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# A survey of digital printing in home décor textiles: 3 case studies

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**A Survey of Digital Printing in  
Home Décor Textiles: 3 Case Studies**

by Meredith O. Needham

A thesis submitted in partial fulfillment of the requirements  
for the degree of Master of Science  
in the School of Print Media  
in the College of Imaging Arts and Sciences  
of the Rochester Institute of Technology

May 2008

Primary Thesis Advisor: Professor Pat Sorce  
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Rochester, New York

Certificate of Approval

A Survey of Digital Printing in Home Décor Textiles

This is to certify that the Master's Thesis of

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has been approved by the Thesis Committee as satisfactory  
for the thesis requirement for the Master of Science degree  
at the convocation of

May 2008

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A Survey of Digital Printing in Home Décor Textiles

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## **Abstract**

This thesis examines the rising focus on digital textile printing in the home décor industry. The current textile market is dominated by roto-gravure and screen printing, making small, customized orders impossible. Industry analysts are predicting increases in digital printing because of customers' increasing demands for a wider selection of products, as well more customized products. This changing desire is termed “mass customization” and is the lens through which the research is conducted.

Three digital textile printers were interviewed to find out: 1) what is the current market for digitally printed textiles? 2) what is the workflow for a typical customized digital textile? 3) what are the future predictions for the market of customized digital textiles? Company A is an industry leader that offers customized workflow and production processes depending upon the customers' final needs. Company B is a small-sized service provider, which is dedicated to providing whatever service or product the customer may desire. Company C is a small-sized printer that is currently in the process of leaving the digital textile industry after trying to offer mass customization through an online store.

The findings show that sample printing is still a huge market for digital, while companies are slowly increasing their one-to-one custom textile sales. However, none of the companies have truly brought mass customization to digital textile printing. The material costs are still too high (ink, fabric) and there are too many variables involved to lend digital textile printing to the standardization of mass customization.

## **Chapter 1**

### **Introduction**

#### **Topic Statement**

Digital printing of textiles is a rapidly growing segment of the printed fabric market. Unlike other forms of textile printing, digital offers the potential to completely alter the way printed textiles are created and sold. Workflow and business strategies will be required to change as more businesses adopt the digital printing process for textiles.

#### **Background and Significance**

The printed textile industry is massive: The total retail value of printed textiles worldwide (not including digital) is about \$450 billion, and the value of textile print services worldwide is approximately \$38 billion. The majority of these textiles are printed on giant gravure cylinders or flat-screen printers, so the production of smaller orders is costly and impractical. With each new design new cylinders or screens must be made, fabric is wasted during set up, and the real cost is the risk of having to stock extra fabric and finished goods that do not sell (Hanley, 2000).

Manufacturers and retailers are looking to shorter runs and more customized products to meet changing consumer demand (Tippett, 2000). Across retail categories, customers are demanding a wider selection of products, resulting in smaller order sizes for single designs; Successful retailers must be able to provide customers with a wider

selection of products along with the ability to change their offerings frequently to satisfy these trends (Abernathy, Volpe, Weil, 2004). Many in the textile industry are looking to the concept of “mass customization” as a new way to do business, by developing products specifically for customer wants and needs (Abernathy, Dunlop, Hammond, Weil, 2002).

It is through the lens of mass customization that the changing nature of textile printing for home furnishings will be examined. Textile printers are facing an entirely different way of doing business, along with the possibility of major growth. This project will examine the current textile industry for home décor by answering the following questions: 1) what is the current market for digitally printed textiles? 2) what is the workflow for a typical customized digital textile? 3) what are the future predictions for the market of customized digital textiles?

### **Reasons for Interest**

The researcher selected this subject for study because of her own personal interest in textile printing and the home décor industry. Furthermore, she was interested in the subject because there has been so little research done regarding digital printing workflows and the possible effects on the home décor industry. Mass customization and digital printing are closely related, and much has been written about the relation between digital textile printing and mass customization. Lastly, this subject will be a compliment to other printing research about print-on-demand and customization.

## **Chapter 2**

### **A Review of the Literature in the Field**

#### **Home Décor Industry Overview**

Textiles are primarily used for three industries: apparel, home furnishings, and industrial uses. Home furnishings includes sheets, towels, carpets, curtains and related products (Abernathy, Volpe, and Weil, 2004). It is around this specific market that this literature review focuses.

The U.S. home décor retail market (which includes furniture and appliances as well as textiles) is currently worth an estimated \$18 billion, with growth rates approaching 20% annually (DeGross, 2006). The industry is becoming increasingly fragmented, with multi-channel retailers carrying home décor and furniture. Even big box discount retailers such as WalMart and Target are getting in on the trend by carrying home décor lines produced and designed by well-known designers like Christopher Lowell and Cynthia Rowley (Heller, 2006).

The home décor textile industry is dominated by large suppliers who are currently undergoing a major downward shift in sales. In 2006, the top 15 home fashions suppliers (Springs Global, WestPointHome, Mohawk Home, Pacific Coast Feather, Sleep Innovations, Hollander Home Fashions, Shaw Living, Welspun, Maples Rugs, Franco Manufacturing, Croscill, CHF Corporation, American Pacific, Dan River, and Louisville

Bedding,) saw a decrease of overall sales by 4.8% (to \$6.9 billion), a drop of \$351 million from 2005. This is an overall drop of 17.3% since the high-water mark of \$8.4 billion in 2000. These numbers are part of a steady six-year decline trend for the major suppliers, and overall their sales have barely moved since 1996. Figure 2.1 below shows this steady decline. Companies that are doing well are smaller mid-sized companies (like Hollander) (Hogsett, 2007).

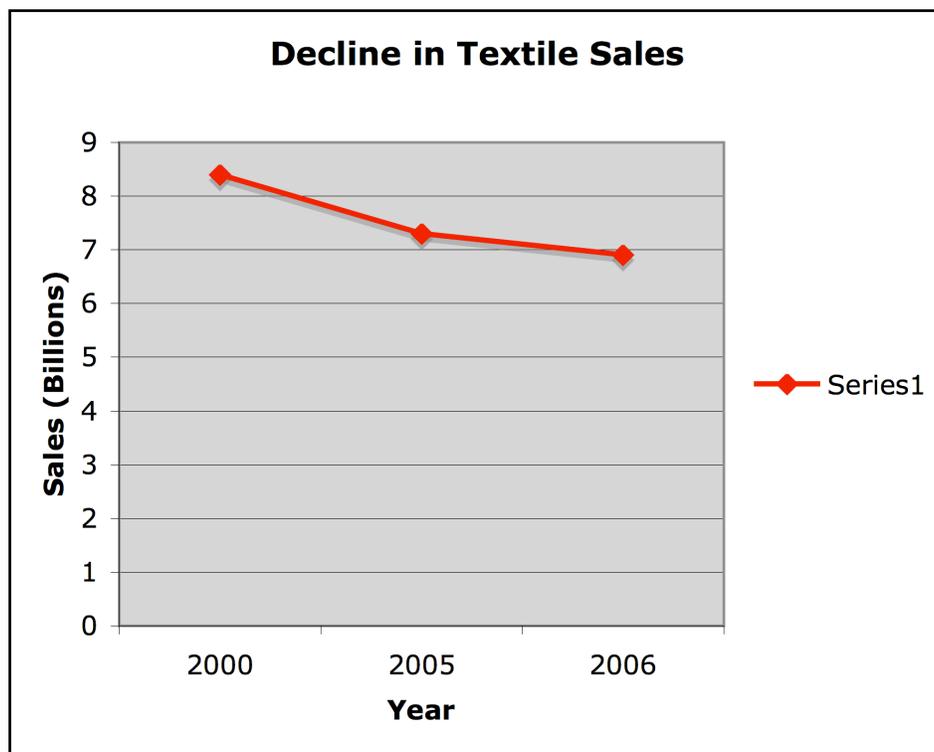


Figure 2.1. Decline in textile sales from 2000 to 2006.

While many home fashions suppliers sell ready-made textile products (such as pillows, curtains, etc.), the “fabric-shop” industry is also a large part of the home décor textile market. Overall, the fabric-shop industry is a \$4 billion market, which includes fashion fabrics along with home furnishings and upholstery fabrics, with 40% of the fabric sold classified as home furnishings and upholstery fabrics (Daniel, 2007). Larger

stores like Calico Corners focus exclusively on home fabrics, while Jo-Ann and Hancock Fabrics include fashion, decorator fabrics and crafts. This is a market that continues to be dominated by larger retailers, with Jo-Ann controlling 50 % of the fabric-shop market. The overall number of retailers in the U.S. has decreased from 12,000 to 4,500 over the past ten years (Daniel, 2007).

### **Digital Textiles**

According to a recent report in Textile Outlook International, digital technology is the fastest growing method of printing textiles. Between 2000 and 2005, digitally printed textile output increased by 300%, up to 70 million square meters. Even with these gains, digital textiles still only account for 1% of the total global market for printed textiles. It is being predicted that over the next decade digital will expand to 10% of the market (“Digital Textile Printing..,” 2007).

It is estimated that in 2005 more than 85 million square meters of digitally printed textiles were produced by some 2,300 digital textile printers (units). Out of this, 75% (about 64 million meters) was signage and 25% (21 million) was interior furnishings and apparel. Research firm I.T. Strategies predicts that digitally printed textiles will grow at a compound annual growth rate of 19%, to more than 186 million square meters by 2010. They are also predicting that the number of digital textile printer units will reach 5,000 (Anonymous, 2007; “Textiles a Growing Segment..,” 2007).

While textiles are being used for signage, apparel and home furnishings, the current markets of digital textile printing also includes sampling. Sampling is used to test how a future printed textile will look as a final product. It is printed on both paper and fabrics

and conforms to the traditional screen/gravure printing that will be used for final production. Digital printing reduces turnaround time for sampling from six to eight weeks (with traditional technology) to just a few days (“Unfolding the Frontiers...,” 2007).

Digital is also being used for other home design products, specifically wallpaper. I.T. strategies estimates that in 2002, digital printing of wallpaper was valued at about \$90 million in the U.S. It currently represents about 3% of the total U.S. wallcoverings market for that year (Larson, 2006).

### *Digital Technology*

As little as 15 years ago digital printing of textiles seemed nearly impossible. The various demands of the textile application are extreme and it did not seem likely that a process would be developed to make it simpler (I.T. Strategies). Early printing methods used for fabrics actually used computer inks, and fabric was usually only printed with black images or text. However, by the late 1980s the development of color inkjet printers by industry leaders Canon and Hewlett-Packard helped to change the way fabric was digitally printed (Doshi, New Wave of Digital).

It wasn't until the 1990s that digital printing on fabric really began to develop with the advancement of large format color inkjet printers. Unfortunately the level of quality on fabrics was lacking, with color problems as well as fading being the biggest issues. In 1999 the Bubble Jet Set technology was created, allowing fabric to be treated, amalgamated to freezer paper with an iron and then put through an inkjet printer (Doshi, New Wave of Digital). The types of digital printing have been categorized as either direct

printing (inkjet) or dye sublimation and transfer (e-stat and inkjet) (“Textiles a Growing...,” 2007).

The area of dye sublimation is not as widely used as inkjet, but it is making gains with changes in technology that are focusing on larger sizes, better productivity and improved value. Water-based inks are the standard with sublimation since they produce finer details and are environmentally friendly, however, they are difficult with wide format because of the amount of water necessary. Therefore, oil-based dye sublimation is becoming more accepted for wide format, though it lacks the close range quality of water-based (Franklin, 2007).

Dye sublimation still requires disposable blotting paper when printing on textiles but fabric suppliers are also beginning to offer a wider variety of fabrics and coatings for dye sublimation because of a growing demand for custom and high-end fabrics and unique applications. The coatings add to the price, but allow the fabrics to be printed directly, and they do allow for a more accurate color. Furthermore, the direct-to-fabric process is less sensitive to errors from environmental factors such as changing humidity and temperature (Franklin, 2007).

Today, the majority of digital textiles are printed with inkjet printers (“Textiles a Growing Segment...,” 2007). Commercial inkjet printers, which were initially developed for paper and industrial printing, are divided into two major types based on the printing method: Drop-on-Demand (DOD) or Continuous Inkjet (CIJ). Drop-on-demand is when a drop of ink is generated only when required for printing, and the two major systems

used are thermal and piezoelectric. Thermal inkjet has a resistor that is heated by a computer signal and the vapor bubble created on the resistor causes a single drop of ink to be ejected from the nozzle. On the other hand, piezoelectric uses a computer that imposes an electrical current across a piezoelectric material, causing a contraction and expansion, causing a drop of ink to be ejected (May-Plumlee, and Bae, 2005).

Continuous inkjet generates a continuous stream of ink drops, some of which are deflected while others come into contact with the substrate. There are two main types of CIJ systems. The first is a binary system, where the drops are charged or uncharged between the jet orifice and a charging plate. The second is the multiple deflection system, where drops are given varying amounts of charge and deflected to the substrate (May-Plumlee, and Bae, 2005).

### *Benefits of Digital*

In terms of product offerings, digital opens up a wide array of options. Typical textile designs are constrained to six to twelve colors, but with digital printing, millions of colors are achievable (Anonymous, 2006).<sup>1</sup> The number of designs that can be printed also increases while decreasing the overall time to create the textiles, allowing for quick feedback and no closeout inventory to finance (Schiffner, 2005). Interior designers and manufacturers of home furnishings also had to adhere to 3,000 yard minimums for custom prints, but with digital they can now create custom prints for as little as 25 yards

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<sup>1</sup> The quality and longevity of digital prints used to be a major factor, but today digital is done using reactive, acid and pigment dyes that still provide good color, but can also withstand washing (Judson, 2005).

(First2Print Demonstrates Instant...). It also allows manufacturers to work closely with retailers, enabling them to create designs and prints that will be closer to the customers' needs (Early, 2005).

### *Issues/Responsibilities*

Proponents of digital textile printing tend to focus on the benefits of the technology, but rarely touch upon the issues and responsibilities that go along with it. To begin, education is a continual process for digital textile printers because the technologies and substrates continue to evolve. There are new inks, fabrics and printers (units), which can be used for a variety of different products. This also requires designers to have a clear understanding of the final product since they are the ones who must set up the sampling parameters with digital design files to meet the specifications (Locastro, n.d.).

For companies that are new to digital textile printing, an obvious way to avoid having to deal with new technologies is to outsource their work. It is seen as a way to avoid dealing with the responsibilities, management or costs of digitally printing fabric. The material challenges alone are significant. In addition,

- The cost of inks and pre-treated fabrics is still high.
- Fabrics are not always consistently pre-treated, there are more than a half dozen common types of synthetic and natural fibres, each with its own ink compatibility characteristics.
- The printer is dealing with a stretchable, highly porous and textured surface.

- Inks clogging, color inconsistencies within the same roll of fabric and print heads that drip (Ragsdale, 2001).

Outsourcing allows manufacturers to benefit financially without having to deal with the logistics of file management, design, ink configurations, fabric inventories and, printer profiles (Locastro, n.d.; “Unfolding the Frontiers...,” 2007).

The outsourcing of design services has become a huge trend for textile printers and manufacturers. This trend is helped by the Internet, which makes collaboration and delivery easier than ever before. More companies are using “service bureaus” which offer complete design development, ranging from original artwork creation to digital textile samples. More bureaus have arisen that offer digital textile printing services for sampling and short run production, making it cheaper for the company rather than owning and maintaining all of the equipment (Chapman, 2001).

The cost for outsourcing depends on the type of work being done. Digital fabric prints range from \$100 to \$250 per yard and art development can range from \$20 to \$100 per color (compared to a store like Joanne Fabrics, where a high end textile can retail for about \$50 per yard). The price also depends on whether the design is digital or manual, the complexity of the work needed, and how quickly the job must be completed (Chapman, 2001). Furthermore, some outsourcing is also done offshore.

As previously mentioned with regard to samples, digital printing allows lead-time to be reduced, taking outsourced offshore production time from several months to several weeks (Anonymous, 2006). Using digital to cut down the total production time for

outsourced offshore production is just the tip of the iceberg in terms of what people see digital being capable of with textiles.

### **Apparel Industry**

It is impossible to discuss the rise of digital textile printing without mentioning the increasing role it plays in the apparel industry. In recent years the apparel industry has undergone significant changes in terms of how clothing is distributed, forecasted and produced. Similar to other industries, product proliferation has drastically changed the apparel sector, meaning that retailers must supply more products on a frequent basis. Stores like Sweden's H&M and Spain's Zara have pioneered this tactic. With more products to offer, demand is also spread across a larger number of goods with a lower average demand and higher levels of variability (Abernathy, Dunlop, Hammond, Weil, 2002).

As a result of this trend, lead times must also be drastically cut down. Similar to home furnishings, the lead times in apparel from order to delivery are quite long, but with these new developments clothing must be created and shipped in six to eight weeks, instead of six months (Tan, 2001). This also means that the elapsed time between order and delivery has become more important and many major U.S. apparel textile companies have started to move their capital to Mexico. Researchers are predicting that similar developments can be expected to emerge in other product industries where replenishment is of growing importance (Abernathy, Dunlop, Hammond, Weil, 2002).

## **Mass Customization**

The trend helping to drive the focus on digital textile printing was briefly mentioned as mass customization. This concept must be examined in greater detail to understand how it relates to the focus on digital textiles. A general definition of mass customization is: “a combination of mass production and custom made production” (Hammond and Kohler, 2000). Basically, it is a reduction in length of the path from product specification through manufacturing to the finished product. It is sometimes referred to as "agile manufacturing," and the production steps are under one umbrella with standard product specification (“Unfolding the Frontiers...,” 2007).

The number of products available to consumers has dramatically increased in recent years. Companies are marketing closer to customers’ individual tastes, and mass customization has become a part of mass production. Instead of standardized products manufactured for the general public, products now reflect the full array of preferences and prices (Roth, 2003). Overall, the goal of mass customization is to deliver customized products at a similar price as mass-produced products (Lau, 1995). However, it must be made clear that mass customization is not the same thing as variety, “Customization means manufacturing a product or delivering a service in response to a particular customer’s needs, and mass customization means doing it in a cost-effective way.” (Pine, Peppers and Rogers, 1995)

While the changing relationship to the customer is an important issue to investigate with mass customization, it also requires an investigation into how companies must alter their workflow and the overall way they do business. In order for a company

to be successful at mass customization they must redefine all of their traditional organizational functions, including their connections to suppliers and customers (Lau, 1995). Furthermore, companies must first have already high levels of quality and skills at low costs (Boynton, Pine and Victor, 1993).

For the purposes of this study, traditional business organization is defined as an attempt to achieve low-cost mass production. In this type of set-up, the business is segmented into specific areas (often called functional or vertical silos), each with its own isolated task. The organization is organized vertically, with information being passed up and decisions handed down (Boynton, Pine and Victor, 1993). However, a business geared towards mass customization:

[R]equires a *dynamic network* of relatively autonomous operation units. Each *module* is typically a specific process or task, like making a given component, a distinctive welding method, or performing a credit check. (Boynton, Pine and Victor, 1993)

These modules can include outside vendors and suppliers and usually do not interact in the same sequence every time. Instead, the way in which they come together to make a product or service constantly changes in response to what each specific customer wants and needs. In general, “It is a world in which the unpredictable nature of each customer’s demand is considered an opportunity” (Boynton, Pine and Victor, 1993). Figure 2.2 below is a simplified outline of the standard textile printing workflow in comparison to digital workflow.

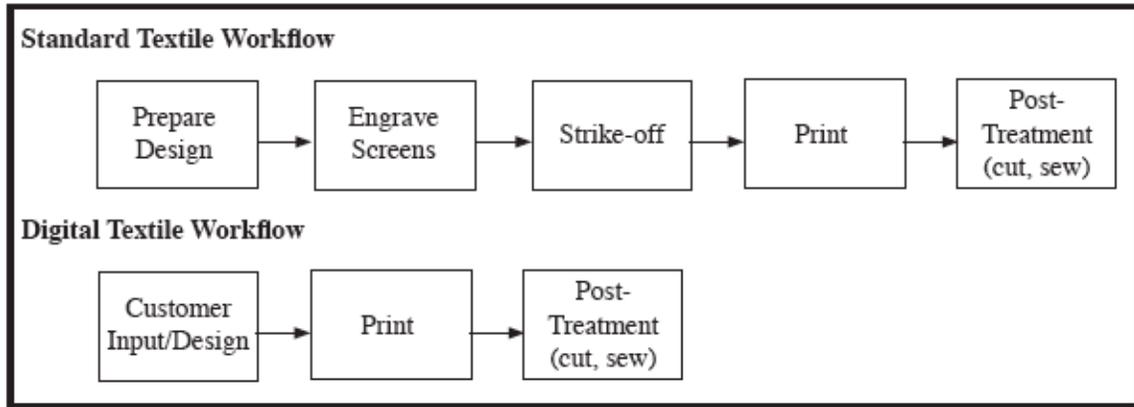


Figure 2.2. Standard Textile printing workflow vs. Digital textile workflow.

Another way to look at the workflow process necessary for mass customization is to think of children using a set number of Lego blocks to create an unlimited number of designs and creations. The modules/components can be assembled in a variety of ways to allow the company to tailor their products and services for certain customers (at a relatively low cost). It is important to remember that these modules can be automated by using a flexible manufacturing system that can choose any product component within its variety. The overall coordination of the network is centralized but each module has its own operational authority for its process (Boynton, Pine and Victor, 1993).

This also means a change in the way managers do their jobs. Companies set on being successful at mass customization must implement “customer managers,” who are responsible for a portfolio of customers with similar needs. Managers must now be responsible for executing different product processes for each customer’s requirements. They are also responsible for obtaining all the business possible from each customer (Pine, Peppers and Rogers, 1995).

It is important to remember that mass customization is not just present in apparel and textiles, it is evident in all aspects of the marketplace. Automobile customization

sales (such as engines, wheels and accessories) have grown 46% from 1996 to 2001 to about \$26 billion. The purely aesthetic part of the automotive market makes up about \$10 billion of the entire industry (Postrel, “Aesthetic Imperative,” 2003). Another example is kiosks set up by Hallmark Cards and American Greetings, which allow the customer to choose from various templates the type of card they would like to create. While standing at the kiosk the customer pays, designs and prints the card (Pine, Peppers and Rogers, 1995).

### *Rise of Aesthetics*

This push for wider product selection is also linked to the rise of aesthetics as a major selling point. As social critic Virginia Postrel points out in her article “The Economics of Aesthetics”:

Successful businesses understand that aesthetics is more pervasive than it used to be—not restricted to a social, economic, or artistic elite, or limited to only a few settings or industries, or designed to communicate only power, influence, and wealth.

In other words: “The drive for aesthetic value is creating opportunity throughout the supply chain” (Postrel, The Economics of Aesthetics).

Postrel points out that this has meant a huge growth for industries that focus on beauty, such as day spas, nail salons, and piercing shops. She also draws attention to the fact that people are focusing on beautifying their environments, and it should come as no surprise that membership in the American Society of Interior Designers has more than doubled since 1992, rising to over 33,000 (“Aesthetic Imperative,” 2003).

Home décor has also expanded its aesthetic focus, as previously mentioned, big box retailers are using designers for their clothing and home furnishing lines. Even pure fabric stores are embracing well-known names. In 2006 Jo-Ann Fabrics began a partnership with designer Christopher Lowell to offer an array of bedding, bath and kitchen merchandise at their stores (Mammarella, 2006).

### *E-Commerce*

The importance of mass customization and aesthetic choices cannot be discussed without the role Internet and e-commerce is playing. The benefits of online sales and promotions is obvious, allowing retailers to offer as many choices as they can, whereas physical stores can only hold so much merchandise (Corral, 2005). As Postrel states: “More and more economic value seems to be coming from giving consumers greater choice, off-line as well as online” (2004).

Home furnishing textiles are making huge gains in online sales. In 2005 Internet retail sales reached \$2.6 billion for home décor/craft goods (including rugs and decorative pillows) and \$1.4 billion for linens. Forrester Research Inc. predicts that online sales will continue to increase into 2010, with home décor/crafts goods reaching \$3.9 billion and linens reaching \$1.8 billion (Corral, 2005).

Furthermore, purely online sales sites are beginning to focus on selling home textiles and home goods. Amazon launched its own home and garden division in 2003/2004 and the bedding and bath section became a huge seller. They indicated that home textiles were selling well because the rise in home decorating (Corral, 2005).

With any discussion of the Internet and the increase of choices facing customers there are always critics who say that too much choice is paralyzing, resulting in less sales. Counter-critics like Postrel admit that variety can be overwhelming, but she also points out that consumers do not have to sort through item by item. Online shopping includes tools like search engines, as well as customer reviews and referral services. Furthermore, when looking at what people buy when they shop online, the selection of choice seems to be the deciding factor. In a study on what type of books were purchased on Amazon.com researchers determined that nearly half of the book sales at Amazon were of obscure titles (Postrel, "Selection Ranks..," 2004).

This should not be surprising, because the Internet as a whole has ended up streamlining the overall search process, which in turn heightens customers' expectations about finding the exact product they want. "Increasingly, that expectation has come to include customized fit, and customized design" (Hammond and Kohler, 2000). This means that the impact of the Internet on the consumer, and on the overall industry will lie in how retailers and manufacturers use the Internet to meet expressed and latent customer needs (Hammond and Kohler, 2000).

*The Long Tail of E-Commerce.* The ways the Internet is changing consumer buying habits, as well as manufacturers' business strategies, is the focus of Chris Anderson's book *The Long Tail*. This book is an important treatise on buyer behaviors and serves as an important reference for this study. Anderson's premise is simple, "The economics of the broadband era are reversed" (5). Instead of making lots of money by selling lots of

general mass market goods, more companies in the Internet age are making their money by focusing on smaller niches, and as a result “the era of one-size-fits-all is ending, and in its place is something new, a market of multitude” (5). Instead of having brick and mortar stores with a very limited selection, we now have online distribution and retail and are “entering a world of *abundance*” (Anderson, 18).

This also means that the idea that all consumers want similar items and goods is false, as “the mass market is turning into a market of niches” (Anderson, 5). The Internet has helped spawn services and products that are more focused than ever, as more retailers are realizing that “focus is no longer expensive. Mass is” (Godin, 184). In a market where consumers are used to high quality goods wherever they turn, companies must now focus on offering unique and remarkable products in order to stand out from the crowd (Godin, 182).

With these concepts beginning to take root, it comes as no surprise that more companies are offering a wide array of products that can be personalized. As Anderson states, “When you can dramatically lower the costs of connecting supply and demand, it changes not just the numbers, but the entire nature of the market” (The Long Tail, 26).

### **Lean Retailing**

In close relation to the rise of mass customization is the growing trend known as “lean retail.” Under the traditional model, there are infrequent large shipments of goods. Lean retailing has frequent shipments on the basis of ongoing replenishment orders from the retailer (Abernathy, Dunlop, Hammond, and Weil, 2002). Much like mass customization, the forces driving lean retailing are: product proliferation, shorter product life-cycles,

technological advances and forecasting uncertainty (Hammond and Kohler, 2000). Lean retailing is not limited to a few select retail channels, but is being implemented in department stores, mass merchants and specialty stores.

As a result of these changes retailers now avoid the risk of carrying items with unpredictable demand by ordering in smaller quantities of each product, and only reordering enough quantities of what has sold during the previous week. This replenishment cycle is helped by developments in technology such as product ID bar codes point of sale scanning, electronic data interchange (EDI) and lastly, automated distribution centers. (Hammond and Kohler, 2000). These distribution centers and suppliers' warehouses are now like "virtual" warehouses for retailers (Abernathy, Volpe, and Weil, 2004). This also means suppliers must now undertake the complicated task of using sales information to "undertake the increasingly complicated task of using information on consumer sales to determine the allocation of production across supply chains with different cost, product variety, quality, lead time, and risk characteristics" (Abernathy, F. Dunlop, J., Hammond, J., Weil, 2002).

## **Conclusion**

Digital printing of textiles is a quickly expanding market. It is currently the fastest growing method of textile printing and in five years (2000 to 2005) digital output increased by 300% . While these numbers are impressive, digitally printed textiles only account for 1% of the total global market, but are predicted to expand to 10% of the total market over the next decade. The technology of digital printing is now at the point where

companies can do smaller, customized runs, whereas traditional textile printing has always required large yardage minimums (“Digital Textile Printing..,” 2007).

These developments are happening at a critical time, since consumer buying habits are becoming more demanding. Business analysts are calling this rise in customized goods for mass prices, “mass customization,” and it is present in every industry from clothing to cars. Digital printing of textiles has the ability to cater its goods to a new customer segment, but must also change business workflow and the overall way of doing business. Industry trends indicate that the increase of digital textile printing will alter the way consumers purchase home décor goods as well as the expectations for getting the exact product they desire (Tippett, 2000).

## **Chapter 3**

### **Research Questions**

The home décor textile industry is on the verge of undergoing some major changes in workflow processes as well as how it markets and sells its goods to consumers. This thesis answers questions about what current digital textile printers are doing right now in the home décor industry. The following questions are answered: 1) what is the current market for digitally printed textiles? 2) what is the workflow for a typical customized digital textile? 3) what are the future predictions for the market of customized digital textiles? This research sheds light on the current digital textile industry, while enabling us to make predictions about what the industry will be like in five to ten years.

## **Chapter 4**

### **Methodology**

The previously mentioned objectives required the following methods:

- A literature review and bibliography that will focus on the general state of the textile industry, the home décor industry, current textile printing practices, and developing digital technologies.
- Interviews with digital textile producers in the United States through email or phone to answer the following questions: (See Appendix A for proposed questionnaire)
  - The average customer profile.
  - Whether the company does its printing in-house or outsourced.
  - If demand has increased for customized and short-run products.
  - Describe the average workflow for creating a customized textile.
  - Where they see textile printing going in the next few years.
- Six companies were selected through a general Internet search or because they were mentioned in articles relating to the textile industry. All six exclusively offer digital textile printing services. Only three companies were able to participate in the survey, and the company's names have been withheld for confidentiality:
  - Company A
  - Company B

- Company C

Since there is very little research done in this area interviews with current digital textile printers allows for a more in-depth examination about the current state of the digital textile market and future trends.

## **Chapter 5**

### **Results**

#### **Company A**

Company A is a leading print service studio whose clients are primarily textile manufacturers. The company has offices in Los Angeles, California and New York, New York, with a total of twenty-two employees. They concentrate solely on textiles for the apparel and home furnishings industries and do not do signage or promotional textiles and all of their clients come to them specifically for printed fabric. The Director of Operations (DOA) indicated that Company A focuses on such a narrow market because it allows them to have a larger number of clients. While they do not offer design services, Company A has a sister company that offers a full service CAD (computer-aided) design studio focusing on the home furnishing and fashion markets.

Company A currently has about 250 to 350 active accounts and is printing a total of 3,500 yards a month. Their accounts are evenly divided between two business sectors: samples and short-run printing. As previously mentioned, sample printing is generally used by traditional manufacturers for prototypes of potential fabrics. The DOA indicated that manufacturing companies come to them because it is quicker and cheaper, allowing the manufacturer to then place a traditional order off-shore. The average turnaround time for sample printing is about five days.

Short-run printing is concentrated around niche markets, which often need small yardage runs. The average turnaround for short-run printing is seven to fifteen business days. Company A also indicated that most of their clients are not geographically close to them, but that physical proximity tends to be more of a factor for the sampling clients. In terms of volume and profit both customer bases are fairly even, but a year ago it would have been mainly sampling. The rise of short-run printing for niche markets has been a more recent development.

### *Workflow Process*

In terms of Company A's workflow process, the DOA indicated that each product's workflow is different depending upon the clients' needs. She said, "digital printing requires a lot of little puzzle pieces to fit together, it is not a direct science since it involves so many variables: hardware, software, fabric, pre and post-treatment, inks, suppliers, and the designers." Company A has dedicated itself to being able to provide variety to their clients, offering 70 types of fabric and using five different printers, including Dupont's Artistri™ 2020 Digital Textile Printer (all printing is done in-house). Clients who submit their own designs are requested to export them as TIFF files from Adobe Illustrator. Company A also requests that jobs contain color-matching samples, which can include: pantone chips, Scotdic, color service sources-cotton inc, Huepoint, or swatches, original artwork, and paint chips.

Traditional textile design usually requires a designer to hand off the ideas to a production manager, who then turns the idea into reality. At Company A however, the designers must have a clear understanding of what they are producing as well as the

entire production process, so they can set up digital design files to meet the specific needs of that project. This means that designers who come in with a graphics background must be educated on the fundamentals of rotary print production, while the designers who come in with rotary printing backgrounds must be taught the various digital printing technologies (especially issues related to color profiling, file set up, and color matching with process colors).

The typical job separation found in traditional textile printing is not present at Company A, instead, a single employee can help a client through each step of the creation and production process. This means each client is treated as a relationship, because “sometimes we’re the designers and sometimes we’re the printer behind the designer. We can become part of their product development cycle at point A or at point F.” Figure 5.1 on the below is an outline of Company A’s general workflow, which would normally be performed by a single employee.

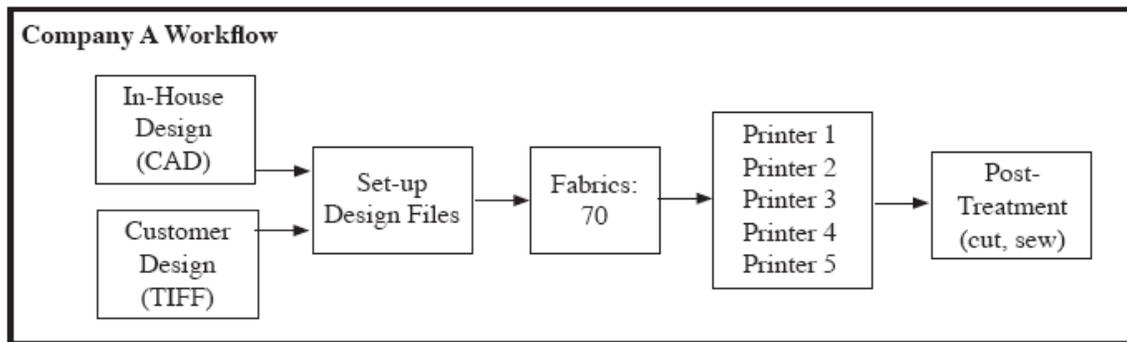


Figure 5.1. Company A workflow process.

Lastly, Company A is predicting growth in the short-run market, and they have responded by recently investing in short-run production equipment. The DOA states that as a result of this growth in short-run printing “there will be a change in how we work

and new markets will be emerging. We want to be a different business model than your regular textile mill.”

### **Company B**

Company B is located in Minneapolis, Minnesota and promotes itself as a “full service bureau for textile design and print” and has a total of 6 employees. The company was formed to offer its custom design and print services primarily to the home décor market, however, the owner discovered that Company B’s services were not initially in high demand by interior designers. Much of the company’s first jobs came from marketing and events, as well as flags, banners and promotional textiles. One of the company’s first major jobs was printing the fabric for an outdoor wedding, where the bride wanted the tent pattern to match the tablecloths and wait-staff’s apparel.

Company B indicated that it deals with about 25 accounts or jobs within the average year, with the most commonly requested product being fabric by the yard. The owner says about 75% of the total jobs performed are for business-to-business sample fabric printing, and short-run production. 20% of the jobs come from individuals seeking customized fabrics, with 5% of the accounts representing home décor companies. Geographic location does not seem to play a role since the majority of the U.S. customers are out-of-state, and some are even international clients.

### *Workflow Process*

As previously mentioned, Company B provides full design services but also accepts pre-made designs for printing using Dupont's Artistri™ 2020 Digital Textile Printer. The

company charges about \$125 a yard, with no yardage minimum and has an average turnaround time of five to seven business days. Most of the printing is done on cotton, linen, silk, bamboo, corn-based fibers, polyester, and spandex, which the company usually purchases directly from textile mills. If the client chooses to submit their own designs for printing, Company B requests that the files be in Adobe Illustrator, Photoshop, or InDesign files. They prefer to work with TIFF files, but will also accept high resolution JPEG as well. Similar to Company A, Company B's employees work with a customer from the design creation to the actual production of the fabric, requiring employees to have a knowledge of the digital design software and printing requirements. Figure 5.2 below shows the standard workflow for a Company B employee.

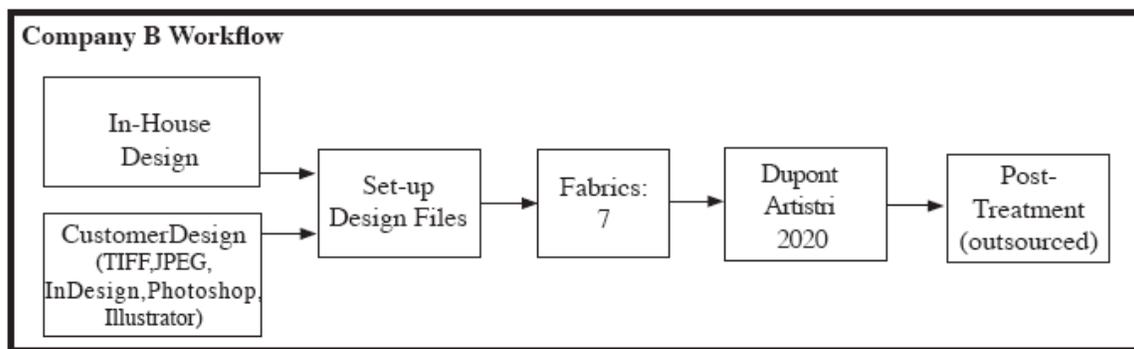


Figure 5.2. Company B workflow process.

The owner of Company B indicated that initially the interior design community did not seem interested in the customized textile services, but she is slowly seeing a gradual shift. “When people see the object and then they see the result, then they understand what the possibilities are, and the light bulb goes on” (Nordstrom, 2006). The company is also giving tours to interior design students as a way to introduce the idea of customized textiles as an option for their work.

Company B dedicates itself to working closely with the customer and tries to not limit itself as the owner stated, “if they [the customer] really want something, I’ll try it.” For her, printing on demand means, “You can have pretty much what you want, when you want it, on any kind of fabric you want. Your life, your style, when you want it” (Nordstrom, 2006).

This dedication to the customer seems to be working since the owner indicated an increase in the request for Company B’s services over the past year. The biggest hurdle to overcome is the customers’ fear of using a new and unfamiliar process for printed textiles. However, the owner predicts the biggest change for her industry will be the customer’s direct contact with the printer to order and design custom textiles.

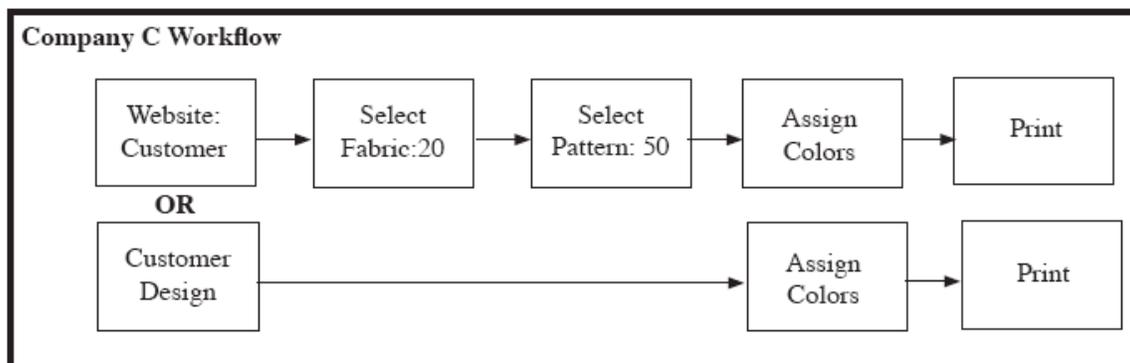
### **Company C**

Company C is located in Peyton, Colorado, has a staff of 5 employees and was created with the designer and decorator in mind. The mission of the company is to “deliver mass customization to interior and fashion designers, graphic artists, upholsterers, interior decorators and quilters.” It currently offers custom fabrics for window treatments, fashion, tapestries, quilts, and soft signage all printed on its Dupont Artistri™ 2020 Digital Textile Printer. Unlike Company A and B, Company C is currently in the process of selling its equipment and exiting the industry. The owner states, “The business model of custom textiles for retail is flawed in the sense that people want instant gratification.” When designing and purchasing a customized textile they want approach it from a “what you see is what you get” attitude, expecting it to look exactly as they envisioned, and not taking into account that some factors such as color or fabric may have to be altered.

Company C does have interest from individuals for custom textiles, but found “they simply do not understand the design process, color, and textiles [...] digital textiles are simply not there for the price points they want.” The company said a truly customized textile, for which only 25 yards is printed, costs about \$25 a yard, which was “enough to drive 50% of our business from individuals away.” Furthermore, “they [the customer] demanded perfection and there is only so much that can be done when they are designing on a non-calibrated computer screen and uploading a file server hundreds of miles away.”

### *Workflow Process*

Company C’s workflow for a customized textile is a fabric specification and production tool they call SPA<sup>TM</sup>, which stands for: **S**elect a fabric type, **P**ick a pattern and **A**ssign colors. First, the client chooses from the 20 available fabrics, picks a pattern from the over 50 choices on the website, and finally assigns the colors to the design. All of the patterns are in Adobe Illustrator and Encapsulated Post Script. Figure 5.3 on the following page outlines Company C’s workflow process.



*Figure 5.3. Company C workflow process.*

Company C does allow customers to submit their own designs (preferably in Adobe Illustrator), and they have found that “each had its own set of problems.” The company states that color has turned out to be a huge issue during the design process. They charge \$25 for a color book, which includes the solid matte pantone color palette. However, most customers do “not know how or want to change the colors in their design.” Lastly, the color choices often overwhelm the client unless they have previous experience doing professional design work.

The owner of Company C indicates they were “better off working with industry professionals on samples and prototypes. They had a much better understanding of the design process and it would usually not take more than one sample to get everything correct.” While the company initially tried to market its services to interior designers they were not interested. Younger designers did show more interest, “but they were typically not in a decision making position.”

## **Chapter 6**

### **Summary and Conclusions**

#### **Summary of Findings**

As previously stated, these three companies were studied in order to answer questions about: what the average customer profile is, if demand has increased for customized and short-run products, what the average workflow is for creating a customized or short-run textile, what future predictions they have for their industry and if the industry is ready for mass customization.

Each company represents a different part of the digital textile market and how companies are responding to the changes the market is experiencing: Company A is a market leader with a highly focused clientele, which seeks to offer its services for any step in the production process; Company B is a smaller scale printer, offering all forms of textile printing and continuing to expand its client base; Company C has not been able to find a profitable client base, and as a result is closing its doors.

#### *Clients*

It is clear that sampling is still a major source of profit for digital printers, therefore most of them had a large number of manufacturers as their main client base. It unlikely that this will change in the near future. However, Company A and Company B both have a growing customer base devoted to individual or niche printing. A lack of technology

training and textile education has proven too be difficult for Company C to deal with customer's requests and expectations. This could become a bigger issue if more individuals attempt to design their own custom textiles.

It is evident that more and more clients do not seem to regard geographic proximity as an important factor when working with a digital printer, since most of the job information can be sent via the Internet. Lastly, the interior design community has not fully embraced the new option of custom digital textiles. Company B is still trying to promote its services within the design community, while Company C found there was little or no interest.

#### *Workflow and Mass Customization*

In terms of workflow, each company no longer uses the traditional top-down approach still implemented by roto-gravure textile printers. They are all using a more "flat" or horizontal work approach and the design and physical creation is now combined into one fluid process, usually completed by a single employee. For employees, this means understanding every step in the creation and production process for digital textiles. Companies who choose to enter this field will have to ensure ongoing education opportunities for employees and the ability to work with a more horizontal organizational structure.

While the general workflow process for digital textile printing is more unified than screen printing, this does not mean it lends itself to mass customization. As previously mentioned, mass customization is "a combination of mass production and custom made production" and a reduction in length of the path from product specification

though manufacturing to finished product (Hammond and Kohler, 2000). The basic goal is to deliver customized products at a similar price as mass-produced products (Lau, 1995). Furthermore, businesses are segmented into specific areas or modules, each with its own isolated task.

Each of the three companies interviewed were creating customized textiles, but on a one-to-one basis. It was only Company C that attempted to offer truly mass customized textiles through an online store, allowing the customer to use the automated selection process to create their own customized textiles. It found that there were too many variables to allow standardized results, including the type of software the customer used to create the design. Customers rarely understood why they could not use specific colors or fabrics, and were often disappointed with the final result. It was only sample-printing that allowed Company C to create customized textiles economically because those buyers were professionals who understood the entire design and production process and its limitations.

All three companies discussed how each workflow must be customized to each specific end-product, and each employee must have the necessary education and training in order to handle the orders. The variety of variables and factors (textile used, ink, printer, pre-media software, etc.) make it impossible to truly standardize and automate the process. While the overall process may seem simple, each segment (ie. design, fabric choice, printing) has a host of factors associated with it. On the following page Figure 6.1 shows an updated workflow of digital textile printing, with some of the basic factors listed.

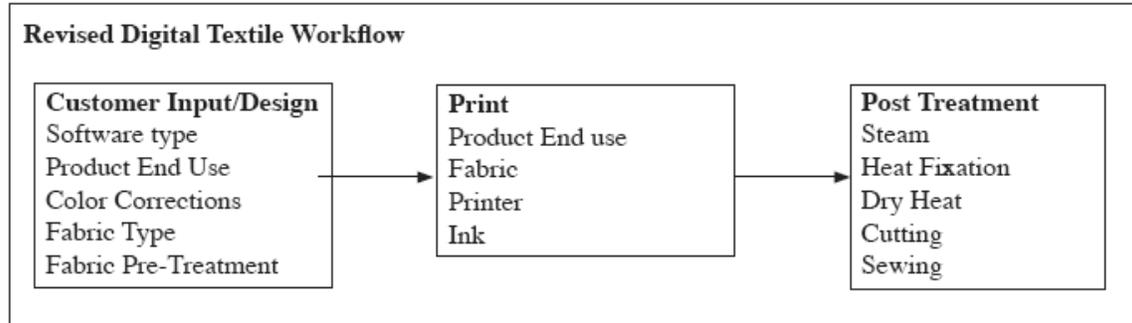


Figure 6.1. Revised digital textile workflow.

Furthermore, the price point of customized textiles is still too high because of the high material costs. Company C found that customers did not want to pay such high prices, and Companies A and B do not offer low-end prices either. The fabric, inks, pre and post-treatments, and employee education factors raise the prices significantly. Customers may be interested in customized textiles, but they want them as mass prices.

### *Future Predictions*

Each company has its own outlook on the digital textile market. Company A predicts that short-run printing will continue to grow, and as a result will change the way business is done. Their current focus of giving the customer whatever they need, at whatever stage of the creation process, fits this potential change in business.

Company B predicts that more customers will be in direct contact with the textile printer in order to create and print their own custom textiles. This means printers will have to be able to serve individual needs, and handle the ensuing technology and education issues customers may have regarding textile printing. Company C on the other hand, predicts that it is the demands and expectations of the customer that make it impossible for the digital textile market to continue onward. The lack of customer

education, along with the inability to lower prices due to high material costs, means that custom textiles do not work as a marketable product. In order for digital textile printing to reach mass customization, it must be able to offer the same prices as other mass-produced goods.

It is evident that all three companies are dealing with a changing customer mentality of higher expectations to customized wants and needs. Company A and Company B are dedicating themselves to providing whatever the customer needs, adjusting each job workflow accordingly. Company C on the other hand, sees this change in customer attitude as a problem that cannot be overcome.

It is clear that in order for a company to succeed in this market segment, they must have a clear understanding of printing process for textiles, as well as the changing technology being used to transfer design ideas into reality. Companies must also have a strong desire to offer their customers an unique experience, and be willing to adjust their workflow patterns depending upon that clients particular needs. This means having a dedicated and highly educated staff that understands each step of the process, from the initial design to the actual printing process.

### **Benefits of the Study**

This study was able to give an overview of three very different companies in the digital textile market and to offer some insight into what issues they are currently facing. It showed that companies that wish to succeed in offering digital printing services for the textile market must be ready to deal with more demanding customers and constantly changing workflows and technologies.

### **Recommendations for Further Study**

This study is only a small part of the possibilities for further research on this topic. A more in-depth look at specific companies would probably be highly beneficial, as well as a more detailed look at workflow practices for digital textile printing. The industry is currently undergoing profound change, and the way companies set up their workflow processes will be a huge indicator of which companies will continue to be successful, and which companies will fold. More research can also be conducted on the technology of the various digital textile printers, textiles, treatments and inks, since each company indicated that quickly changing technology is a major issue.

## Bibliography

Abernathy, F., Volpe, A., Weil, D. (2004, December). *The Apparel and Textile Industries after 2005: Prospects and Choices*. Harvard Center for Textile and Apparel Research.

Abernathy, F. Dunlop, J., Hammond, J., Weil, D. (2002, December). *Globalization in the Apparel and Textile Industries: What is New and What is Not?* Harvard Center for Textile and Apparel Research.

Anderson, C. (2006). *The Long Tail*. Hyperion: New York.

Anonymous. (2007, August 27). Digital textile printing expanding into new areas. Retrieved on October 3, 2007 from <http://www.csgia.org/en/Nnews/2007/08/2710104261.html>

Anonymous. (2006, October 25). Baby Strollers Get Fashionable with Customized Digital Textile Printing from First2Print. *Business Wire*. Retrieved on October 3, 2007 from <http://www.allbusiness.com/services/business-services/3951591-1.html>

Boynton, A., Pine, B., Victor, B. (1993, September-October). Making Mass Customization Work. *Harvard Business Review*. Retrieved November 6, 2007 from EBSCO Publishing database.

Chapman, K. (2001, May). Outsourcing Creative Services. *TechExchange.com*. Retrieved online September 15, 2007 from [http://www.techexchange.com/thelibrary/Outsourcing\\_Creative.html](http://www.techexchange.com/thelibrary/Outsourcing_Creative.html)

Corral, C. (2005, November). Home Textiles Finding Shelf Space Online. *Home Textiles Today*, 27(11), 1,6. Retrieved October 7, 2007, from ABI/INFORM Global database.

Daniel, F. (2007, March 11). Nook Niche: Boone Fabrics' specialty on home décor is in growing part of the industry. *Knight Rider Tribune Business News*. Retrieved October 2, 2007 from ABI/INFORM Global. ProQuest.

DeGross, R. (2006, April 26). Home Depot buys special décor seller. *The Atlanta Journal- Constitution*. Retrieved October 2, 2007 from ABI/INFORM Global. ProQuest.

- Digital Textile Printing Will Increase Its Share More than Tenfold in Five Years. (2007, April 11). Retrieved August 4 2007 from <http://www.textilesintelligence.com/til/press.cfm?prid=370>
- Doshi, G. The New Wave of Digital Fabric Printing Technology. Retrieved on February 2, 2008 from <http://ezinearticles.com/?The-New-Wave-of-Digital-Fabric-Printing-Technology&id=372724>
- Early, J. (2005, April 1). Digital vs. Screenprinting: Choosing What's Right for You. *Apparel*, 34-36. Retrieved December 13, 2006 from ABI/INFORM Global. ProQuest.
- First2Print Demonstrates Instant Textile Customization at Material World Show with Digital Printing Services; Digitally Printed Fabrics, Furniture and Flooring Materials Give Edge to Interior Designers and Manufacturers. (4 April). *Business Wire*, 1. Retrieved October 7, 2007, from ABI/INFORM
- Franklin, T. (2007, October). Wide and Dyed. *Digital Output*, 13(10). 44-48.
- Godin, S. (2006). *Small is the New Big*. Portfolio, New York, NY.
- Hammond, J., Kohler, K. (2000, September). E-Commerce in the Textile and Apparel Industries. *Harvard Center for Textile and Apparel Research*.
- Hanley, M. (2000, November). *Digital color Printing of Textiles: Challenges & Rewards*. Session presented at the IMI 2000 Digital Printing of Textiles Conference, Atlanta, GA.
- Heller, L. (2006, December). Reaching the Masses Online. *Retailing Today*, 45(22), 20-21. Retrieved October 7, 2007, from ABI/INFORM Global database.
- Hogsett, D. (2007, January 8). Biggest Producers Get Smaller in Competitive Market. *Home Textiles Today*. ABI/INFORM Global. ProQuest. Retrieved 19 April 2007. <<http://www.proquest.com/>>
- I.T. Strategies. Textile Industry Opportunities for Digital printing. Retrieved on February 2, 2008 from <http://it-strategies.com/individual/03.htm>
- Judson, E. (2005, April 1). Digital vs Screenprinting: Choosing What's Right For You. *Apparel*. ABI/INFORM Global. ProQuest. Retrieved 5 December 2006. <<http://www.proquest.com/>>
- Larson, M. (2006, May). Wallpaper goes digital for impact. *Converting Magazine*, 24(5), 34. Retrieved March 20, 2007 from ProQuest ABI/INFORM Global.

- Lau, R.S. (1995, September-October). Mass Customization: The Next Industrial Revolution. *IM*. Retrieved November 6, 2007 from EBSCO Publishing database.
- Locastro, D. (n.d.) Digital Textile Printing in Today's Commercial Marketplace. Retrieved October 3, 2007 from [http://www.first2print.com/digital\\_textile\\_printing/printing-marketplace.php](http://www.first2print.com/digital_textile_printing/printing-marketplace.php)
- Mammarella, J. (2006, September). "Jo-Ann Embraces Christopher Lowell." *Home Textiles Today*, 27(38), 1,23. Retrieved October 7, 2007, from ABI/INFORM Global database.
- May-Plumlee, T., Bae, J. (Spring 2005). Behavior of Prepared-for-Print Fabrics in Digital Printing. *Journal of Textile and Apparel, Technology Management*, 4(3), 1-13.
- Nordstrom, G. (2006, August). Your design, your colors, your fabrics—on demand. *Industrial Fabric Products Review*, 72-77.
- Pine, B., Peppers, D., Rogers, M. (1995, March-April). Do You Want to Keep Your Customers Forever? *Harvard Business Review*. Retrieved November 6, 2007 from EBSCO Publishing database.
- Postrel, V. (2004, April 22). Selection ranks above price among the benefits of shopping online. *New York Times*. Retrieved October 3, 2007 <http://www.dynamist.com/articles-speeches/nyt/internetvariety.html>
- . (2003, July). The Aesthetic Imperative. *Wired*. Retrieved October 3, 2007 from ABI/INFORM Global database.
- .(Fall 2003). The Economics of Aesthetics. *Strategy + Business*. Retrieved October 2, 2007 from <http://www.dynamist.com/articles-speeches/index.html>
- Ragsdale, W. (2001, November). The Challenges of a Digital Textile Printing Pioneer. Retrieved October 3, 2007 [http://www.techexchange.com/thelibrary/digital\\_printing\\_pioneer.html](http://www.techexchange.com/thelibrary/digital_printing_pioneer.html)
- Roth, R. (2003, December). Consolidation in the Distribution of Residential Building Products. *Joint Center for Housing Studies*. Harvard University.
- Schiffner, B. (2005, December). Digital Fabric Printing Offers Opportunities For Savvy Shops. *Wide-Format Imaging*. ABI/INFORM Trade & Industry. ProQuest. Retrieved 12 April 2007. <<http://www.proquest.com/>>
- Tan, B. (2001, February). On Capacity Options in Lean Retailing. *Harvard Center for*

*Textile and Apparel Research.*

Textiles a Growing Segment For Digital Printing. (2007, March). *Printing News*, 158(12), 14. Retrieved October 7, 2007, from ABI/INFORM Trade & Industry database.

Tippett, B. (2000, November). *Can Digital Printing Fit the Bill?* Session presented at the IMI 2000 Digital Printing of Textiles Conference, Atlanta, GA.

Unfolding the Frontiers and the Future of Digital Printing on Textiles. (2007). I.T. Strategies. Retrieved on October 7, 2007 from <http://www.techexchange.com/thelibrary/FutDigTextilePrint.html>

**General Reference**

Postrel, V. (2003). *The Substance of Style*. Perennial: New York, NY.

D. Locastro (interview/personal communication, March 12, 2008)

R. Polk (personal communication, March 11, 2008)

S. Tolan (interview, January 30, 2008)

W. DeYoung (personal communication, March 6, 2008)

## Appendix A

Name:

Title:

Company:

Company's Annual Income:

Job Description:

Amount of employees in your company: (Please break down by department, example: pre-press/graphics, printing)

### Interview Questions

- 1) How many custom products does your company usually design within the average year?
- 2) What is the typical process to print a customized textile with your company?
- 3) Do you own the printing machines that print the textiles or do you outsource? If you own the printing machines how many are they and what are the brands?
- 4) What are the most commonly requested products? What is the average turnaround time?
- 5) What percentage of your customers fit the following profile?  

Home Décor Companies	_____
Individuals	_____
Other (please specify)	_____
- 6) What is the average age/demographic of your customer base? (Describe your company's average/typical customer)
- 7) Are your customers usually geographically close to the company? Is that a draw for them?

- 8) Have you seen an increase or decrease in requests for your services over the past 5 years?
- 9) What are the challenges in running your firm in today's market?
- 10) How do you see the demand for customized home décor products changing in the coming years?