing the Line
5. Pre-production
6. Sourcing
7. Apparel Production
8. Distribution
Using the Burns and Bryant (1997) model as a generic framework for the stages involved in the apparel product development process, the other apparel development models found in the literature were reviewed and compared to determine which stages in the apparel development process were included. All of the models reviewed in the literature, The Retail Product Development Model (Gaskill, 1992), the Revised Retail Product Development Model (Wickett, Gaskill and Damhorst, 1999), NICPPD Model for Apparel (May-Plumlee and Little, 1998) and the Apparel Design Framework (Lamb and Kallal, 1992) included the research, design and design development and style selection stages as found in Burns and Bryant’s framework. The Retail Product Development Model and the NICPPD Model for Apparel were the only 2 models reviewed that included a ‘marketing of the line’ phase. The Revised Retail Product Development Model and the NICPPD Model for Apparel were the only 2 models which incorporated pre-production and sourcing phases into the framework for new product development. The NICPPD Model for Apparel was the only model reviewed which included an apparel production stage.

**Sequential versus Concurrent Models**

In the development of new apparel products it is important to note that products are developed in product lines as opposed to individual products (May-Plumlee and Little, 1998). The practice of developing and managing several lines or groupings during a season is a complex process and the majority of the models found in the literature fail to outline such a developed network of inter-related tasks, but rather present the process as a list of chronological steps.
The model presented by Burns and Bryant (1997) can be categorized as sequential. A sequential model is defined as a progression of linear steps through a process. According to May-Plumlee and Little (1998), sequential models are segmented, causing interaction between departments to be minimized, and do not allow for backward and forward movement in the design and development process. Burns and Bryant’s model while generally outlining the steps involved in apparel development, does not effectively show the interactions and simultaneous development that occurs over the various functions of the organization: product development, marketing, merchandising, and production.

Concurrent models provide a more integrated approach to the development of new products. Sequential steps are still utilized to outline the overall process; however, the interactions and deadlines required of all divisions of the development team are identified and displayed as a continuous exchange of information. In the No-interval Coherently Phased Product Development Model for Apparel (May-Plumlee and Little, 1998), Figures 1-8, the development process is outlined not only by the different phases involved in the process of creating apparel lines, but is also defined by the four functional divisions involved in new product development: marketing, merchandising, design and development and production. The incorporation of the four functions of the development process is important in that it clearly defines the specific roles of each function in the process. This also allows for identification of the points in the process in
Figure 1: NICPPD Model for Apparel Legend

Source: May-Plumlee and Little, 1998
Figure 2: Apparel Product Development Process Overview

Source: May-Plumlee and Little, 1998.
Phase 1: Line Planning and Research

Marketing Plan

Sales Forecasts

Feedback from Customers

Focus Groups

Target Consumer Research

Sales Data from Previous Lines

Market Research

Trade Literature

Trade Associations

Color, Fabric and Style Direction

Fashion Forecasting Services

Retail Market Direction - Competitors' Direction

Trend Research

Raw Material Vendors

Color Research

Fashion Forecasting Services

Merchandising and Product Development

Color Forecasting Services

Retail Market Direction - Competitors' Direction

Fashion Forecasting Services

Merchandising

Line Plan

*Dollar Investment
*Line Concept
*Color palette
*Materials
*Seasons
*Weeks of Sale
*Proof Points
*No. of Classifications
*Size Ranges
*Quality Level
*Size Standards
*Fit Standards
*Model Stocks
*Unit Plans

Source: May-Plumlee and Little, 1998.

Figure 3: NICPPD Model for Apparel-Phase 1
Source: May-Plumlee and Little, 1998.

Figure 4: NICPPD Model for Apparel-Phase 2
Source: May-Plumlee and Little, 1998.

Figure 5: NICPPD Model for Apparel-Phase 3
Phase 4: Marketing the Line

Final Adoption:
- Sizes / styles / colors assigned to line plan
- Assortment diversity / volume / utilization determined
- Prices established
- Gross margin established

Archived for future reference

Back to previous phases

Modified Line:
- Adapted Line Minus Dropped Pieces Plus Added Styles/Colors/Sizes

Merchandising

Product Development

Marketing

*Sizes / styles / colors assigned to line plan
*Assortment diversity / volume / utilization determined
*Prices established
*Gross margin established

Figure 6: NICPPD Model for Apparel-Phase 4

Source: May-Plumlee and Little, 1998.
Modified Line
Adopted Line Minus Dropped Pieces Plus Added Styles/ Colors/ Sizes

Production Patterns
Final Garment Specifications
Size Specification Sheets

Graded Patterns
Production Marker

Final Line
*Quality Specifications
*Material Specifications
*Engineering/Production Specifications

Merchandising and Production, Planning and Control

Source: May-Plumlee and Little, 1998.

Figure 7: NICPPD Model for Apparel-Phase 5
Source: May-Plumlee and Little, 1998.

Figure 8: NICPPD Model for Apparel-Phase 6
which functions work together to accomplish a common goal or interact. The model effectively gives an overall understanding of the development process, and identifies the information exchange and the critical convergent points of each function in the development of apparel products through the use of concurrent and parallel processing steps, fuzzy gates and “porous phase boundaries”. The fuzzy gates, also known as ‘soft gates’, are decision points where involved departments of the development team collaboratively make decisions on the progression or recycling of styles within the line, while still allowing the rest of the product development process to move forward, resulting in “porous phase boundaries”. By progressing styles forward in the line, the development of those styles continues to the next stage in the process. If a style is recycled, it is taken back into the previous stage in the development process to be “reworked” and is later evaluated. Since the product development process continues on a forward progression and does not come to a halt based on the decision point, cycle time is ultimately reduced.

In the Retail Product Development Model, Figure 9, presented by Gaskill (1992), the product development process is outlined using both sequential and concurrent methods, but the model does not effectively show the different divisions responsible for each of the defined stages.
In the Revised Apparel Retail Product Development Model by Wickett, Gaskill and Damhorst (1999), Figure 10, the development process is divided into four phases: Research, Line Conceptualization (Pre-adoption), Product Visualization and Evaluation (Pre-adoption/Adoption) and Technical Development (Post-adoption). These phases are then divided into sub-phases or activities which occur with in those phases. The separation of the apparel development process into phases is also seen in the NICPPD Model for Apparel (May-Plumlee and Little, 1998), the Apparel Design Framework (Lamb and Kallal, 1992) and apparel product development process as outlined by Burns and Bryant. The division of the development process into a series of phases provides a method of structure to the product development process as a whole.
The sub-phases provide insight into the specific activities that occur at each stage of development. The NICPPD Model for Apparel by May-Plumlee and Little provides an in-depth view to the activities and processes which occur within the sub-phases of the development process, in contrast to other models in the literature. This in-depth look at the apparel development process allows for not only a fundamental understanding of the process but also a solid foundation for researching and developing new methods to create an improved process (May-Plumlee and Little, 1998). The Apparel Design Framework by Lamb and Kallal does not include sub-phases.

The number of internal and external factors influencing the development process has been expanded from Gaskill's Apparel Retail Product Development Model, in the Revised Apparel Retail Product Development Model to include business/sales trends, target customer base, employee input and marketplace research as internal factors and global market trends, competition, media, government regulations and producer capabilities as external factors. The defining of internal and external factors influencing the product development process is unique to the Retail Product Development and the Revised Retail Product Development Models. The line conceptualization phase of the process, showing backward and forward movement, now includes theme and fabric development as well as structural and surface fabric decisions. The decision points are not clearly defined and thus it is difficult to assess how and when the process moves forward. The Revised Retail Product Development Model again
Figure 10: Revised Apparel Retail Product Development Model

does not show which functions of the development team are involved in the various stages of the process. This ultimately inhibits a complete understanding of the apparel product development process because, while stages within the development process are defined, it is unclear as to what function(s) of the organization are involved with each specific stage.

The Apparel Design Framework by Lamb and Kallal (1999), Figure 11, is a combination of their FEA consumer needs model and other design process
models by Hanks, Belliston & Edwards, 1977 and Koberg & Bagnall, 1981. The
design process model of Hanks, Belliston and Edwards (1977) can be applied to
any form of design and outlines the design process as a series of six steps. The
steps included in their model are problem identification, preliminary ideas, design
refinement, analysis, decision and implementation. The design process model
by Koberg and Bagnall (1981) can also be applied to any form of design and
includes the following steps: accept situation, analyze, define, ideate, select,
implement and evaluate. The model is presented in a linear form, but the
authors also note that the model may be used in other configurations such as
circular, a constant feedback system, or a branching system. Lamb and Kallal’s
(1999) framework is divided into a series of sequential phases; problem
identification, preliminary ideas, design refinement, prototype development,
evaluation and implementation. During the problem identification phase, once
the problem is outlined, “the designer defines the FEA criteria with the target
consumer in the context of the problem situation” (Lamb and Kallal, 1999). The
FEA criteria are categorized by Functional, Expressive and Aesthetic
characteristics and are based around the profile of the target consumer. The
functional, expressive and aesthetic characteristics can also be interrelated:
functional-expressive, expressive-aesthetic, and aesthetic-functional. In the
evaluation stage, the samples are assessed based on the criteria established in
the problem identification phase and the functional, expressive and aesthetic
needs of the target consumer (Lamb and Kallal, 1999). While this model outlines
specific phases in the apparel development process and relates the development
of new product to the needs of the target consumer, the Apparel Design Framework gives no insight as to the activities which occur to move the process from one phase to the next as can be seen in the other models found in the literature. Nor does it outline functional areas which are involved in the development of new apparel.

Table 1, is a comparison of various characteristics of the apparel product development models that were reviewed. The characteristics that were
compared were model type: sequential or concurrent, whether or not the functions or department involved in the various stages of the development process were defined, and whether or not the model included decision points which determine how and when the apparel development process moves forward. The NICPPD Model for Apparel (May-Plumlee and Little, 1998) effectively shows the concurrent activity of the apparel product development process, defines the functional areas of the organization that are involved at each process stage and shows the decision points of the process. The NICPPD Model for Apparel by May-Plumlee and Little (1998) is the only model reviewed which exhibits all of aforementioned characteristics.
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Table 1: Comparison of Reviewed Apparel Product Development Models
Textile Product Development

The generic framework for textile design proposed by Studd (2002), Figure 12, outlines the process for developing new textile products and is structured so that it can be applied to the various aspects of textile design: woven design, knit design, and print design. The framework is sequential in nature. For the purposes of this research it will be referred to in the context of print design only.

Studd, through case study research involving a design studio, a freelance designer, a design consultant and three textile companies, mapped the design processes of the six sources into a generic framework for textile design. The five key phases of the framework are planning, research and analysis, synthesis, selection and production.

According to Studd, “the design process begins once the client or company has the initial idea (trigger) for a new fabric design or product range”. From this trigger a phase review meeting is held and Phase 1, planning, begins. The design expertise, whether it is an in-house designer or a free-lance designer, is sourced at this stage. The design project is then planned and the aims, objectives and outcome of the project are defined and reviewed at a phase review meeting.

The second phase of Studd’s framework is the research and analysis phase. During this phase briefing, idea generation and research occur. In many
cases a briefing document will be written which outlines the project, aim, objective, season, background, consumer, outcomes and technical specifications


Figure 12: The Generic Framework for Textile Design
for the project. Mood and color boards are also developed to work in conjunction with the briefing document and then are reviewed with either the client or the development team if the firm is designing for themselves. Once the direction of the project is clearly understood by all parties, idea generation and the creative process begin through techniques such as sketching, brainstorming, and researching color and trends in the market place. Following idea generation the direction of the project is reaffirmed before concepts are developed.

The third phase is synthesis. During this phase the concept is developed, design creation begins, design solutions are made and color ways are developed. Concept development and design creation involves developing designs through hand rendering techniques and often using CAD for either design creation or artwork manipulation. In terms of print design, factors that influence the creative process and cost of a design are the number of colors used and the repeat size (Studd, 2002). For printed design, color ways are developed and typically include a warm, cool and neutral palette (Studd, 2002). From these designs, design solutions are chosen and sampled in a range of color ways that meet all of the requirements set at the design briefing. The sampled fabric designs are either selected by the company or purchased by the client depending on if the project was for a client or an internally developed fabric line. This decision occurs at a meeting usually including the design group, project manager, head designer client and the sales/marketing team (Studd, 2002). The designer will typically present the designs (to either the company
(internal) or client (external)) showing the development of the design from ideation to the final collection.

The final phase of the design process is production. During this phase, the designs chosen are sampled for production and then, based on a final fabric check, are manufactured.

Concluding each phase of the design process, review meetings are held involving the entire development team (design, sales, marketing, and production) to “give comprehensive feedback on the progress of the project” (Studd, 2002 p.39).

Generic Process for Designing Printed Fabrics

In discussing the development of products made of printed fabrics, it is important to look at the design process of the designer of printed fabrics. Often computer aided design, or CAD, is used by the designer through the entire design process or rough sketches are developed by hand and then transferred to the CAD system for further refinement, layout, repeat and color rendering. Even with the ever present use of CAD, it is still important to understand the stages involved in the creation of printed fabrics, whether they are carried out on a computer or by hand. CAD technology will be discussed in more detail later in the chapter.

From research and concept development for a new product range a designer must begin the task of creating actual designs from inspiration and idea to repeat. According to the literature, this process typically begins with a rough
layout or sketch. A rough layout is rough motif sketch and shows options for motif placement and direction (Yates, 1996). The rough layout is typically created on a large scale (> 4” for apparel), which can then be easily reduced, if needed, later in the design process. From the rough sketches that are developed the designer will choose a rough layout that seems to be working well and will refine the sketch into a polished layout.

According to Yates, a polished layout is the final artwork in the correct repeat size that will be taken to the mill for sampling. When developing the layouts, one aspect of textile design that is important to note is that instead of arranging motifs based on their relationship with the boundaries of the composition, the motifs must be arranged in relationship to each other. This is because when the motifs are put into repeat the compositional boundaries will no longer exist.

There are several types of layouts typically used in textile design; all-over, free-flowing, stripes, set, scenic, five-star, patchwork, and one and two-way layouts. With apparel prints, most are typically created in a two-way layout. This method positions motifs in two directions. When the fabric is turned 180°, the direction of the motif cannot be differentiated. According to Joyce (1993), a two way layout allows the fabric to be turned in either direction on the grain when garment pieces are cut and therefore, minimizes waste.

Three factors that determine the size of a design are the size of the motifs and space, the end use of the fabric, and the equipment that will be used to print the fabric (Yates, 1996). In designing printed fabrics for apparel, designs are
typically produced on the vertical axis, except when producing a horizontal stripe and the motifs are typically relatively small (Yates, 1996). After the size of the design is determined, motifs are redrawn to meet the specified size. Photocopies of the motif are often made to help in determining their placement and to provide quick and easy identical copies of the motif if the design work is not being done using a CAD system.

The polished layout is then made with top left corner marked as a reference angle and the exact size of the layout space marked off (Yates, 1996). Using the rough layout as a placement guide the individual photocopied motifs are placed in the correct orientations and positions and the design is transferred to the new piece of paper. It is crucial that the designer checks to be sure that there are no alleyways, line ups or holes in the repeated design and that the overall design is in balance (Yates, 1996). Figure 13, illustrates a repeat that has alleyways of negative space and subsequent holes in the pattern (left) versus a design that has been shifted to resolve these problems (right).
In addition to the polished layout or final line drawing, designers create color roughs which show which colors will be used in which parts of the design. When selecting the colors for a design it is important to remember the number of colors that can be used and the amount of fabric coverage the design has, as both of these factors directly correlate to the cost of the design at production. Prints designed for apparel typically use no more than six colors (Joyce, 1993). Using the color rough as a guide, the designer will create a painted rendering of the design. The rendering serves as the format for the development of alternate colorways (Yates, 1996). Once color is finalized, the finished layout is transferred in its final form to “good” paper (Yates, 1996).
Technologies Available & Systems Utilized in the Development of Printed Fabrics for Apparel

*Computer-Aided Design*

There has been a movement in the US textile and apparel industry towards relying heavily on CAD as a design tool in the development of new products. Using CAD software in the development of new apparel styles and printed fabrics for those garments has become a mainstream practice among US apparel manufacturers (Dickson and Coles, 1999). Utilizing a CAD-based design process allows designers to develop, change and modify their designs more rapidly and ultimately is a major contributor to the reduction of cycle time. Cycle time reduction has been a major focus in the textile and apparel industries. According to Holmes, “by representing a design digitally its processing and manipulation become more flexible” (Holmes, 21).

When using a CAD-based design process for the development of printed fabrics, an existing image or artwork must be either photographed digitally or scanned and imported into the computer software (Holmes, 1993). Another option is to create an original design using the CAD software’s drawing and painting functions. CAD systems allow for all the steps of the of the printed design process, historically done by hand as discussed earlier in the chapter, to be carried out much more efficiently. CAD systems allow the designer to add and remove components from a design, alter the scale of the design, put the motif into a variety of repeat types, and explore various colorations of the design
According to textile designer Holly Henderson (Joyce, 1993), one of the most fundamental benefits of using CAD systems in the development of printed fabrics is that any changes made to a design or repeat can be visualized immediately as CAD systems allow for a design to be magnified or stepped out and immediately printed out on paper or fabric (Holmes, 1993). Though computer printouts are not the same as a three-dimensional strike-off, the overall pattern can be evaluated and corrections made before the design is sent to the print vendor to undergo engraving and printing which is a time consuming and costly process according to computer graphic designer, Kenji Takabayashi and Simon Poulton, a Graphics Sales Manager (Joyce, 1993).

CAD systems are also used extensively by designers creating new apparel products (Burns and Bryant, 1997). While some designers still heavily rely on their ability to do rough sketches and flats of garment designs, again the trend with US apparel manufacturers is to move to a CAD-based design process as CAD effectively works into the short-cycle business strategy of the industry. CAD software allows apparel designers to import their existing flat sketches through the use of either a scanner or digital photography or to sketch new silhouettes using the CAD software. Whether it is used to design printed fabrics for apparel or the apparel garments themselves, a major benefit of CAD is that it facilitates communication within all the functions of the product development process through the exchange of information digitally or the ability to reproduce a physical copy of a working design at any stage of the process for all persons involved in the creation of the new product.
Color Management and Communication

The apparel industry is an industry driven by color (NPDGroup, 2003). Color is developed in the creative function of the business and must be carried through various outlets in the supply chain before being implemented correctly in production, so that ultimately the end-consumer is able to purchase the same color product the design team originally developed. In the past, and at smaller sized companies today, color may be managed and samples from the vendor approved by the apparel designer. However, the trend in apparel company infrastructure has shifted so that color is managed through highly specialized color approval departments and teams which have specifically defined responsibilities, documentation processes and color management systems (Hipps, 2003). Some typical responsibilities of a color department include approving lab dips, approving production samples, managing and documenting color samples to ensure that all fabrics, trims and other hardware used in the construction of a garment match visually in terms of color and serve as the communication point between dyeing/finishing/printing suppliers and the apparel company. By managing color through a separate color department the designers and merchandisers have more time to spend on the creative aspect of their jobs.

New technologies in color communication are also being introduced in the apparel manufacturing industry. One trend for instance, is the use of digital color standards. A digital color standard is taken using a spectrophotometer which gives a series of numbers representative of the color’s spectral reflectance curve.
This number series can then be used to communicate the color through the supply chain.

Another color communication technology that is catching on in the apparel industry is color information management systems. These systems allow color to be communicated electronically by calibrating computer monitors so that the viewer cannot visually detect a difference (Hipps, 2003). These systems also have the ability to combine the texture of the fabric in question with color and alter the light source on screen, creating a virtual light box (Speer, 2003). Through the use of color communication, monitors and printers can be calibrated so that the entire product development team “sees” the same color in all the sketches, prints, artwork, etc. Also color communication systems such as the virtual light box, allow for efficient communication between the apparel company and the supplier as to color approval status and changes (Hipps, 2003).

Archiving Systems/ Digital Asset Management (DAM) System

The implementation of an archiving system for apparel manufacturers is vital as various functions of the product development process constantly refer back to past designs and information about those designs in the creation of new products. Archiving systems can be used to quickly retrieve not only past silhouettes and fabrics that went to production, but also those that were dropped, or never fully implemented. Additionally, artwork that has been purchased by the company is typically archived for future reference.
Instead of using filing systems to archive physical samples, as in the past, Digital Asset Management Systems (DAM) are now being used by companies to catalog images in an electronic database so that these images can be quickly retrieved by various functions within the company through their own workstations (Chapman, 2003). DAM systems are organized so that apparel and fabric styles can be searched by criteria. For example, an apparel style may be located by style, product grouping, size, primary colors, secondary colors or fabric pattern, while fabric styles may be located by criteria such as design element, design type, primary colors, secondary colors, technique or style. Designers can also set their own criteria by establishing input data when they submit a design or artwork for archiving.

Benefits for the design and development departments of an organization include categorization of images and quicker access to archived images. In addition, if all members have digital access to archived images, original art, graphic files and developed patterns, time can be saved in that personnel do not have to go to a filing system to search for a design, and then import the physical design to their workstation. DAM systems also serve as a preservation method for the company’s intellectual property. With the gravitation towards the use of CAD systems for design and development of apparel and printed fabrics, DAM provides a way of organizing and archiving the number of designs that are created by apparel organizations seasonally (Chapman,K., 2003).
Digital Printing

Digital printing is a print technology which can be used for direct printing onto fabric from a CAD file (Owen, 2000). There are various types of digital printers; however, the textile and apparel industries typically use ink-jet printers which deposit dyes onto the surface of the fabric (Lawrence, 2003). More development in digital printing technology is needed for it to replace more traditional methods used in production runs of fabric. While there are some companies, both textile and apparel, utilizing digital printing with niche and specialty products, a main use of the technology is for proofing and sampling fabric designs. Since sampling and engraving costs for traditional printing methods are so high, digital sampling and proofing offers a sampling or strike-off alternative (Bohringer, 2000). In terms of fabrics designed internally at an apparel company, instead of sampling a final design on a piece of paper before sending it to a supplier for engraving and sample yardage printing, the use of a digital printer would facilitate the creation of a 3-dimensional sample for the development team to evaluate in terms of the overall design and it’s relationship to the fabric surface. A limitation of using digital printing for sampling is that a digital sample may not be reproducible using traditional printing methods.
Summary

The previous chapter has given an overview of the apparel product development process, the print design process, and a few technologies and systems that are available for use in the development of printed fabrics for apparel. While there are several models of the apparel product development process found in the academic and trade literature, these models do not discuss in detail the role that the design and development of printed fabrics plays in the development of new apparel lines. In addition, there is a limited amount of literature describing the printed textile design process conceptually. Through investigation of the print development process as it is carried out at apparel organizations, further insight will be gained into the ways in which the textile print development and the apparel development processes can be integrated into a single, comprehensive product development process.
Research Objectives

The goal of this research was to study the integration of the apparel design and textile print design processes, and to create a conceptual, industry-focused framework based on the findings. The framework will be incorporated into the No-interval Coherently Phased Product Development Model for Apparel by May-Plumlee and Little, 1998. The research objectives to achieve the aforementioned goal are as follows:

1. Identify the phases and the design process involved in the development of a printed fabric created internally by an apparel company.
2. Identify how the development of a printed fabric integrates into the overall apparel product development process.
3. Determine what types of technologies and systems are used in the design and development of printed fabrics at an apparel company.
4. Identify if any of the technologies are used in both the printed fabric design process and the apparel development process.
5. Determine the interaction points and scope of interactions between the apparel and print development functions.
Research Design

As the nature of this study is exploratory, a qualitative, collective case study research method was chosen to explore the design and development of printed fabrics within an apparel organization. A collective case study involves collecting and analyzing data from several cases rather than studying one case with various sub-cases (Merriam, 1998). A qualitative, collective case study research method allowed for a greater amount of information to be collected and an in-depth understanding of the process to be achieved (Merriam, 1998). In addition, case study research allows for the use of open-ended, semi-structured interviews which enables “the researcher to respond to the situation at hand, to the emerging worldview of the respondent and to new ideas on the topic” (Merriam, 1998). Choosing a smaller number of cases to research, as opposed to a survey with a larger sample size, also contributed to the detail and extensiveness of the information that was collected.

Instrument Development

Qualitative data was gathered through a series of individual case study interviews. Each interview followed a semi-structured format following a series of open-ended prompts and topics developed prior to the interview process. Those prompts, in the form of an interview instrument (Appendix A), were then used to guide the interview, while still allowing for flexibility and additional ideas to be discussed based on the direction of each interview.
The interview instrument was developed to address and explore each of the five research objectives outlined at the beginning of the chapter. Before case study interviews were conducted using the interview instrument, a pilot study was conducted to test the questions and prompts. The pilot study enabled the questions to be tested for rewording, useless data, flow of the interview, and additional questions/topics that should be included in the interview. The pilot study involved reviewing the research instrument with three individuals, all with work experience in the product development sector of the apparel industry.

Table 2 represents the matching of the five research objectives outlined at the beginning of the chapter to the questions used in the research instrument. Questions 8, 9, 10, 12, and 13 were used to obtain information regarding the phases and the design process involved in the development of a printed fabric designed internally by an apparel company (RO 1). Questions 1, 4, and 7 were used to determine information about how the development of a printed fabric integrates into the overall apparel product development process (RO 2). Questions 5, 5.1 and 5.1a-c were used to determine what types of technologies and systems were currently used in the design and development of printed fabrics at an apparel company (RO 3). Question 6 was used to determine if any of the identified technologies were used in both the printed fabric design process and the apparel development process (RO 4). Questions 2 and 3 were used to obtain information regarding the interaction points and scope of interactions between the apparel and print development functions (RO 5).
Table 2: Instrument Development

<table>
<thead>
<tr>
<th>Research Objective</th>
<th>Instrument Item</th>
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<tbody>
<tr>
<td>1</td>
<td>#8,9,10,12 and 13</td>
</tr>
<tr>
<td>2</td>
<td>#1, 4 and 7</td>
</tr>
<tr>
<td>3</td>
<td># 5, 5.1 and 5.1a-c</td>
</tr>
<tr>
<td>4</td>
<td>#6</td>
</tr>
<tr>
<td>5</td>
<td>#2 and 3</td>
</tr>
</tbody>
</table>

Sample Selection

A collective case study approach was used to conduct this research. A case study research method allows, through a series of specific research questions, a limited number of events or conditions and their relationships to be analyzed (Soy, 1996). The cases for the sample were selected based on the following criteria:

1. *Design and Development of Printed Fabrics for Apparel Products*

Interviewees were selected from apparel companies that designed and developed printed fabrics for seasonal apparel lines.
2. **Job Description**

Interviewees were required to be involved in the design and development of printed fabrics for apparel or in the design and development of apparel that utilized internally produced fabrics.

3. **Location**

Interviewees were required to work for a company based in the United States.

4. **Convenience**

Individuals were chosen through industry organization directories and network contacts. A convenience sample was chosen because of difficulty locating qualified participants without providing the participant a reference (Babbie, 1986).

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**Sample Procedure**

Apparel companies in various segments of the industry were identified (children’s wear, women’s wear, men’s wear, and sportswear) as domestic. If contact could be established with the company, managers at the apparel companies were contacted via telephone as a starting point for data collection. These managers were screened based on the remaining sample selection criteria and then either participated in the interview process themselves or recommended more appropriate company representatives to participate in the research. Each person recommended was contacted via telephone and was then sent a letter formally requesting participation, and a letter of informed
consent. Whenever possible, apparel designers and print designers at a company were interviewed to ensure a well-rounded perspective of the role print design plays in the apparel development process. In some cases, respondents were asked to recommend potential interviewees at other companies to participate in the study. This method is known as snowball sampling which was an efficient means of identifying qualified candidates (Babbie, 1986). Of the 25 individuals contacted who fulfilled all four sample selection requirements, nine agreed to fulfill the request for an interview.

Data Collection

Interviews for this research were conducted over a five-week period during Spring 2004. For each individual selected, a telephone interview was conducted. The interview followed the predetermined set of questions/prompts which were tailored to the participant’s area of expertise (print designer vs. apparel designer) as seen in the interview instrument (Appendix A). The interviews ranged from 25 to 60 minutes.

Data Analysis

Following data collection, the interviews were transcribed in paragraph form. The data was organized by process steps and technologies and then translated into graphical representations. The graphical representations were compared for similarities and differences, and were then consolidated into a single graphic representation based on the conclusions drawn from
observation. The graphic representation of the textile print design process at apparel companies was then integrated into the No-interval Coherently Phased Product Development Model for Apparel by May-Plumlee and Little (1998). The result was a framework that serves as a theoretical foundation for research in the integration of the apparel design and textile print design processes.
RESULTS AND DISCUSSION

RESULTS

Sample Description

The research sample was composed of nine cases. The nine cases were with individuals involved in or responsible for the development of printed fabrics at an apparel company or of apparel that utilized internally produced printed fabrics.

Case One: Company A

Company A is a children’s wear manufacturer that produces clothing for infant, toddler, girls and boys sizes. Both an apparel design director and an artist were interviewed from Company A. The design director oversees the work of the apparel designers that work on the boys, girls and infant lines. The artist is responsible for the design of printed and woven fabrics, screen prints, trims and embroidery designs for the girls’ collections. The phases in the print design and development process at Company A are shown in Figure 14. It is important to note that the prints are being developed by the art department while at the same time, the apparel designers are merchandising and creating silhouettes for the apparel line.
Figure 14: Print Design and Development Process-Company A
In conjunction with the apparel designers, who are typically responsible for trend research at the beginning of each season, the print design function is also involved in this process. Trend research is a group effort between the apparel designers and artists and is accomplished by reviewing magazines, color services, trend services, shopping the market place and through visits to print studios and print shows. The artists at this company are also involved not only in the research, but also in selecting the artwork that will be purchased from the print studios. After the trend research is complete, artists begin to develop ideas as to color and theme direction for the new line as it relates to print, embroidery and trim. These ideas are then presented in conjunction with the apparel designer's concept boards to the apparel design department, art department, product development director and merchandisers at a concept meeting. From the input and discussion at the concept meeting, the artists begin developing print concepts for the line with the apparel designer. The apparel designers are responsible for working with the director of the art department each week to determine the goals and priorities of each artist. Once the designer and the artists have concepts for each of the prints, the artist imports either purchased artwork or original artwork into the computer where the image is traced, “cleaned”, modified and the selected design elements are put into a layout using CAD software. When artwork is “cleaned” the number of colors are reduced to the amount that will be used in the printed fabric and stray pixels are removed. The layout is then put into repeat, and colorways for the print design are created. The artist and the apparel designer communicate frequently concerning the
progression of the print design, as the workstations at the company are close together.

Once the print is put into repeat and the colorways are created, the apparel designer is responsible for approving the completed print design. If the design is approved, the artist is responsible for creating a specification sheet for the print design. The specification sheet includes an image of the print design at the correct scale and also identifies grain line and the top of the print. The specification sheet includes the colors used in the print, the color names and identification numbers, the base fabric that is to be used, the sample yardage required, the name of the print, the collection and season the print belongs to and whether the screen is new or existing. The specification sheets and discs with the actual artwork are sent to vendors by the artist. Approximately three weeks later, the strike-offs are received for evaluation of the printed fabric. It is the direct responsibility of the apparel designers to assess the strike-off. However, very often, the artist is also involved with this stage of the process. Depending on the success of the first strike-off, several other passes at the fabric may be made by the vendor to achieve the best fabric possible. Based on all the successfulness of the samples received from the various vendors and the cost per yard, the apparel designer will decide to which vendor the program will be awarded.
Technologies and Systems Utilized at Company A

Computer-Aided Design

Company A uses CAD software as a tool in the design of new textile prints. While the artists still rely on hand drawing to sketch motifs that need a “hand-drawn feel”, the majority of the textile prints created by the art department are created using only the CAD system. In addition, all purchased artwork is traced, cleaned, manipulated and put into repeat using the CAD software. The same CAD software used by the artists to create print designs is also used by the apparel designers in the creation of the silhouettes for the line.

Color Management System/Color Communication

Company A has a color department which is responsible for assessing the color of dyed goods and the base cloths used for printed fabrics using the color standard and a light box. The same system is not used in the assessment of the colors of the print. Instead, the apparel designer is responsible for assessing the colors. However, there is not a system in place which the designer must follow to do this.

In terms of color communication as it relates to printed textile design, all computer monitors and printers that product development utilizes are color calibrated. This allows for the entire product development team to visually see the same colors in a design whether they are looking at it on a monitor or as a paper print-off. When the color palette is selected and standards are approved, the ratios of those color standards are entered into the CAD system, so that all
designers are using the exact same color palette. This also ensures that each vendor is receiving the same color information from each artist. The colors used in the print design are communicated to the vendor on the print design specification sheet and physical swatches of the colors are also sent to the vendors.

Archiving Systems
At Company A, there is not a formal archiving system for past designs, artwork and styles. Each individual is responsible for archiving digital and hardcopies of their designs and artwork. The product development department utilizes a computer server to store digital work, which is accessible by the entire department. Each individual has their own storage space. However, the information is not categorized so that an individual looking for a certain type of image, for example, a flower, could easily access it.

Digital Printing
The company does not use textile digital printing as part of it’s design and development process.

Case Two: Company B
Company B is an apparel manufacturer who produces clothing for infant, toddler, boys, girls, juniors, men’s and women’s. A textile designer who works for the company was interviewed. The textile designer was specifically responsible for the design of knits, wovens and prints for the children’s wear division of the
Figure 15: Print Design and Development Process-Company B

- Concept meeting
  - Themes and color palette presented
- Visit print houses/shows
- Purchase artwork & prints
- Import purchased or original art into CAD
- Develop print design concepts
- Modify/Clean image & create layout
- Put layout into repeat & create colorways, color separation
- Concept meeting - print selection
  - Not Approved
- Selected print designs handed off to production team
- Approved fabrics placed in garment sketches
company. The design and development process of the textile design function at Company B is illustrated in Figure 14.

At company B the season begins with a concept meeting. At the concept meeting the themes for the deliveries of the season and color palettes are presented to the graphic design, textile design and apparel design teams by the vice president of design and the two apparel design directors who have gathered inspiration and trend information on shopping trips in Europe and New York City. Following the concept meeting, the textile designers in conjunction with the apparel designers visit print studios for inspiration and to purchase artwork which fits into the themes for the season. The artwork is then brought back to the studio and scanned into the CAD system by the textile designers. Based on the themes, colors, inspiration, and purchased artwork, the textile designers create new artwork and manipulate the purchased artwork to create print designs that are age appropriate and maintain the corporate image of the company. Once the artwork, original or purchased, has been cleaned, manipulated, and put into repeat, colorways for each print are created using the season’s color palette. It is the responsibility of the textile design team to assess all print designs for repeat size, layout and to be sure there are no alley-ways in the design.

The print designs are then taken to a second concept meeting where they are presented by the textile design team to the apparel design team. The apparel designers then select which prints they would like to use in their group. If adjustments need to be made to meet the apparel designer’s requirements, the textile designers are responsible for making those adjustments to the design. A
digital copy of the selected print designs and colorways are handed off to the production team. The assistant apparel designers are responsible for creating the specification sheet for each print which is also given to the production team. The production team is responsible for sending the artwork and the spec sheets to the vendors and then assessing the strike-offs received from the vendors as to the compliance of the samples with the design specification. The final approval of the printed fabric for production is given by the director of apparel design. Once a design has been sent out for sampling the textile designers are also responsible for inserting the print designs into the appropriate garment drawings on the CAD system.

Technologies and Systems Utilized at Company B

Computer-Aided Design

The textile design department at Company B uses CAD software in the development of new textile prints. The CAD software is used by this designer to draw new motifs and manipulate purchased artwork. The CAD software program also allows for layouts to be put into repeat rapidly. This company’s textile designers use CAD as it facilitates the creation of a larger body of work within a short amount of time.

Color Management System/Color Communication

The color management system used at Company B is focused on the solid fabrics used in the collection and the base fabrics used in the prints. While the base fabric of the print will be approved based on the color standard, the print
itself, is not assessed under the same system. In terms of color communication, the color monitors at this company are not calibrated, so no two individuals in the design department will see the same color on-screen. The printers are however calibrated to print out the same color. Once the color palette for a season has been determined, the palette is “mixed” on the computer within the CAD software so that everyone in the design department has access to the correct color percentages to ensure the output of all colors in the designs are the same. To communicate the colors that need to be used in the print to the vendor, the colors (named and numbered) are included on the design which references a color standard for that season. A physical swatch of the color standard is also included in the package to the vendor.

Archiving Systems

At company B all of the digital assets are archived by department. Therefore any designer within that department has digital access to past artwork and designs facilitating a quicker design process when referring back to previously created work. The company does not have the staff at this time to link all the departments’ digital archives together to create a fully functioning digital asset management system. All hard copies of purchased artwork, in-house created print designs and past styles are physically archived by an individual on staff. The physical archive is accessible to anyone in the company.

Digital Printing

At the present time Company B does not utilize textile digital printing.
Case Three: Company C

Company C is a mass merchandiser who manufacturers apparel for all ages and genders under several private label brands. A textile designer and an apparel designer at Company C were interviewed. The textile designer is responsible for creating fabric prints, embroideries, screen prints, trims and woven plaids and stripes. The apparel designer is responsible for the design and development of the girls’ line under one of Company C’s private labels. The print development process (Figure 16) for Company C begins with the assessment of trends through resources such as magazines, catalogs, color services, trend services, and shopping trips. The lead textile designer from each textile design team for each division travels to print shows and print houses to purchase artwork and print designs based on their trend research.

Once the textile designers and the apparel designers have returned from their respective trips, the trend manager for the company gives a presentation on trend direction and presents “forward ideas” to the textile designers and apparel designers. Following the trend presentation a division concept meeting is held where the apparel designers and textile designers begin developing themes, color palettes, silhouette direction and art/print direction for each collection. At this meeting the textile design team presents the purchased artwork to the apparel designers. From the ideas and direction determined at the division concept meeting, mood, theme, print, silhouette and color boards are created.
The boards are then presented to the company’s buyers by the lead textile and apparel designers at a concept meeting where all apparel divisions are present.
The lead designers are then responsible for reporting to the rest of the division the line plan and theme adjustments suggested by the buyers.

Based on the line plan and the theme and color direction, the textile designers scan in purchased artwork and also create original artwork that will be used to develop new print designs. The artwork is then manipulated, colored and put into repeat.

A first review meeting is held which involves the buyers, textile design and apparel design. At this meeting 80 percent of the work on all of the prints that will be used in the collections are due. Based on the buyers’ feedback, the textile design team has three weeks to make changes and complete any unfinished print designs. At the end of the three weeks a final design review is held to determine which print designs and apparel styles will be approved for sampling. Specification sheets are made and handed off to the developer with a digital copy of the artwork for the designs that were approved by the buyers. The developer is responsible for getting the print information out to the vendors for sampling.

When the first strike-off is received from the vendor, the sample goes directly to the lead textile designer who is responsible for assessing the printed fabric in regards to repeat, scale, registration, hand, and color. The lead textile designer then takes the strike-off and her corresponding comments to the color department where the colors of the print are compared to the color standard. The sample is then sent back to the vendor where another pass is made at the
fabric. This process continues until the fabric is approved by the textile designer and the color department.

Technologies and Systems Utilized at Company C

Computer-Aided Design

The textile design department at Company C utilizes CAD software for the design of original textile prints and for the manipulation of purchased artwork into repeat. The CAD software that the textile designers use is different from the CAD software that the apparel designers use to draw their silhouettes for the apparel line. However the CAD software for apparel does allow for the print designs created by the textile designers to be imported into the silhouettes.

Color Management System/Color Communication

The color management system at the Company C is handled by an internal color department and an external dye company. While the internal color department is responsible for assessing the color on all fabrics, trims and hardware, the dye company is responsible for creating colors and the formulas for those colors on different types of substrates. The colors that are used in the actual print are indicated on the design. These colors match color standards for the season and physical samples of these standards are also included in the package sent to the vendor.

The in-house color library houses knit color 'chips' which are displayed under store lighting. The designers go to the color library at the beginning of the season and put together the color palette for each delivery using the chips. The
selected palette is then submitted to the dye company and they produce color standard swatches which vendors will request and try to match. The lab dips and strike-offs are assessed in the in-house color department.

**Archiving Systems**

At the present time there is not an archiving system in place for the entire company. However, the company has recently hired an individual who will be responsible for archiving past styles, artwork and prints. The company feels that this is an important step as the artwork and past designs are not only an asset to the company, but a digital archive system would allow designers to retrieve artwork that had been previously cleaned by another designer, instead of having to find the physical artwork and start at the beginning of the process. At this time every individual is responsible for archiving their own work. The textile designer interviewed keeps all of her digital assets on the product development server and keeps past tangible art at her desk for one year. At the end of one year, the physical artwork is filed in the company’s storage.

**Digital Printing**

Company C does not use digital textile printing as part of the design and development process.

**Case Four: Company D**

Company D is an apparel manufacturer which holds the license to exclusively design children’s wear for a popular designer label. The individual interviewed has the title of apparel designer, but is responsible for the
development of both the apparel garments and the prints that go into those garments. The process used by company D in the development of printed fabrics is shown in Figure 17. At the beginning of the season, the designers research trends by shopping in Europe and New York City, attending print shows/houses, visiting antique swatch archives and using color and trend services. The designers then bring back their inspiration (purchased artwork, swatches, garments) and assemble concepts of theme, color palette and direction for both print and apparel. There is then a concept meeting with the director of design and merchandising where the concepts for the silhouettes and fabric designs are presented for each collection.

Using the line plan, the designers and the merchandisers determine how many garments will be in the collection and how many of those garments will need prints. Based on the print direction discussed at the concept meeting, the designers use the purchased artwork and swatches as inspiration, and begin making rough sketches of print designs and patterns that they would like to have in the line. Boards are then made with the rough sketches detailing the type of repeat they want, the technique or “hand” they want the print to have, the original artwork or inspiration for the sketch and the color palette/colorways. The print design sketches are then taken to the director of design for approval. If the designs are approved they are handed off to a freelance artist who then creates the final layout for the textile repeat and colors it by hand (without the use of a CAD system) under the direction of the designer.
Figure 17: Print Design and Development Process-Company D
The finished print designs are shown to the apparel design director for approval. If the designs are approved a spec sheet for the design is made and it and the artwork is sent to the vendor for sampling. The strike-offs are then sent by the vendors directly to the designers for assessment. If there are changes to be made the comments are returned to the vendor and the process is cyclic until the print is executed as the designer sees fit.

Technologies and Systems Utilized at Company D

*Computer-Aided Design*

The designers do not use CAD as a tool in the design of their printed fabrics. Instead all the prints designed are put into repeat and colored by hand. This is because the company tries to achieve a hand-made look with their prints that they feel can not be done as successfully with a CAD system.

*Color Management System/Color Communication*

The color of the base fabrics are assessed by a color team, however the executed printed fabrics are never assessed by the color team. The designers are responsible for the overall assessment of the printed fabric. The colors to be used in the print designs are communicated to the vendors using the colors painted on the actual design which correspond to physical color standard swatches which are also sent to the vendor with the artwork.
Archiving Systems

All purchased artwork, swatches, and print designs are archived for one year. As the company has all their prints drawn and colored by hand, they believe they have no need for a digital asset management system.

Digital Printing

Digital printing is not used by the company as none of the textile design is done using a computer.

Case 5: Company E

Company E is a department store which designs clothing for its private labels which range in all sizes and genders. A textile designer from company E was interviewed and is responsible for designing printed textiles for several of the men’s and women’s private labels. The print design and development process of Company E is outlined in Figure 18. The textile designers begin by researching trends using trend services, shopping trips and attending print shows and print studios. At the print studios and shows the designers purchase artwork to use as a foundation for some of the print designs that will be created for the season. The purchased artwork is brought back to the studio and immediately scanned into the CAD system.

An initial concept meeting is held for both the textile and apparel designers to present the collected trend research to each other and the buying team. Following the concept meeting, apparel designers bring the silhouettes for which they need prints to the textile designers. A textile designer then does a print
Figure 18: Print Design and Development Process-Company E
interpretation for each garment and develops concept boards to illustrate the print and pattern directions that they believe are appropriate for each collection. The textile design team develops an assortment of prints in various scales and layout types. To create a design, the purchased artwork or original artwork is scanned into the CAD system. Some designer’s create motifs directly in the CAD system instead of hand rendering and scanning the sketch in. The artwork is cleaned, manipulated and a layout is created. That layout is then put into repeat and various colorways are created using the color palette for the collection.

The concept boards with the designed prints are presented to the apparel designers. Based on the presentation, changes are made to existing designs and new designs continue to be developed for other collections. A second concept meeting is then held where a large portion of the print and pattern work is completed and has been filled into the appropriate silhouettes. The second concept meeting again involves the apparel design team, the textile design team and the buyers. At this meeting the buyers give their feedback on the work that is presented by textile and apparel design. From this feedback the textile designers complete the rest of the designs and send the finalized print designs and the specification sheets for each design to vendors for sampling. This is done by either electronic transfer or it is mailed on a disc. The strike-offs from the mill are returned to the textile design team who assess the samples for overall design, scale, registration and color. Once the textile design team has a strike-off which meets their approval, the sample is shown to the apparel
designer to verify that the printed fabric is compatible with the trim, hardware and other materials that are incorporated in the garment. If the apparel designer signs off, the program is awarded to the vendor for the printed fabric. The textile designer then attends the final line review with the apparel designers and the buyers. The final line review is where all the garment samples made in the appropriate fabrics, trims, hardware, etc. are assessed, and the garments that will go through to production are determined.

Technologies and Systems Utilized at Company E

Computer-Aided Design

The designers use CAD as the primary design tool in creating printed fabrics. The apparel designers develop their garment flats by hand and then give those to technical design where the garment flats are rendered using a CAD system. The CAD system used to create the digital garment drawings is different from the CAD system used by the textile designer. Both software platforms are able to handle image files from both systems.

Color Management System/Color Communication

The color of the base cloths for the prints is managed by the color department. The colors in the print itself are not managed using the same system. The colors in the print designs are matched by the textile designers to Pantone® numbers. The Pantone® numbers and the design are then sent to the vendor, where the vendor uses the Pantone® chips as a standard for the colors in the print design.
The monitors of each design computer station are not calibrated. For each computer printer that is used to print out hard copies of designs, a color matching book is developed. The textile design team takes a physical sample and matches it to the computer print-out. The color is then tweaked until a successful match is made. The formula for each color is then recorded in the color matching book.

Archiving Systems

All artwork and print designs are archived on a digital asset management system. When artwork is purchased, it is immediately scanned and put into the system. When print designs are completed, they are uploaded onto the system. Any digital asset uploaded to the digital asset management system is given several cross-reference descriptors to categorize the work.

Digital Printing

Digital printing is not used in the design and development of printed fabrics at Company E.

Case 6: Company F

Company F is an apparel manufacturer which manufactures clothing for all genders and sizes for its own retail stores. A textile designer from company F was interviewed and is responsible for designing printed and woven textiles for the boys’ and men’s line. The print design and development process of Company F is outlined in Figure 19. The textile designers begin by researching trends using trend services, fashion publications, shopping trips (current and
vintage stores) and attending print shows and print studios. At the print studios and shows the designers purchase artwork to use as a foundation or inspiration for some of the print designs that will be created for the season. Using the information gathered during trend research, the textile designers assemble concept boards outlining the print direction they visualize for the season.

An initial concept meeting is held for both the textile and apparel designers to present the trend research they have found to each other and the vice presidents of each area.
Figure 19: Print Design and Development Process-Company F
Following the concept meeting, themes for each delivery are decided upon and the textile and apparel design functions meet to discuss the number of prints they will need for each collection, and the feel and look they are want to achieve through each print. The textile designer then takes this information and designs a print for each garment. To create a design the purchased artwork or original artwork is scanned into the CAD system or motifs are designed in the CAD system. The artwork is cleaned, manipulated and a layout is created. That layout is then put into repeat and various colorways are created using the color palette for the collection. The textile designer meets with the apparel designer in charge of the collection to review the designed colorways. The apparel designer may ask for designs to be re-colored until the overall print design is “right for the line”. As pattern work is completed the textile designers insert the prints into the garment silhouettes which are used by the apparel designers at line review meetings. As designs are finished a specification sheet is completed for each design, the design is burned onto a disc and sent to the vendors for strike-off. The print deadline, in which all print designs must be completed by the textile designers, is approximately two and one-half months into each season’s development cycle.

There is not a formal review meeting to assess the printed samples as all the prints do not come back from the vendor(s) together. Instead, as print samples are received, the apparel designer and textile designer will assess the sample and either the sample will be approved by the apparel designer, or comments will be recorded and sent to the vendor for adjustment. In some
cases, if there is something wrong with the design itself, the designer will go back to the CAD image and make alterations.

Technologies and Systems Utilized at Company F

*Computer-Aided Design*

The designers use CAD as the primary design tool in creating printed fabrics. The CAD system used to create the digital garment drawings is different from the CAD system used by the textile designer. Both software platforms are able to handle images from both systems.

*Color Management System/Color Communication*

The color of the solid fabrics and base cloths for the prints is managed by the color department. The company has its own color system and does not rely on Pantone® or similar systems. At the beginning of each season, swatches of the color standards are sent out to the vendors. When the prints are received the apparel and textile designers assess the print by comparing the colors in the print to the physical color standard, visually.

The monitors of each design computer station are not calibrated to match each other in terms of visual color. For each computer printer used to print out hard copies of designs, a color matching book is developed. The textile design team takes a physical sample and matches it to the computer print-out. The color is then tweaked until a successful match is made. The designers are responsible for creating the color palette on their individual work stations.
Archiving Systems

At the end of the season, both apparel and textile designers send their work digitally to the corporate archive system (DAM). Each piece of work is filed under previously established categories. The archive is accessible online so designers can refer back to or recycle past designs. The purchased artwork is archived within each department. If a designer wants to access a garment style from a past season, they can go online and submit a request to the physical archive office. The archive office then pulls the garment from the archive and it is brought directly to the requester’s office.

Digital Printing

Digital textile printing is used in the fabric development process for presentation purposes. The digital printer is not used to assess print designs before they are sent to the vendor for strike-off, however.

Case 7: Company G

Company G is a manufacturer and distributor of children’s branded apparel. An artist from company G was interviewed and is responsible for designing prints, wovens, graphics, and trim for the company’s garments. The print design and development process of Company G is outlined in Figure 20. The artists and apparel designers begin by researching color and silhouette trends using trend services and magazines to which the company subscribes. The artists and designers also go on shopping trips (New York, Los Angeles, Europe) and attend print shows and print studios.
Figure 20: Print Design and Development Process—Company G

Trend Research

Shopping Trips
Color/Trend Services
Magazines
Print Houses/Shows

Create concept boards for each theme

Process steps involving print & apparel designers

Trend Research

Develop print concepts & print interpretation & discuss fabrication

Retrieve or create artwork

Clean, manipulate & create layout

Put into repeat & create colorways

Create specification sheet for print design

Present print to apparel

Not Approved

Not Approved

Not Approved

Prints approved for production

VENDOR

Send print package to vendors (digital artwork & spec)

Present print to apparel

Process steps involving print & apparel designers

Alternative Processes

Decision Point

Process Step
At the print studios and shows, trends are observed and artwork is purchased. Purchased artwork is often used as a starting point to develop an apparel collection’s theme. The piece of artwork or components in the art are often used to develop print designs for the collection. The trend information is used by the apparel designers to develop a theme and a color palette for each collection. The artists and the apparel designers then collectively make concept boards to outline the feel, silhouette, print and pattern direction of each collection. The boards are used at a concept meeting to present their line direction to the directors and the vice president of merchandising. At the concept meeting, ideas are shuffled around and concepts are added and removed until a final direction for each collection is decided upon.

Using a line plan, the apparel designers determine how many prints they will need for each collection and for what type of silhouette. This information is translated to the art director who then determines the tasks and priorities for each artist. The artist and apparel designer meet to discuss the apparel designer’s vision for each garment in terms the style and feel of the print that will be created for the garment. The apparel designer also will discuss the fabrication that will be used for the print design, as the type of base cloth used has a direct impact on the printability of certain types of lines/motifs used in a design. The artist will then take these ideas and the information discussed at the concept meeting and begins designing prints to satisfy the apparel designer’s needs.

Before the artist begins designing prints for the season, the color palette is “mixed” on the CAD system. This is done by visually matching the color on the
screen to the physical color standard. To create a print design the purchased artwork or artwork hand-drawn by the artist is scanned into the CAD system. Some artists prefer to create motifs directly in the CAD system instead of hand rendering and scanning the sketch in. The artwork is cleaned, manipulated and a layout is created based on the repeat size needed for the garment. That layout is then put into repeat and various colorways are created using the color palette of the collection. A large number of colorways are typically created at Company G in order to get the strongest possible colorway(s). The artists and the apparel designer's have bi-weekly meetings to review progress and make changes to the print designs. Once a print design is complete, the apparel designer and the director of the designer's area have final approval if the print will go out for sampling. If the print design is approved, specification sheets detailing the color, fabrication, repeat size and the repeat itself are made by the artists and then sent to the vendors along with a disc containing the artwork.

When the strike-offs are received from the vendors, the apparel designer is responsible for assessing the print for technique, registration, scale, etc. The colors of the strike-off are assessed by the color department against the color standards using a light box. If a flaw in the actual design is found, the artist makes the appropriate corrections and resends the artwork. If the corrections that need to be made are vendor related, a comment sheet is sent to the vendor where the fabric will be re-sampled until the apparel designer is satisfied, and the color meets the color standard.
Technologies and Systems Utilized at Company G

Computer-Aided Design

The designers use CAD as the primary design tool in creating printed fabrics. The same CAD system used by the artists is also used by the apparel designers to create their silhouette drawings.

Color Management System/Color Communication

Once the colors are chosen for the season, the colors are matched to Pantone® chips. The color is then communicated at the beginning of the season by the color department to all the vendors by referring to the Pantone® chip number. The vendors are sent packages which include the color palette by collection and the color names that correspond to the Pantone® chip. The color department is responsible for assessing the color of the base cloth that will be used in a print, as well as the colors used in the print. This is done through visual assessment in a light box. Color corrections are communicated to the vendor through email.

Archiving Systems

All digital designs (prints, styles, graphics, trim) are filed on the product development server according to season. Purchased artwork and paper copies of all digital designs are filed by season for referencing purposes.

Digital Printing

Digital printing is not currently used in the design and development of printed fabrics at Company G.
Case 8: Company H

Company H is a manufacturer and distributor of children’s branded apparel. An apparel designer from company H was interviewed and is responsible for designing sleepwear for girls and boys and working with the artists to develop prints for her collections. Artists at the company are responsible for designing the prints, however, the individual interviewed would also design prints when the company was understaffed. The print design and development process of Company H is outlined in Figure 21.

To begin a season, the apparel designers and artists begin researching color and trends. They use trend and color services, magazines, historical references and shop in Atlanta, New York, Paris and London for clothing, (all ages/price ranges), fabric, stationary, and gift wrap as inspiration. The artist and designers also visit print studios in New York where they observe the trends going on in print, and purchase several pieces of artwork. One piece of purchased artwork can serve as a spring board for 40-50 print designs.

When the design team returns to the studio, the designers and artists will begin discussing palette concepts, art and silhouette direction. From these discussions the color palette, new silhouettes, fabrications and art style are determined. These ideas are put on concept boards which are then reviewed by the vice-president of product development and top level sales staff. Any initial direction changes to theme, color, print and silhouette are made by the designers and artist based on the review committee’s responses.
Figure 21: Print Design and Development Process-Company H
The concepts for each collection are then presented to the entire product development staff, vice president and sales by each designer/artist team at a kickoff meeting, using storyboards, swatches, silhouette sketches and initial artwork. Following this meeting the artists begin developing the print designs.

Purchased artwork or original artwork is scanned in or motifs are drawn by the artist in the CAD system. The image is cleaned to remove stray pixels. The image is then manipulated and worked into a layout. The layout is scaled and put into repeat. The artist will then develop several colorways which correspond to the color palette of the collection. Through out the print design process, the artist and apparel designer meet to assess the print designs and see how they are working with the silhouettes that are being created by the apparel designer. When designs are completed, they are approved by the apparel designer before being sent to the vendor for sampling by the artist. A package for the vendor is assembled by the artist and includes a specification sheet indicating the colors, size, and scale of the repeat and the artwork on disc.

When the strike-offs come back from the vendor, the apparel designer is responsible for approving the overall print design. The color department is responsible for comparing the colors in the prints back to the color standards. Changes concerning the execution of the print are communicated to the vendor. If alterations to the actual print design need to be made, the artist is responsible for making those changes and sending the altered artwork to the vendor.
Technologies and Systems Utilized at Company H

Computer-Aided Design

The artists use CAD as the primary design tool in the creation of textile print designs. The apparel designers use the same CAD software to develop silhouettes, line sheets and catalogs. Using the same CAD platform allows the print designs to be easily placed into the silhouette drawings for the line sheets and catalogs.

Color Management System/Color Communication

The color for the dyed fabrics, base cloths and prints are managed by the color department. The color department uses color standards and a light box to visually assess the color of the aforementioned items. Color is communicated to the vendors through the use of physical swatches. Alterations that need to be made to the lab dip are communicated from the color department to the vendor through email.

Archiving Systems

Each artist/designer team is responsible for archiving the artwork, print designs, styles, and trim at the conclusion of each season. All digital work is copied onto a disc and filed. Physical artwork is filed by season. The company is moving toward the use of a digital asset management system and is now in the process of developing categories in which to file the digital assets.

Digital Printing

Digital printing is currently used in the design and development of printed fabrics at Company H. If a review meeting is coming up and sample yardage of
the print design has not been received, the design will be digitally printed in-house. The use of digital printing at Company H helps decision makers visualize the overall concept by having a physical sample to assess.

Case 9: Company I

Company I is an apparel manufacturer which designs men’s and women’s sportswear. An apparel designer from Company I was interviewed and is responsible for the design and development of the both the women’s silhouettes and the textile prints and yarn dyes used in those garments. The print design and development process of Company I is outlined in Figure 22.

The season begins by researching color using a variety of color services to which Company I subscribes. The color palette is determined for each collection by the women’s apparel design team. The designers then begin researching print and silhouette trends and looking for inspiration by shopping the marketplace, visiting museums, reference books, and magazines. The designer’s also visit print studios, where they purchase artwork to use in the development of new print designs. This information is brought back and each designer develops a theme for their collection. A concept board detailing theme, color, silhouette and print direction is then created and used at the concept meeting to relate the designer’s ideas to the product development team. As both the garment development and print development for each collection is handled by one person, the silhouettes are developed by the designer, the fabrication for the garment is determined, and then the print design is developed that will go
Figure 22: Print Design and Development Process - Company I

1. Color Research
   - Develop color palette
2. Trend Research
3. Print Houses
   - Shopping Trips
   - Museums
4. Create concept boards for each theme
5. Purchase artwork

Process steps involving print & apparel designers

Decision Point
Process Step
Alternative Processes

- Present print designs
- Create specification sheet for print design
- Retrieve or create artwork
- Clean, manipulate & create layout
- Put into repeat & create colorways

Vendor
- Send print package to vendors (digital artwork & spec sheet)
  - Not Approved
  - Approved

- Strike-offs evaluated by apparel
  - Not Approved
  - Approved
- Prints approved for production
with each silhouette. To create the print design, the designer will take purchased artwork and scan it in to the CAD system. The artwork is then cleaned, manipulated, scaled and put into repeat. The designer will experiment with several colorways until a strong design is achieved. The designers bring the prints and silhouettes together and decide as a team if the print should be sent for sampling or if more work needs to be done to the design.

If the print is approved, a specification sheet is written for the design and included in a package which includes the digital artwork, and the color standards for the print.

Once the strike-offs are received from the mill, it is responsibility of the designer to assess the print for overall design and registration. The apparel designers also assess the colors of the print using a light box. The designer will either send comments back to the vendor by email or the designer will make corrections to the print and send a new digital version to the vendor for sampling.

Technologies and Systems Utilized at Company I

Computer-Aided Design

The designers use CAD as the primary design tool in the creation of textile print designs. The apparel designers use the same CAD software to develop silhouettes and line sheets.
Color Management System/Color Communication

Company I is a smaller company, there is not a color department. It is the responsibility of the apparel designer to approve color for the dyed fabrics, base cloths and prints using color standards and a light box to visually assess color.

The color palette selected by the designers at the beginning of the season is matched to Pantone® chips. The Pantone® numbers and the designer assigned names of the colors are then sent to the vendors. Alterations that need to be made to the lab dip or strike-off are communicated from the designer to the vendor through email.

Archiving Systems

Each designer is responsible for archiving their own digital work on the product development server. All purchased artwork is also filed by season for future reference.

Digital Printing

Digital printing is not currently used in the design and development of printed fabrics at Company I.
DISCUSSION

In Table 3, the steps of the print design processes found through the case study research are listed and each company (A-I) that includes these steps in its print development process is denoted by an "X".

<table>
<thead>
<tr>
<th>Print Design Process Steps</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
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</thead>
<tbody>
<tr>
<td>Trend Research</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
<td>Visit Print Shows/Studios</td>
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<td>X</td>
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<tr>
<td>Purchase Artwork</td>
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<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Create Trend, Theme, Direction Presentations</td>
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<td>X</td>
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<tr>
<td>Concept Meetings</td>
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<tr>
<td>Develop Print Concepts</td>
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<td>X</td>
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</tr>
<tr>
<td>Import Artwork/Create Artwork</td>
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<tr>
<td>Modify/Clean Artwork</td>
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<tr>
<td>Create Layout</td>
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<tr>
<td>Put Layout into Repeat</td>
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<tr>
<td>Create Colorways</td>
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<tr>
<td>Create Specification Sheets for Print Fabrication</td>
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<tr>
<td>Send Print Packages to Vendors</td>
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<tr>
<td>Evaluate Strike-offs</td>
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</table>
As seen in Table 3, the print design function is involved in the trend research conducted at the beginning of the season by product development at all of the companies except for Company B. At Company B the apparel designers are responsible for collecting trend information on silhouette, color and print and reporting that information to the print designers.

The print development process at all companies involves visiting print shows and print studios to determine upcoming print directions in the apparel industry. The print designers interviewed are also involved in selecting and purchasing artwork at the print shows and studios to use as either inspiration for print development or for a print design itself.

From the research, it was determined that the print development process involves creating trend and theme presentations to illustrate ideas for print direction for an upcoming season for the product development team. All companies involved in the study, except for Company B, included this step in the print design and development process.

The following print design process steps were customary at all the companies considered in this research: attending concept meetings, developing print concepts, importing purchased artwork into a CAD system or creating original artwork, modifying and cleaning artwork, arranging motifs in a layout, placing the layout into a repeat, and developing colorways for the print designs. Completed designs and their corresponding colorways were approved for sampling by the apparel design function instead of the print design function.
Following sampling approval, specification sheets for print fabrication are created for each print and colorway by the print designers at all companies except company B. At Company B it is the responsibility of the apparel designer to develop the specification sheet.

A print package for each design (which includes the design in repeat and a specification sheet) is sent to vendors as part of the print design and development process at all companies except for B and C. At Companies B and C, the design is handed off to a production developer who assembles the packages and sends them to vendors for sampling. This task is still performed as part of the product development process even though it is not executed by the print designer.

At companies A, C, D, E, F and I print designers are responsible for or participate in the evaluation of the strike-offs received from the vendors. At Company B, the production developer and the apparel designer are responsible for assessing the strike-off. At Companies G and H it is the responsibility of the apparel designer to assess the strike-off.

The companies were surveyed on their use of the following technologies and systems in the print development and design process: Computer-aided design, color calibrated computer monitors and printers, color information management systems, digital asset management systems, and digital textile printing. The use of the aforementioned technologies and systems at Companies A-I are summarized in Table 4. CAD systems were used to design textile prints at all companies except for Company D. Company D, still creates its print
designs through hand-rendering as opposed to using a computer. The only company that controls the color calibration of the computer monitors and printers

<table>
<thead>
<tr>
<th>Technology/Systems Utilized</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
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<th>I</th>
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</thead>
<tbody>
<tr>
<td>CAD to Create Print Designs</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Color Calibrated Monitors/Printers</td>
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<tr>
<td>Color Information Management Systems</td>
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<tr>
<td>Digital Asset Management Systems</td>
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<td>X</td>
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<tr>
<td>Digital Textile Printing</td>
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</tr>
</tbody>
</table>

used by the print designers is Company A. None of the participating companies utilized a Color Information Management System (CIMS) to assess lab dips of the base cloths used in textile prints. However, Sara Lee Corporation, an apparel manufacturer, has reported the use and success of such systems to electronically communicate assess and approve their lab dips (Textile World, 2002).

Companies E and F were the only companies surveyed that utilized a Digital Asset Management System to archive and categorize the companies’ digital assets such as artwork, graphics and print, woven and knit designs. In the majority of companies digital assets were archived on either a product development server or on disc by season.
Companies F and H were the only companies using digital textile printing in their print design and development process. These companies use digital printing to create mock-ups used in design presentations. Company H also uses digital printing for sampling purposes in the early stages of the print design process. All other companies considered have not used digital textile printing to date.

Critical Steps in the Development of Printed Fabrics

When respondents were asked what the most critical step in the design and development of a printed fabric was, a variety of responses were given. Respondents from companies D, G, H, and I all said that knowing the fabrication that the design will be printed on is critical. The respondent from Company A said that maintaining the desired “feel and mood” of the collection when designing a print is critical to its success. The respondent from Company B, said that the most critical step in print design and development is maintaining the company’s corporate image. The respondent from Company F noted the critical step is having the proportion and scale of the print in relation to the garment correct. The respondent from Company C thought the most critical step in the design and development of a printed fabric was having a strong motif. The respondent from Company E said the most critical step was properly merchandising the “right” print with the “right” garment. Though the responses differed on which step is the most critical in the development of a printed fabric, it is clear that each of these steps have a significant effect on the design and
development of a successful printed fabric for an apparel garment. It also can be noted, creating a printed apparel fabric internally requires a design approach considering both printed textile and apparel design within an integrated process.
CHAPTER V

MODEL DEVELOPMENT

The NICPPD Model for Apparel (May-Plumlee and Little, 1998) was used as a foundation for the apparel development process. The print design process steps found in this study for print designs developed internally at apparel companies were integrated into the NICPPD model. To determine the process steps, a model for each company was constructed based on the interview results. From the individual company models, all process steps reported were organized in a table. Each company’s model was reviewed and its corresponding steps were identified in Table 3: Print Design and Development Process Steps Found at Companies A – I. The steps in the print development process were significantly consistent at all companies. The print design and development process steps were found to occur in Phases 1-3 of the NICPPD Model for Apparel.

The integration points of the print design function and the apparel design function at each company are denoted in Table 5. These points were identified from the interviews conducted with each company and the models that were created to graphically depict the results.
Table 5: Integration Points of Print Design and Apparel Design Functions at Companies A-I.

<table>
<thead>
<tr>
<th>Print Design Process Steps Where Apparel Design Is Involved</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trend Research</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Visit Print Shows/Houses</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase Artwork</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Create Trend, Theme, Direction Presentations</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept Meetings</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Develop Print Concepts</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get Approval of Designs</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Evaluate Strike-offs</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Figure 23 is a combination of the original NICPPD model legend and the new shapes used to denote the print development function of the apparel design process. Figures 24-26 detail the steps involved in the print design and development process and how this process integrates into the apparel product development process outlined by May-Plumlee and Little (1998).

In Phase 1: Line Planning and Research, the print design and development process begins as the apparel designers begin conducting fabric, trim, color and fashion trend research. The print design function is involved in
Figure 23: NICPPD for Apparel Legend and Print Design and Development Model Legend
Figure 24: NICPPD for Apparel and Print Design and Development – Phase 1 (May-Plumlee and Little, 1998)
Figure 25: NICPPD for Apparel and Print Design and Development- Phase 2
(May-Plumlee and Little, 1998)
Figure 26: NICPPD for Apparel and Print Design and Development-Phase 3

(May-Plumlee and Little, 1998)
apparel design’s trend research or conducts its own color, fashion and print research to develop concepts that will be used as a starting point for the clothing line. Also during this phase the print development function visits print studios and trade shows to determine directions in print design and to purchase artwork that can be used as inspiration for the season’s print designs or as a print design itself.

In Phase 2: Design/Concept Development, the next step in the print design process is to assemble concept groupings. These groupings detail color, theme, and technique directions as they relate to the printed fabrics that will be designed for the season. These concepts are presented at the product development color and concept meeting. At the concept meeting the apparel design and print design concepts are exchanged. Concepts are either dropped or approved. If a concept is dropped it may be replaced or it may be archived for future reference. If a concept is approved, print design concepts are developed with apparel design to coordinate with a collection’s theme, style, color palette and fabrication.

In Phase 3: Design Development and Style Selection, the print design function begins to create print designs for the apparel line. Artwork is first imported into the CAD system. The artwork may be purchased, hand-rendered by the print designer or created in the CAD system by the designer. Once artwork is in the CAD system, it is modified and cleaned to the designer’s satisfaction. The motifs are then arranged into a layout. The layout is then put into a repeat size, which will co-ordinate with the intended garment’s
specifications. With a repeat finalized, the designer will create various colorways using the season’s color palette, determined in Phase 2. The print design and colorways are taken to apparel design to be approved for sampling. For the designs and colorways that are approved, a specification sheet is made and is sent to vendors for sampling along with a copy of the digital artwork. If a design is not approved, it may be reworked by the print designer.

When a strike-off of the print is received from the vendor, the printed fabric is assessed for characteristics such as registration, scale, repeat, color and overall aesthetics. The assessment of the print design may be done by the print designer, the apparel designer, the color department, the production developer, or a combination of these functional departments. If the strike-off is approved, the fabric will be presented at the sales and merchandising meeting where it can be approved and incorporated into the line, revised or replaced. If the strike-off is not approved, it can either require revisions to the original design to be made by the print designer, or it may require alterations in the print execution (registration, color, etc.) to be made by the vendor.
CHAPTER VI

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

CONCLUSIONS

In Chapter II, Review of Literature, it was found that the apparel product development models examined did not discuss in detail the role that the design and development of printed fabrics plays in the development of new apparel products. Also, there was a limited amount of literature describing the printed textile design process conceptually. Insight into the aforementioned topics was gained as a result of this research. This was done first through the development of a conceptual model of the print design and development process as it is carried out by apparel manufacturing firms, and secondly, through the successful integration of the print design and development model into the NICPPD Model for Apparel by May-Plumlee and Little (1998). This was possible through the identification of the print design and development process steps, the integration points of the print design and overall apparel product development process, and the integration points of the apparel design and print design functions. The following phases were identified in the design and development process of printed fabrics created internally by apparel companies:

1. Trend Research
2. Visit Print Shows/Houses
3. Purchase Artwork
4. Create Concept Presentations for Trend, Theme, and Technique as related to Print Direction
5. Participate in Concept Meetings
6. Develop Print Design Concepts for the Apparel Line
7. Import/Create Artwork
8. Modify/Clean Artwork
9. Create Motif Layout
10. Put Layout into a Textile Repeat
11. Create Colorways
12. Create Specification Sheets for Print Fabrication
13. Prepare Print Packages for Print Vendors
14. Evaluate Strike-offs

The integration points of the print design and development process into the overall apparel product development process were found to be:

1. Trend Research
2. Color and Concept Meeting
3. Sales and Merchandising Meeting

The process integration points between the apparel design and print design functions were found to be:

1. Trend Research
2. Purchasing Artwork
3. Development of Print Design Concepts
4. Approval of Print Designs for Sampling
5. Strike-off Evaluation

From the process steps and points of integration with the apparel design function and the apparel product development process as a whole, it was found that the print design and development process occurs simultaneously with the apparel design process.

Technologies and systems used in the design and development of printed fabrics were surveyed as a part of this research. It was found that Computer-Aided Design is widely used in the design and development of printed fabrics at apparel companies. In some cases the CAD software used to develop print designs is also used in the design of garment silhouettes for the apparel line.
Digital Asset Management Systems are being used to archive artwork and print designs at some apparel companies. Also, digital textile printing is being used for preliminary samples and presentations to merchandising and sales at some apparel companies. Lastly, Color Information Management Systems were not used by any of the companies interviewed however; there are reports in trade publications in which some apparel companies are utilizing the technology to digitally assess lab dips (Textile World, 2002).

LIMITATIONS

There are two limitations to this study. The first limitation is that the available contacts were heavily based in the children’s wear segment of the apparel industry. Five of the nine case studies conducted for this research were with companies that designed and manufactured children’s clothing. The second limitation is that since the research was conducted using a case study approach, only a small sample of the industry could be studied and therefore generalizations about the entire industry were made. Saturation was evident in the results of the nine cases of the study, which signifies a sufficient sample size to draw conclusions and previous work has shown six cases to be sufficient to achieve saturation in the results (Studd, R., 2002).
RECOMMENDATIONS FOR FUTURE RESEARCH

There are several recommendations for future research. First, the phases and the design process used for internally designed and developed knit and woven fabrics by an apparel company could be identified and integrated into the NICPPD model for apparel. Second, as only apparel companies inside the United States were interviewed, future studies could include companies outside the United States. Third, further studies could test the print design and development process model develop as a result of this study. Lastly, future research could include investigating how the printed textile design process model presented in this research applies to different corporate environments (small, medium and large companies) and working across geographic distances in global firms.
REFERENCES


APPENDIX A: INTERVIEW INSTRUMENT

Name:

Company:

Position/Title:

Research ID Code:

1. What is the typical path a new style takes from beginning to end at your company?

2. What stages of this process are you involved in?

3. Tell me about your role in these stages.

4. What role does print design play in the development of an apparel style?

5. What type of technologies do you use in designing a print design or a printed apparel style?

At what stages of your design process do you use these technologies?

   a. CAD software
   b. Color Management System/Color Communication System
   c. Archiving System/Software (DAM) data asset management
   d. Digital printing

6. Are any of these technologies used in both the development of print designs and new apparel styles?

7. Are there interactions between the print design and apparel design functions when developing products? If so, please tell me about them.

8. Please describe your individual design process when developing a
   • Print design for a garment
• Printed apparel style

9. What do you feel is the most critical step in the development of a
   • Print design for a garment?
   • Printed apparel style?

10. Are there any steps you find are repeated the most when you are designing?
    a. Necessarily or unnecessarily?

11. What is your educational and work experience background?

12. Was there a particular style or approach to designing you were taught through your education?
    a. Do you still use it?
    b. Have you modified it?

13. If you were in an ideal situation, would your approach for designing a print design/printed garment be different?
    a. If so, how?