Developing A (CTS) Computer-to-Screen Application Using an Inkjet Printer to Apply a Stencil Directly to the Mesh in a Hybrid Screen Printing Processes

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Keywords: computer-to-screen, inkjet-to-screen, screen-printing, inkjet innovations

Abstract

This research explored an inkjet, computer-to-screen (CTS) imaging system to prepare print screens for screen-printing without the need for film or emulsion. The equipment for preparing a screen-printing screen utilized a MIMAKI UJF-6042 on-demand piezo head flatbed printer. In addition, this research developed a test target to standardize the imaging process and gauge the coverage amount that would sufficiently block out and hold a stencil allowing the ink to pass through a screen to create an image. A successful CTS system could provide an alternative to imaging film, emulsion, and capillary films and shorten the make-ready time for preparing to screen print.

Introduction

Several U.S. patent applications and inkjet technologies employ computer-to-screen imaging systems to prepare print screens and methodologies for producing an image on a printing screen (Baxter 2006, and Bourne 2006). For example, there are three different technologies for exposing a U.V. photo-sensitive coated mesh used as a stencil in screen printing with a U.V. light source (Gmuender, 2017):

[1] Film exposing, either directly mounted on the stencil or indirectly imaged by using a projector; and
[2] direct exposure using Digital-Micromirror-Devices (DMD) or a U.V. laser beam, also called Computer-to-Screen (CTS).

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[3] And Direct-to-Screen (DTS), where the image first is printed on the stencil by an inkjet printer and then in a second process is exposed by a U.V. lamp (Gmuender, 2017).

In the 2006-Bourne patent, a specifically formulated emulsion was used in which the emulsion is mixed with a cross-linking agent to create a self-curing image (Bourne, et al, 2006). In the case of the Baxter patent, a photo-activated emulsion is coated onto a printing screen. The emulsion is then exposed to a digitized pattern using light-emitting diodes (LEDs). Using direct laser imaging in which a laser is scanned point by point over a screen coated with a photo-activated emulsion to create an image in that emulsion. (Baxter 2006).

In 2008, Berner developed an exposure device to produce screenprint stencils (Berner, 2008). Berner's exposure system had a light source and a lens system in an exposure head that was movable. The signal source yielded digital signals related to the exposure system. Several laser diodes were present on the exposure unit and controlled by the signal source. The laser diodes are guided to a raster plate in the exposure head. The light output of the raster plate is transferred to a focusing lens system in the exposure head (Berner, 2008).

Nearly a decade later, a patent by Van Ness in 2015 developed a screen-printing device and methodology for exposing an emulsion coated screen to light that comprises an array of ultraviolet light-emitting diodes (UV-LEDs). This system created a positive impression of the artwork to be printed; a flat transparent plate disposed between the array of UV-LEDs and the positive impression; a screen coated with a light-curable emulsion; the positive-impression is disposed on the side of the screen having the emulsion (Van Ness, 2015).

More recently, a patent by Oleson in 2017, a mechanical system in which pre-stretched emulsion coated screens, digitally prints thereupon, and exposes them before further processing and use in a screen-printing machine. Some of these patents have shown commercial value, as in the "i-Image ST™ Computer-to-Screen (CTS) Imaging System: from the M&R Companies (M&R Website).

In developing a Computer-To-Screen (CTS) application by using an inkjet printer to apply a stencil directly to the Mesh in a hybrid screen printing processes, this research explored applications of UV curable primer in an inkjet, computer-to-screen imaging system for preparing of print screens in a screen-printing process with a MIMAKI UJF-6042 on-demand piezo head flatbed printer that was not designed primarily for this function. The goal of the project was to develop a computer-to-screen system that would replace a need for emulsion and film for transferring an image to a tensioned mesh screen. The potential objective was to produce stochastic screens for four-color process printing.

The intent of this research was to print a single layer of inkjet UV cured primer application of a test target (Figure 01) onto a variety of screens with varying mesh counts to test the needed amount of primer coverage that would sufficiently block out the plastisol ink that passes through a screen. Based on previous observations in testing screens with several inkjet colors onto the mesh, it was suggested by the OEM to consider testing primer only at varying percentages of application based on the primer's better adhesion qualities could provide better results.

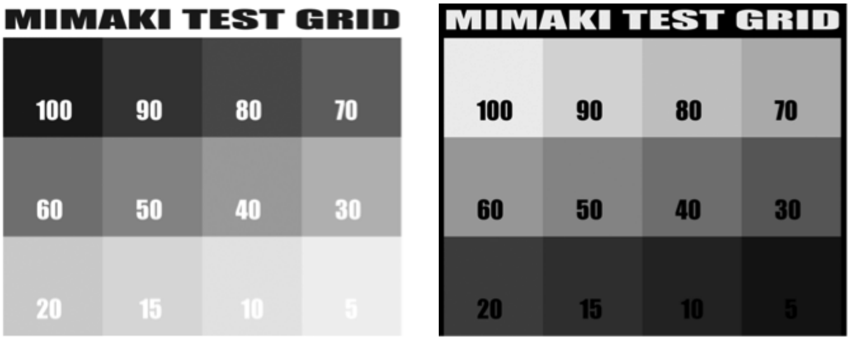

Figure 01: *Test grid stencil for primer applications on left. Reversed ink output on right.*

The method and equipment for imaging a screen-printing screen harnessed the capabilities the MIMAKI UJF-6042 on-demand piezo head flatbed printer. The flat bed was able to adjust to the height of a standard 20"x 24" x 13/8" aluminum screen printing frames and self-adjust the print heads so to print directly onto the various screen materials. For this research, 195, 230, and 420 mesh counts were chosen to offer a lower to higher range to gauge.

The test target was developed to standardize the imaging process and gauge the amount of coverage that would sufficiently block out and hold a stencil allowing the ink to pass through a screen creating an image. Inspection of coverage by the human eye proved difficult due to the color or the screen material (yellow), and the transparency of the primer made it was difficult to differentiate the level of the coverage of primer. To ensure better visuals for the application of the primer, a Dino-liteTM Digital Microscope was used to take pictures of primer and mesh as demonstrates in images: (Figure 3, Figure 6, and Figure 9). Prior to applying and testing with the plastisol ink, visuals of coverages of percentages of primer were documented in this report. It should be noted, as documented in the following images, in preliminary review of the three applications of primer in imaging the test target, it appears there are varying number of unwanted holes in all percentages of coverage of primer in a single layer of application. Suggestions for addressing these anomalies will be addressed in conclusion.

The next step in phase one of this research process was the application and testing ink to observe if the single layer inkjet primer is blocking out the ink in comparison to use of emulsion and block-out in conventional screen-printing applications. In following images, the test grid is post screen printing. It should be noted that some of the images are better as the mesh counts goes higher. Suggestions for addressing these variances will be addressed in conclusion.

Results and Observations from Phase I
(Stencils made from single layer of primer application)

195-mesh count screen

Figure 2: *In the test grid printed above on a 195-mesh count screen, the single layer coverage of the primer was insufficient to block out the mesh. Below (Figure 3) shows primer coverage and (Figure 4) is printed results.*

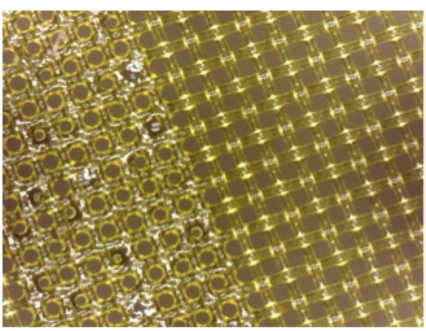

Figure 3: *single layer primer coverage with the image boundary alongside of an open area*

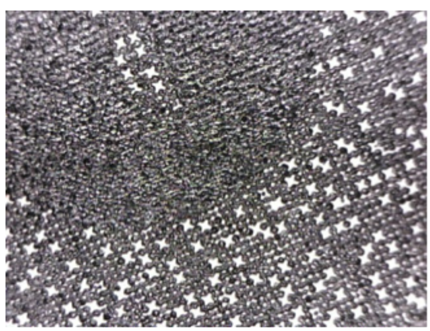

Figure 4: *Printing results show image upper left area and blocked out area*

230-mesh count

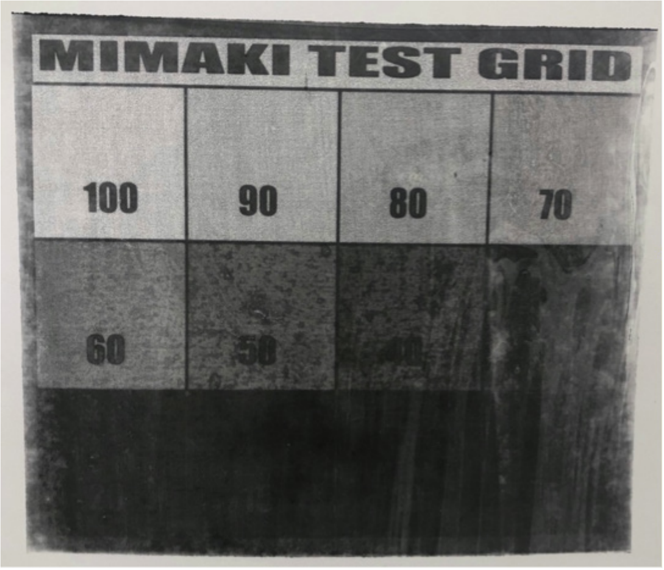

Figure 5: *In the test grid printed above on a 230-mesh count screen, the coverage of the single layer primer was insufficient to block out the mesh. Below (Figure 6) shows primer coverage, and (Figure 7) is the printed results.*

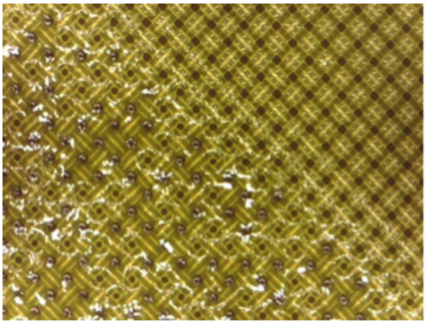

Figure 6: *single layer primer coverage with the image boundary alongside of an open area*

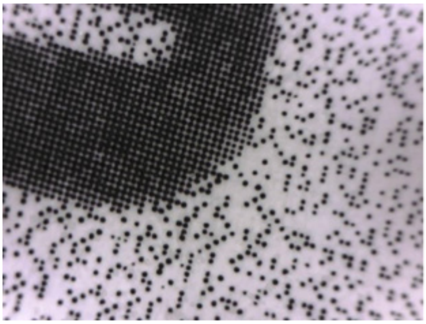

Figure 7: *shows the printed image and area that should be blocked out.*

420-mesh count

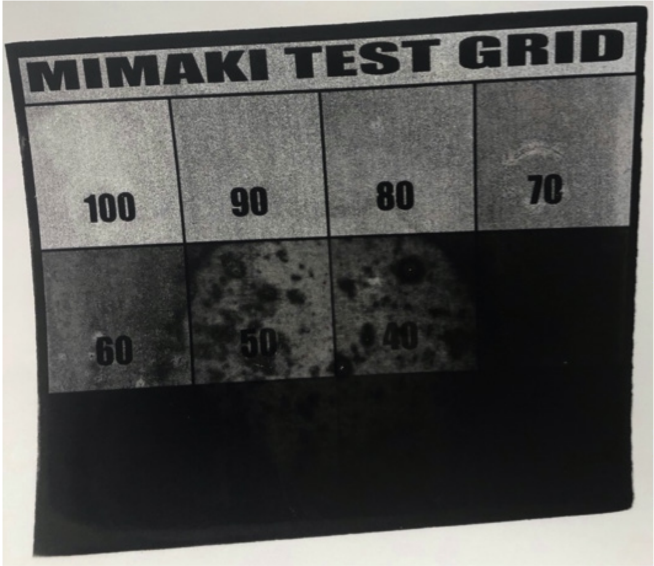

Figure 8: *In the test grid printed above on a 420-mesh count screen, the coverage of the primer was insufficient to block out the mesh. Below is an enlargement of the single layer coverage area.*

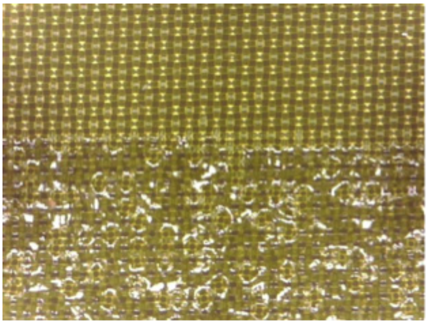

Figure 9: *Single layer primer coverage with the image boundary alongside of an open area.*

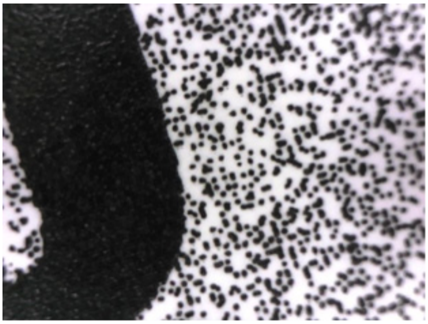

Figure 10: *shows the printed image and area that should be blocked out.*

Results and Observations Phase II
(Stencils made from two layers of primer application on 230 mesh)

Further testing continued, the next step was be to create a screen that is has clear distinctions between ink and non-ink areas that mimics emulsion printing. The goal was to develop a four-color process screens using a stochastic design that includes utilizing two layers of primer on a standardized 230 mesh screen.
Based on several trials and enhancing the contrast in the images processed, two layers of primer was successful in created a dithered dot process image that could be output to the screen.

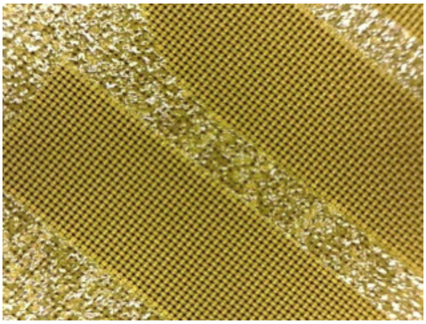

Figure 11: Two layers of primer

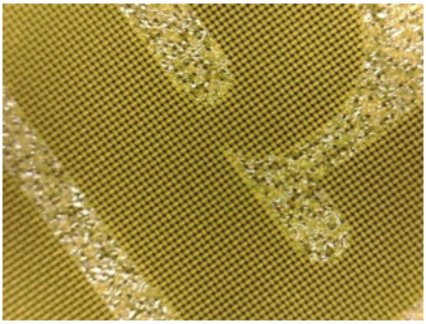

Figure 12: Two layers of primer

Based on previous research with single applications of primer, a second application was utilized. This proved successful, so the research moved forward with test prints. Based on the results, two layers of primer produced better outcomes than the single layer samples as seen in Figure 13 below.

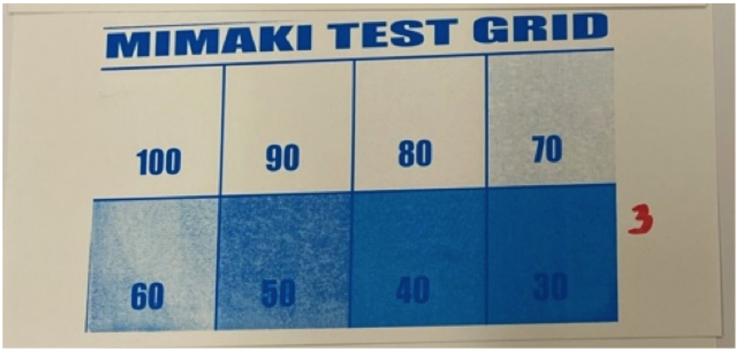

Figure 13. *Print sample of the two layers of primer of the standardized target grid. The results provide and idea on how well this CTS process does with line art, text and some tints.*

Image Selection and RIPs

The selection of a peacock feather was purposeful for creating test sample that would offer a challenge to recreate the combinations of colors. Prior to creating an original image file, several found online images of peacock feathers were enlisted to help determine the best image size and resolution going forward.

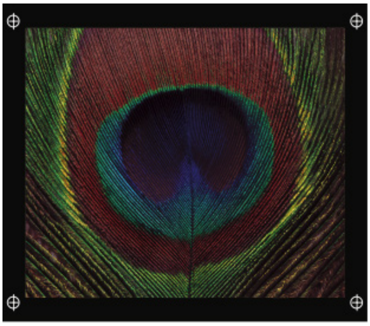

Figure 14: *To ensure copyright, a peacock feather was scanned at full color and 600 dpi. This image was used to create the four-color separations by splitting the channels and preparing those files into bitmaps and saved as TIFFs. Adobe Photoshop 2021 was utilized to process the images.*

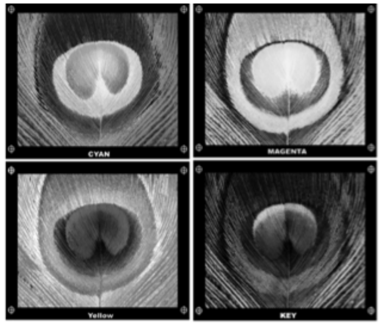

Figure 15: *Tiff files were generated from four-color separations and output as 85lpi at 170 dpi images. These images were approximately 12" h. x 13" w. Each of these files were imaged onto 230 mesh pre-stretched frames. Images are reversed.*

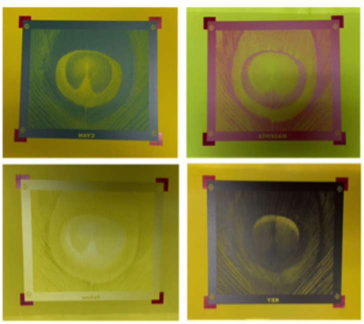

Figure 16: *Four 230-mesh screens were utilized. Each screen was printed with two layers of primer, and a color-coded cap layer to eliminate the stickiness of the primer.*

Figure 17: *Registration and set up proved to be time consuming even with the color-coded screens. The yellow mesh decreased the visibility of the yellow color separation.*

Summary Phase I Observations

- The single layer application of primer was insufficient to block out the screen mesh counts at 195, 230, nor 420 as shown in these tests of screen printing. An application of 200% (two layers) of the primer would be the next test at the higher mesh counts and is probable to provide complete coverage with less bleed through to mimic the quality of the emulsion's coverage.
- Though this single layer application was insufficient to prevent the ink from passing through the screen, it does demonstrate an ability to apply a half-tone though the screen with a gradient that is evenly distributed that across the mesh. This could have desirable applications depending on the design of the artwork. It could also offer the ability to mimic a distressed look onto the substrate that is popular in fashion.

- Additionally, in stochastic 4 color printing, the slight tone of color could add a desirable affect to the overall image to make it overall effect appear more interesting and create a “noise” in the image, whereas stochastic color prints appear mechanical or digital.
- Once the printing was completed, the screens were reclaimed through conventional means with no additional processes.

Summary Phase II Observations

- Screen mesh-count comparisons: 230 mesh count proved the best. Higher mesh counts and the primer would sit atop the screen, lower mesh counts and the inkjet application would blow through the mesh
- Mesh paper backing, reflective materials: Several paper and vinyl materials were tested as mesh backing to control for inkjet blowing through the screens. Black foam board worked well, as well as aluminum foil.
- Comparisons to coated with UV emulsion. This system could apply spot color designs – line art images and text. This compared well to output of conventual emulsion applications.
- Comparisons to capillary film: The application of two layers of primer is thinner than capillary film.
- Clean up: The inkjet created stencil removes easily under the same conventional systems with a pressure washer. However more tests need to be done on affluent.
- Time Comparisons: To inkjet print four stencils onto four screens that are approximately 12”x12”, it takes 30 minutes per screen. (Two hours make ready).
- Additional unknowns: More testing needs to be done on durability of the imaged screen.

Conclusion

Figure 18: *Four-color peacock feather sample produced. This CTS system was capable of imaging the screens to print CMYK product, however the quality of the final product needs improving. The color gamut produced did not match the color gamut requested.*

- Further testing is needed for better success. The next step would be a better selection of inks. For this sample run, the conventional CMYK inks used were old and last of the ink in the containers. Care was taken to cover the inks on the screens when not used, however these conventional inks rapidly dried out and clogged the screens rendering them marred. When using some solvent to try and clean up the screens, the chemical damaged the primer. A trial using CMYK plastisol inks will be a suggested next step.
- Earlier produced peacock color separations from images found online had better success in reproducing a printed image. However, these files had unknown origins and possible copyright issues. Those image files had brighter colors and provided better details once separated. Possibly the scanned feather file needs greater diversity of colors than presented.
- Photoshop 2021 was used to RIP and process the scanned feather image into TIFFs. Best to consider alternative RIP software options for generating a stochastic, four-color separation.
- The goal of this project was to explore CTS systems and consider available technologies for innovating printing processes. Encouraging learners to reflect on all possibilities through creativity and innovation.

Acknowledgements

Thanks to Mr. Robert G Drago, Mimaki USA, Region Manager, and Mr. Jeremy Hopkins, Mimaki USA, Regional Service Manager, Southeast Region, Suwanee, GA 30024, USA for their assistance and expertise on this project.

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