

# INVESTIGATING BRAND COLOR ACCURACY OF DYE SUBLIMATED TEXTILES

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## **Abstract:**

*Textiles do not currently encompass a large part of the print industry; however, they are one of the fastest growing segments. With emerging production alternatives growing in popularity including dye sublimation, direct-to-garment printing, and direct-to-film, the need to ensure color accuracy becomes even more important and arguably more difficult due to the switch from spot colors with screen printing to CMYK on these newer technologies. This paper builds on a previous study which examined color brand accuracy and durability of two brand colors using the three most common production processes on a variety of textiles. Results revealed that performance varied based on material, process, and ink color. This study seeks to focus on a single process, dye sublimation, and analyze color accuracy on three different textile samples, consisting of polyester and polyester blends, and expand to include a broader spectrum of brand colors based on the athletic branding for eighteen universities in the United States. Our primary research goal is to determine if there are parts of the color spectrum that are more difficult to print consistently using dye sublimation on the three different textiles. The findings will add to existing research by providing recommendations for brands and printers who print textiles with dye sublimation.*

**Keywords:** Color accuracy, dye sublimation, textile printing

## **1. INTRODUCTION**

The global dye sublimation printing market size was estimated to be at 14.9 billion USD in 2024 and is projected to grow to 28.0 billion USD by 2030, at an increase of 11.3% from 2025 to 2030 [1]. The textile market has experienced substantial growth due to the increasing demand for customized apparel and promotional merchandise [1]. Dye sublimation printing accounted for the largest share of the market based on product type, print technique, and application in 2024 [1]. Dye sublimation is quickly becoming a popular printing method for garment printing due to its flexibility in design and its cost effectiveness, particularly for shorter print runs [2]. However, color accuracy is challenging when printing textiles on dye sublimation due to the many variables that can affect the results.

This study is based on previous research by Walker and Bridges [3] which tested two brand colors, orange and purple, and used three different printing processes: dye sublimation, direct-to-garment (DTG) printing, and screen printing. Testing was conducted with the following three types of textiles: 100% cotton, 50/50% cotton/polyester blend, and 100% polyester. Consistency and durability tests were run in order to determine color accuracy. Findings were mixed revealing that performance varied based on material, process, and ink color. Screen printing produced the most accurate and consistent color when compared against the brand specifications. On all three fabrics, the Delta E was 2.5 or below, with the cotton shirt being the most accurate color with a Delta E of 1.35. Purple colored ink produced less accurate color reproduction than the orange, although screen printing was still the most accurate process even when printing purple. Delta E measurements for that group ranged from 5.27 to 7.52 for the purple colored ink. Cotton fabric was the least accurate color reproduction with the purple ink on the blend material reproducing the purple brand color most closely. Both the dye sublimation and the DTG

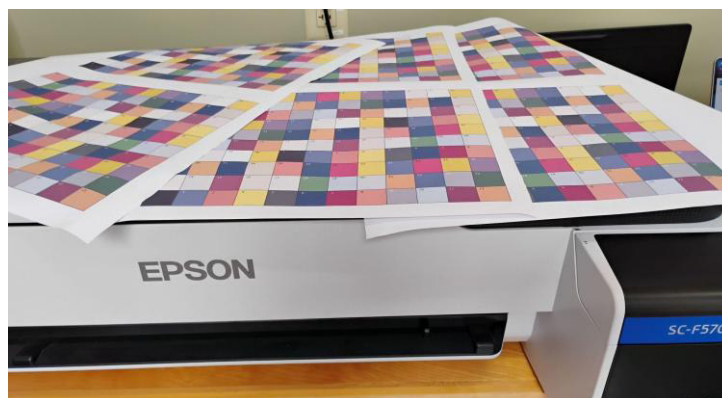
processes produced much less accurate color compared to the screen printing process. Delta E values ranged from fourteen to twenty-eight which would not be acceptable in a commercial setting. Between these two processes, dye sublimation produced the most accurate colors on polyester fabrics with Delta E readings of fourteen for both brand colors. DTG performed better on orange across all three textiles compared with purple.

This study seeks to focus on a single process, dye sublimation, and analyze color accuracy on three different textile samples, consisting of polyester and polyester blends. The researchers have expanded the color target to include a broader spectrum of brand colors based on the athletic branding for eighteen universities in the United States. Our primary research goal is to determine if there are parts of the color spectrum that are more difficult to print consistently using dye sublimation across these three different textiles. This study also seeks to explore how effectively dye sublimation reproduces accurate color when using manufacturer provided color profile settings. The findings will add to existing research by providing recommendations for brands and printers who print textiles with dye sublimation. It will be particularly beneficial for small-scale print production facilities that may not have the capability to create custom color profiles for each textile type. The researchers are also post-secondary educators who teach the dye sublimation process and the findings will help in instructing students regarding color management when printing textiles using alternate production processes.

## 2. EXPERIMENTAL

Dye sublimation, also referred to as heat transfer printing, is an indirect printing method that uses sublimation inks that are transferred onto a special paper, heated, and then pressed onto the substrate under controlled pressure [4]. During the sublimation process, the ink is heated and changes from a solid to a gas [5]. When using this process to print onto textiles specifically, the ink becomes part of the fabric fibers rather than laying on top of the surface, allowing for greater print durability [6]. Due to this fact, dye sublimation has been used in the textile printing industry for many years [4], and is considered a viable alternative printing method to traditional screen printing. Some notable advantages of dye sublimation printing are substrate versatility, durability of the print, the ability to print a wide range of colors, and the process is relatively easy to use [6]. However, experts agree that one of the main challenges in dye sublimation printing is color accuracy and management, particularly when producing branded athletic apparel and matching colors to dyed fabrics [7].

This study began with 64 brand colors to represent each athletic team in the ACC (Atlantic Coast Conference division). Duplicate colors were removed which resulted in 40 colors on the test target. Each school provided brand color values as: Pantone, CMYK, RGB, and hex values. LAB values were pulled from Esko Color Pilot software, which has the Pantone digital library installed. From there the test target was built in Adobe Illustrator. Each value was repeated three times on the target, Figure 1.



*Figure 1: Example of printed targets on the Epson SC-F570 printer used to produce them.*

The textiles used for the study were 100% polyester, 60%/40% polyester/cotton blend, and 50%/50% polyester/cotton blend. All textile samples were the same brand and ordered from the same vendor. Textiles were treated with Dyepress Poly T Pro sublimation coating according to the manufacturer's recommendations which required the coating to be sprayed on followed by the application of a water border around the poly coating. The materials were then cured in a clothing dryer for 30 minutes on high heat and cooled before being pressed in the heat press to print.

The printer used for printing the test targets was an Epson Sure Color F570 series with Epson brand dye sublimation inks loaded with 24" roll dye sublimation paper, Figure 1. The dye sublimation press used to print the textile samples was a George Knight Swing Away flatbed heat press with a 16 x 20 inch platen. Settings used for output from Adobe Illustrator were "Don't Color Manage" and the print was set to "Custom" with Epson SC-F500 series selected as the printer. Color handling was set to "Let Illustrator determine colors." The printer profile selected was "Epson SC F-500 General Purpose/Rigid" with rendering set to "Relative Colormetric." Printing was completed according to poly coating recommendations at temperature 385 fahrenheit with heavy pressure for 10 seconds followed by a sublimation time of 70 seconds with heavy pressure, Figure 2.



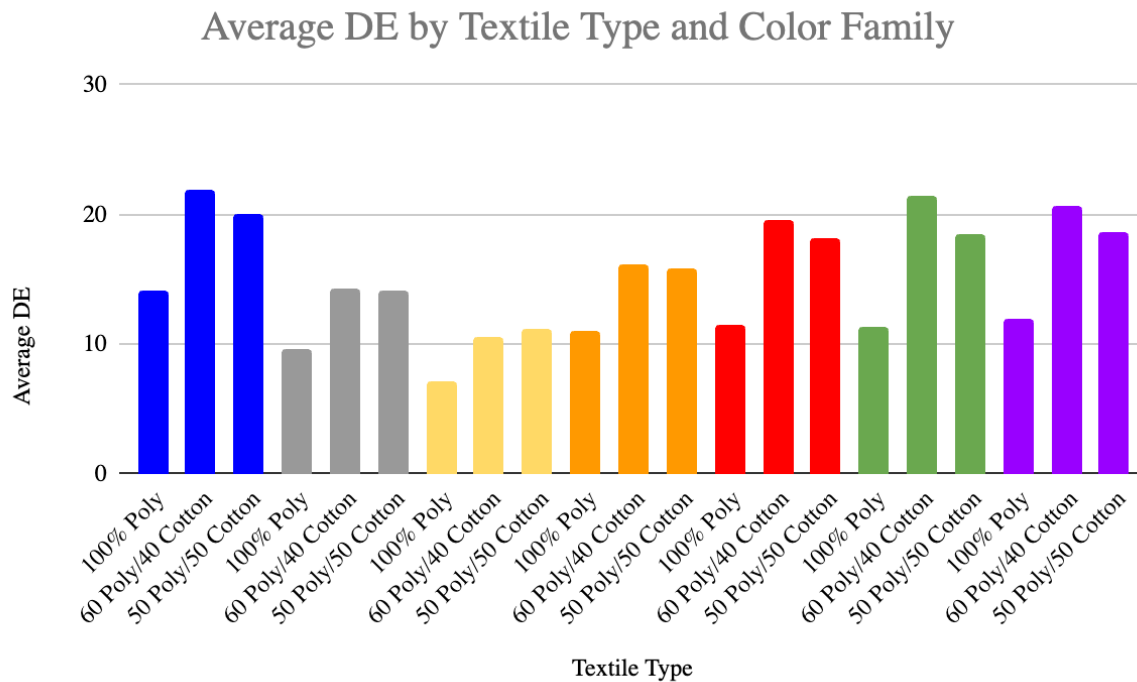
Figure 2: Photograph of the three different textiles with the finished printed targets.

The device used for measuring the color targets was the i1Basic Pro 3 Plus spectrophotometer set to D50/2°. This particular unit has a wider aperture of 8 millimeters, which is more accurate when measuring textiles. Calibration was done prior to each measurement using the manufacturer provided white patch. A white poster board backing was placed under each sample to ensure no external colors interfered with the color measurements. Measurements were completed manually under natural UV light and conditions were set to M1 (D50). All three areas printed on the target of the brand color were averaged to produce final LAB values for each brand color. Averaging all three patches was done to evaluate whether or not the color varied across multiple locations on the fabric. Delta E 2000 values were then calculated against the LAB reference color used to build the target in Illustrator. Recording was completed using Microsoft Excel.

### 3. RESULTS

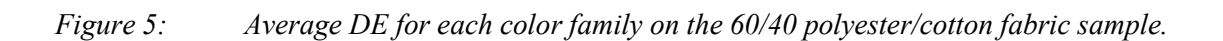
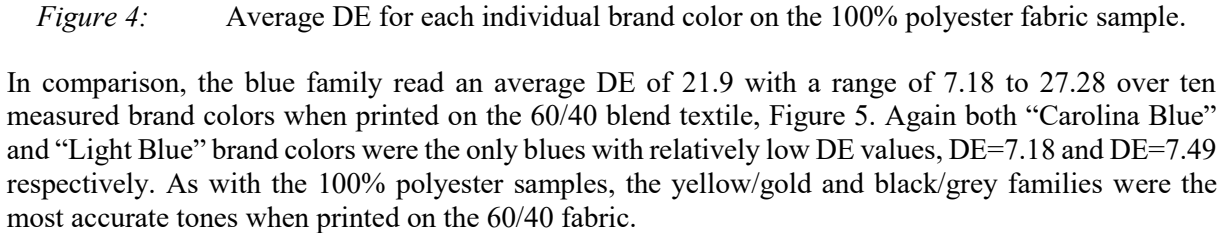
Previous findings would suggest that textiles with more polyester result in more accurate color with dye sublimation printing. Results in this study showed that 100% polyester performed the best in all color families compared to any other fabric. However, the 60/40 polyester/cotton blend performed worse than

the 50/50 polyester/cotton textile for all the color families except for yellow/gold, Figure 3. In addition, no color family met acceptable Delta E values of  $<5$ , but yellow/gold performed the best of all the color families across all three textiles tested.



*Figure 3: Averaged results for brand color families across all three fabric types showing that 100% polyester performed best across all the fabric choices and that the yellow/gold, black/grey, and orange color families performed better than cooler colors such as blues, purples, and greens.*

As with previous studies, the results were not cleanly delineated. When looking at the colors individually, two of the blue brand colors, “Carolina Blue” and “Light Blue” printed on 100% polyester, produced the most accurate color reproduction of any individual color on any of the textile types,  $DE=4.36$  and  $DE=4.98$  respectively. All three patches of each of these two colors produced readings that were very similar. No other blue color read as less than a  $DE=14$  with eight out of ten of the worst readings registering from the blue family, Figure 4.



#### 4. DISCUSSION

Results are similar to the previous study and other previous research in dye sublimation with 100% polyester textiles performing the best in all color families even when all the fabric samples are pre-treated with the additional polymer coating. Warm colors such as yellows and oranges and neutral tones like blacks and greys performed better overall than cool colors including purples and blues, which is consistent with findings from the previous study, with the exception of two colors from the blue family on 100% polyester fabric “Carolina Blue” and “Light Blue.” The researchers surmise that these two blues might be more similar in color range to light-tone greys than to the deeper or brighter blues like Navy or Royal Blue colors which might have resulted in better color accuracy for those two colors.

Delta E scores were mostly above 5, including on 100% polyester, indicating a noticeable, visual difference between the intended color and the printed color. This may be due to color profile accuracy when using manufacturer settings along with several other variables in this research such as quality of textiles and type of pre-treatments. The 60/40 blend performed worse than 50/50 in all color families with the exception of yellow/gold. The researchers speculate that this could be due to several factors, but suspect it could be due to the 60/40 fabric weight and weave. Though the same brand of textile samples were used for testing, the GSM (grams per square meter) of the fabrics was not available to the researchers. Other factors affecting the results include the polymer coating, both brand and application, and lighting consistency during measurements as measurements were taken under natural UV light.

#### 5. CONCLUSIONS

Our primary research question was to determine if there are parts of the color spectrum that are more difficult to print consistently using dye sublimation and manufacturer recommendations on the three different textiles. This study revealed that yellows, oranges, blacks, and greys provided more accurate color reproduction than blues, purples, and greens. This would be an important consideration for manufacturers when printing brand-specific colors, particularly the ACC team colors tested in this study. This is also a beneficial lesson to pass along to students when working with textiles using alternative print methods and manufacturer provided color settings.

This study will serve as a starting point for additional research where custom-built color profiles can be created and tested for color accuracy. Further research may include expanding into different processes, such as direct-to-garment and direct-to-film printing. Other studies could expand into durability testing in both home and commercial laundering units. It would also be interesting to investigate durability with exposure to UV light and test the effects of laundering and stain treatments on color fastness. The researchers also recommend future testing to determine the impact of different fabric weights and thicknesses. Finally, this line of inquiry would benefit from additional research regarding the types of polymer coatings available on the market.

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