EFFECT OF PLATE BUILD-UP ON FLEXOGRAPHIC TONE REPRODUCTION

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Abstract: Flexograhic printing many times has problems with tone reproduction especially in the shadow areas. Many times detail is lost in this area due to higher dot gain and poor ink lay down. Building up the back of plates could improve this area as it does improve solids. This experiment does show that building up the back of flexographic plate material can improve tone reproduction in centain cases. This paper discusses the results of an experiment where metal tape was placed on the back of plates and a tone scale was printed with the tape present. A comparison with untaped areas showed a better dot-gain curve using the tape.

Purpose

The purpose of this experiment was to improve tone reproduction using the flexographic printing process. In industry it is common to build up areas of the plate behind solids to improve solid ink density and ink lay down. In this experiment, these techniques were used to try and improve the overall tonal range. This information could then possibly be applied process color reproductions.

Variables

The variables of this experiment were the build-up areas versus the area without build-up, and a change in impression settings. The impression was changed to see if the build-up area performed better with less or more impression. Theoretically, the greater the impression the more dot gain you will get. However, the more impression could also produce cleaner print. Both impression and build-up were controlled independently. The dependent variables were dot gain comparisons, and subjective evaluations of the tonal range and transition points.

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Equipment & Materials

Equipment

- Press - Carint Gemini (six-color, central impression)
  - Anilox Roll - 500 line, 2.3 bcm
- Page Layout - Macintosh IIci in Aldus Freehand
- Imagesetter - Agfa ProSet 9800
- Processor - Polychrome
- Densitometer - X-Rite 418
- Platemaker - Kelleigh

Materials

- Plate - DuPont Cyrel PQS
- Stickyback - 3M 1120
- Films -

  3M Imagesetting IR - 4 mil

  DuPont BLDM - 7 mil
- Substrate - Polypropylene
- Ink - Coats Bros. Orion Hi-Tone

Null Hypothesis

There is no difference in flexographic tone reproduction between built-up areas and areas with no build-up.

Experimental Hypothesis

Flexographic tone reproduction is improved when the tonal range in built-up. The shadow area will carry greater detail and have less pinholing.

Statement of the Problem

Does plate build-up improve tonal range? If so, to what extent? What method should be used to build up the area of the plate? Will the impression change, effect the print in a positive way?

Method of Study

The first step in the design of this experiment was to decide how to apply a build-up to the back of a plate. Also, what was this build-up material going to be? Early on in the experiment, it was planned to use a material that could be exposed through a negative. This would enable specific areas of a continuous tone reproduction to be built-up. For example, from the 60% dot and up to a solid could be built-up through the use of a posterization exposure to the original. Because of the availability of screen printing materials and equipment, the first build-up testing was done in this area. Capillary emulsion was wet and adhered to the back of a plate. The plate has already been exposed and washed out at this point. The emulsion was then put in a dryer to fully dry before it could be exposed. The posterized image on the film was going to be visually registered to the image already on the plate. Then the emulsion would be exposed, washed out, and the area exposed would stay on the plate to act as the build-up area, while the area not hardened by the exposure would wash away. A problem arose early, however, because the emulsion would not dry and adhere properly to the back of the plate. No air was getting to the underside of the emulsion like it would through a screen to dry the emulsion. In addition, on a screen, the fibers help the adhesion as opposed to the smooth plate backing.

The next attempt was in the screen printing area also. A test area was exposed on a screen using capillary film. Then direct screen printing emulsion was printed through the screen onto the back of a plate. Emulsion was used instead of ink itself because of a greater thickness due to a high solids content. The emulsion did adhere to the back of the plate after different squeegee pressures were applied. After drying the emulsion in a dryer, it was observed that the lay-down was inconsistent and air bubbles had formed in some areas.

Another attempt to get a hold of a photo sensitive material to use was made. Since ultraviolet (UV) exposure units were available, a UV curable adhesive was another possibility. After speaking with several manufacturers, this option did not seem plausible. Many of the adhesives came in their own dispensing devices and the manufacturers could not guarantee a uniform coating of the material. In addition, the cost and minimum purchase order were limitations.

It was finally decided to just tape the back of the plate as is done in industry. A metallized tape was selected for stability. It was .004" thick. The layout of the test target is diagramed in Appendix A. 16 identical scales were created in Aldus Freehand on a Macintosh and output in line on the Agfa ProSet 9800. Each scale was divided in half with one side having tape and the other side without. There were 18 steps on the scale. The first scale had no tape, the next had tape on one side in step 18 which was a solid, the next scale had tape on one side in steps 17 and 18. This was continued through step four. This continuous movement down the scale was used to see where a good transition point from tape to no tape would be. The reason that the tape was not used all the way down to step one was because of lack of room and lack of need. It was not believed to be needed because overimpressing the highlight areas of a tone scale would just cause dot growth where critical highlight detail is needed.

The plates were exposed with two pieces of film like the diagram in Appendix A (end of paper). Each plate was then cut in half for mounting. The plates were staggered to ensure at least part of several plates were against the impression cylinder at all times. This would prevent bumping up and down from areas where there was no plate to where there was a plate, as the cylinder rotated. A diagram of the mounting is in Appendix B.

The experiment was run using black ink in station five of the Carint Gemini. The ink viscosity was controlled at 31 seconds in a #2 Zahn cup. Dial indicators were placed on the press to gauge impression. The press was started and the optimum impression was set. This was at the first point when impression was being brought in where the whole image was printing cleanly. Some ink adjustments where made to reduce some pinholing and mottling. Then the test began. The speed was brought up to 500 feet per minute. The optimum impression was run for about 20 seconds and then flagged. Then the impression was brought in .001". It was run for again about 20 seconds and flagged. This was repeated to .005" impression. Then the impression was brought back to -.003" and run for 20 seconds again. It was repeated for -.002" and -.001". The -.003" setting was disregarded in the analysis because part of the image in the untaped areas was starting to disappear.

Observations and Analysis

The graphs of the taped versus untaped areas are in Appendices C-J. Each graph has the dot % of the film used to make the plate on the x-axis and the printed dot % on the y-axis. The printed dot % was interpolated using the Yule-Nielson formula. The dot percentages used are just an approximation due to the difficulty of getting a reasonable number. This is caused by the color and reflection capabilities of the polypropylene film substrate. When computing the dot gain the substrate was subtracted out and an n-factor of 4 was used. This was done after looking at what step under a glass the 50% dot was at, approximately. Then the n-factor was determined through trial and error until the step came close to 50% by calculation. When discussing the results, it is not as an important to have the exact dot gain readings, but to be able to compare taped and untaped areas at different impressions using the same formula.

Another important note about the readings is that they were all taken from the same scale for each impression. This was done to shorten the time it took to make all the readings. Random areas on all the sheets were checked to make sure the readings were consistent across the sheet before only using the one scale with tape behind step 4 through step 18 was used. Half of the scale had tape, while the other half did not. It was also verified that the tape next to the untaped areas did not affect those readings by checking another entirely untaped scale for consistency. In addition, each patch was read twice in two different spots, then averaged, to get the density number for that step.

The first thing to observe about the different graphs are the similarities in the shape of the curves. It easy to see there is a difference in the shadow areas between the taped and untaped areas across all eight graphs in Appendices C-J. The curve is higher in the taped area than in the untaped area. The greater impression causes a greater dot gain in the shadows, but this also causes a smoother overall curve and better print characteristics. There is less pinholing in the taped areas due to the greater impression. All these results were anticipated in the hypothesis. The graphs did show, what appears to be, a significant difference in the taped and untaped results. This difference was a little greater than had been anticipated before the experiment was conducted.

The next important observation is where the taped and untaped curves head in significantly different directions. It is hard to pinpoint exactly which step is the one where the curves change, but it appears to be around step 8, or the 80% area of the printed sample. As the impression increases, however, this point appears to slide up the scale to around step 9 or 10. This is around the 85% to 90% area of the printed sample. The most significant thing to observe is that there is no real difference in dot gain between the taped and untaped areas in the highlight through the mid-tone areas. Basically, increasing impression by as much as .005" does not affect the highlight and mid-tone dot gain, but improves the shadow areas by reducing pinholing and creating a smoother curve. The side of the scale with the tape, as a whole, has a better looking gradation. It also does not appear a lot darker in the highlight and mid-tone areas than the untaped side.

The last major observation is the difference in dot gain from impression to impression. There is no discernible difference in the highlight and mid-tone areas between all of the impressions. Even the -.002" and the +.005" graphed on top of each other show no visible differences in theses areas (Appendix K). The differences do not show up until the extreme shadows. The -.002" impression dips down around steps 14-16 in comparison to the +.005" impression. This comparison is similar to the untaped versus taped results.

Conclusions and Recommendations

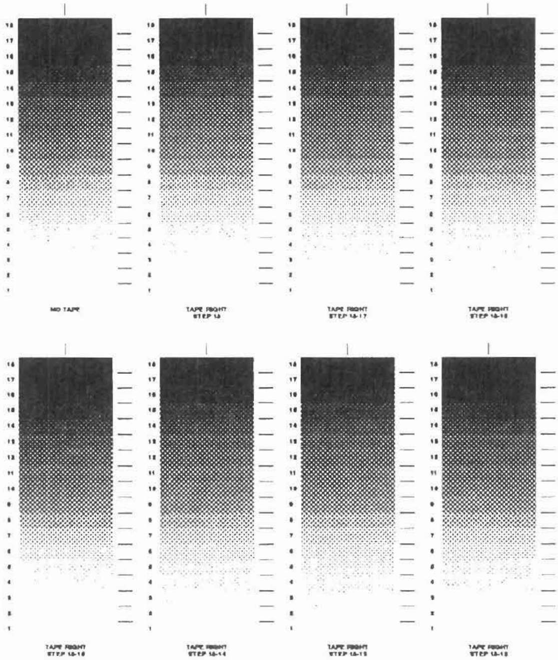
From the observations, it appears that increases in impression does not affect dot gain in the highlight and mid-tone areas, but indeed does in improve print quality in the shadow areas. In this experiment, the .004" tape plus the .002" impression appears to be the first optimum printing curve as impression is increased. Before the +.002" impression, there was still a small dip in density in the step 14-16 area.

Future studies could be done to see if it is the tape plus the extra impression which improves the print quality, or if the impression could just be increased on an untaped plate to .006", for example. Also, the tape could be used all the way down to a 1% or 2% film dot to see if the impression makes a lot difference all the way down there. In this study tape was only applied to a 18% film dot and up. It is not expected to make too much difference, however, because there is no visible jump from step 3 to step 4 where the tape was applied.

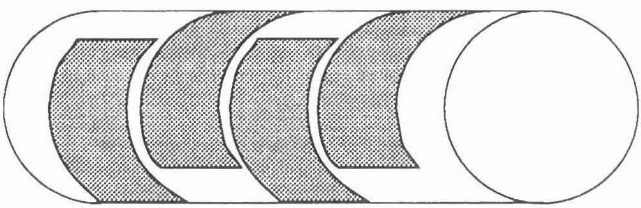
The next step in the experimental process is also to test halftones and process color reproductions. Tape and/or impression could be applied increasingly, and observations of print quality could be made.

The conclusions and recommendations are based solely on the results from this experiment. The analysis was done using only the materials and machinery of this experiment. In order to make assumptions for other substrates or stickybacks, for example, more extensive experimentation is necessary.

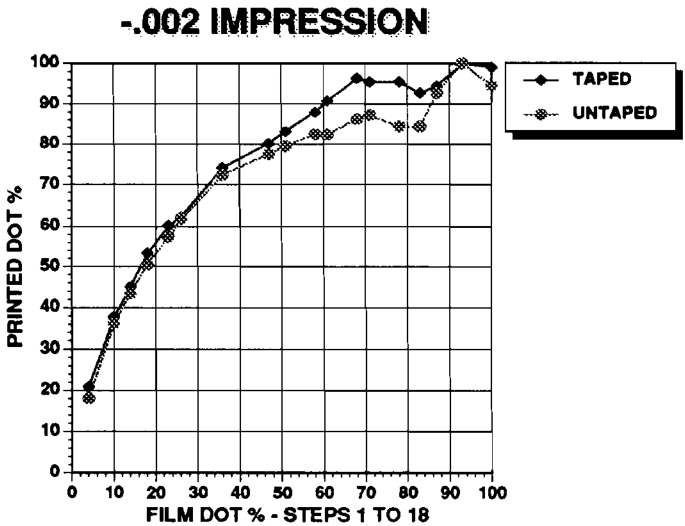
Appendix A



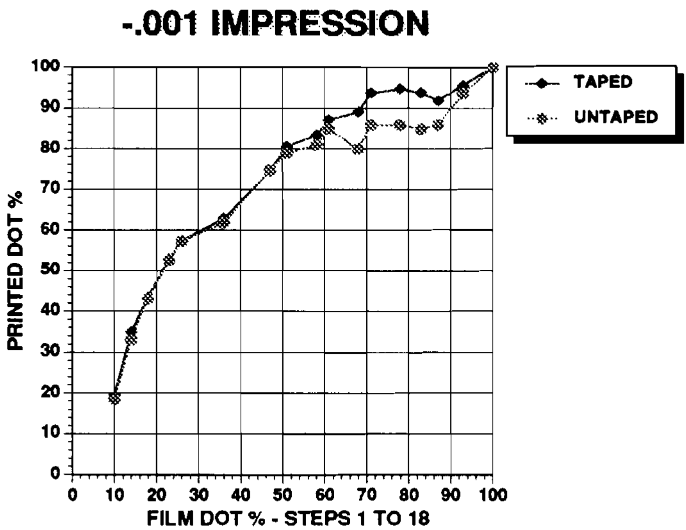
Appendix B



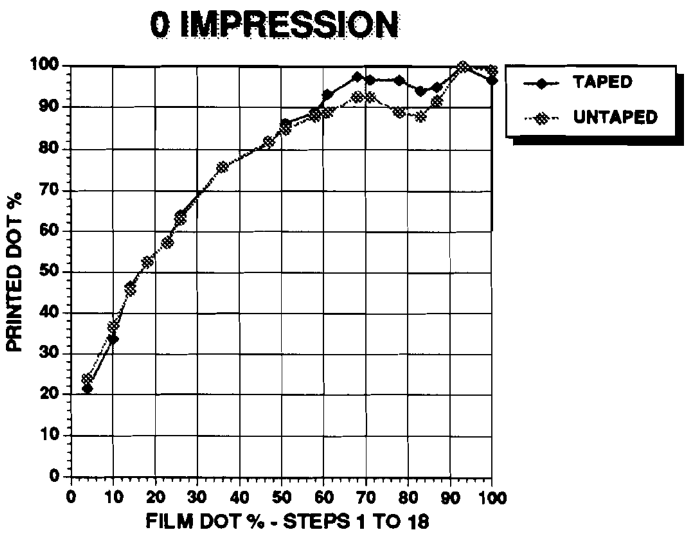
Appendix C



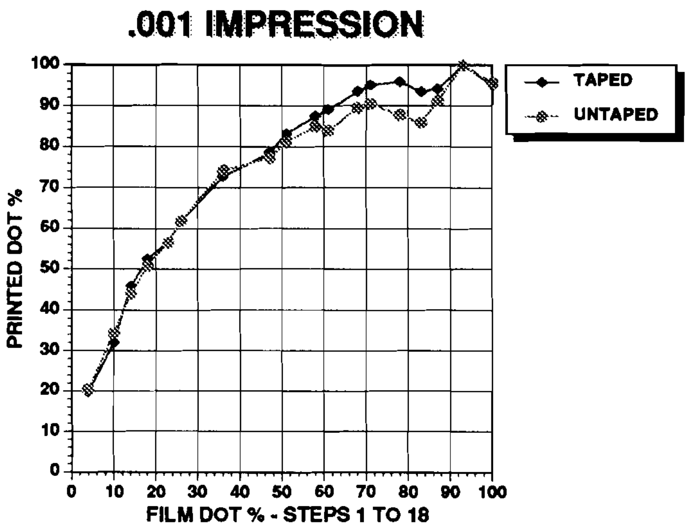
Appendix D



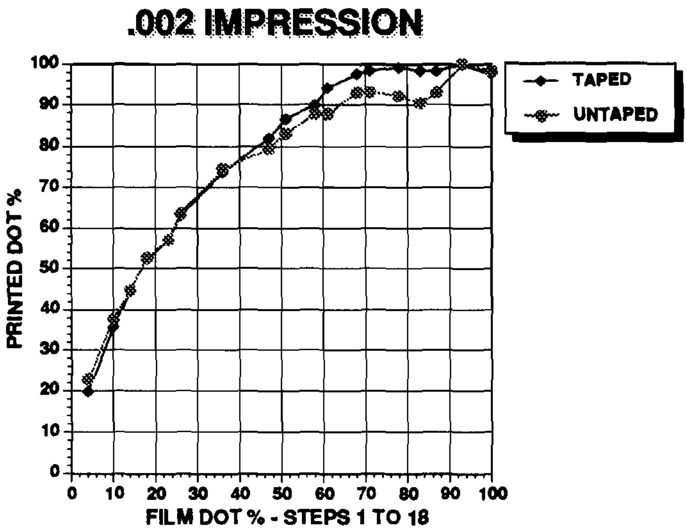
Appendix E



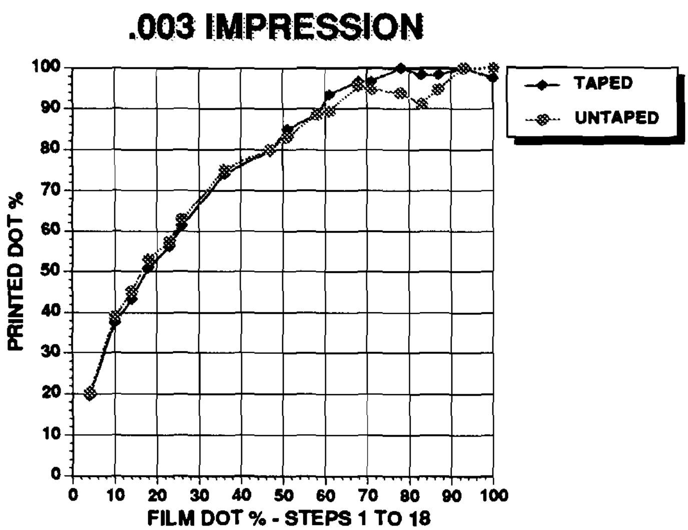
Appendix F



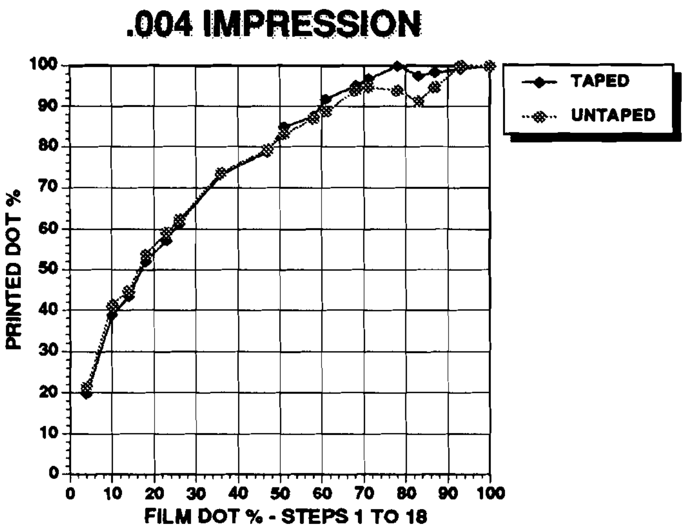
Appendix G



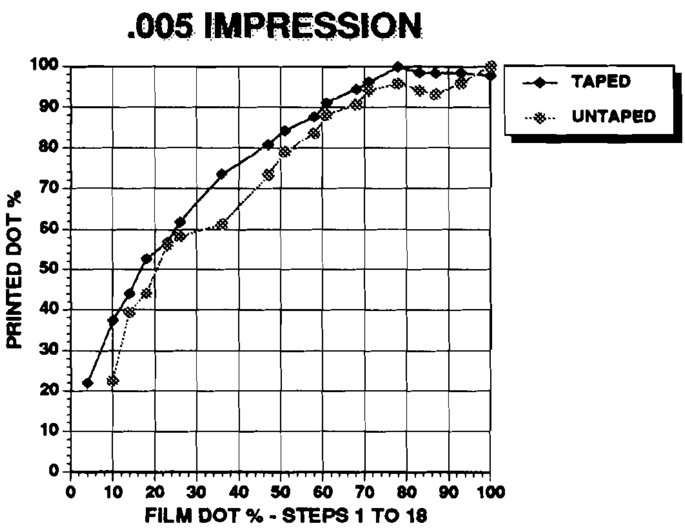
Appendix H

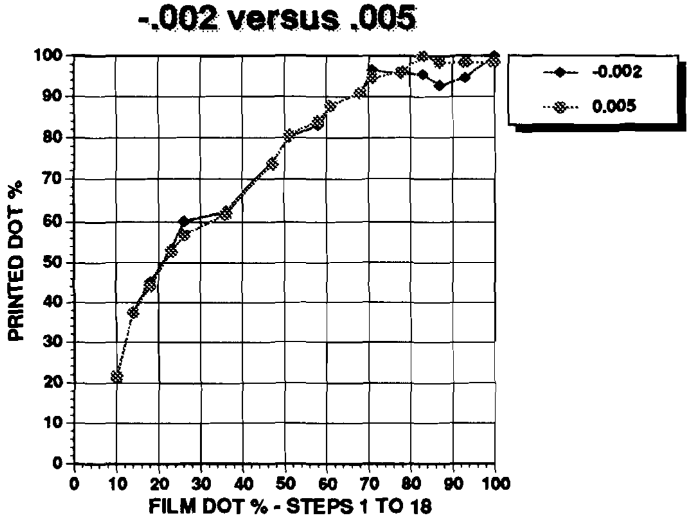


Appendix I



Appendix J





-.002 versus .005
-0.002
0.005
PRINTED DOT %
0
10
20
30
40
50
60
70
80
90
100
FILM DOT % - STEPS 1 TO 18