

Test Image Design:

*Designing a test image for use in a Comparative Evaluation of the
Color Gamuts of Flexography and Rotogravure for Flexible Packaging.*

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The purpose of this study was to design a test image ideally suited for the examination the color gamut for gravure and flexography. By focusing on these processes specific application in flexible packaging, a target was designed to provide a comparison of the spectral capabilities of both processes, directing further research towards a quantitative evaluation of the image reproduction capabilities of each.

This study investigates the specific needs of an experiment designed for this purpose. It examines specific elements of the experiment to determine the most logical method of extrapolating data from a press run. In doing this, the study outlines the process of this test image's development.

The result is a final test image, which is ideally suited for a study of color gamut in the flexible packaging sector. The ideas employed in its development are applicable to a wide range of pressroom experiments, and draws conclusions that can benefit others engaged in the design of this critical testing component. These conclusions may find use in the design of test systems for characterization in the commercial pressroom as well as the laboratory pressroom.

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Chapter One

Introduction

BACKGROUND

Today, relief impression processes such as flexography and gravure dominate the growing market for print on flexible films. These two processes are in direct competition with one another for market share in this segment of the packaging industry. Each offers its customers a unique set of characteristics, making the buyer's decision much more complicated than simple price comparison.

What is lacking from this system is a clear outline of the differences between both processes. What are the characteristics that define gravure and flexographic printing? What benefits can each offer, and at what cost do those advantages come? Which is better for the purposes of flexible packaging, and how can that be determined?

In order to determine which process yields the best result, the characteristics of each process must first be outlined to determine the differences between them. In addition to this, a common system for comparison must be selected. Ideally, this would be done using a quantitative evaluation of some shared property. This metric will allow for a performance comparison of both gravure and flexography in the context of flexible package printing.

For this purposes, one must examine the respective color gamut of each process. A comparison of the spectral capabilities of both processes will provide a quantitative evaluation of the image reproduction capabilities of each. In order to measure the spectral properties of each process, an experiment must be designed in which all other variables are controlled. In order to accomplish this, a common test image must be used. By reproducing this common image in a controlled setting, the same characteristics can be evaluated for each process

PURPOSE

In order to conduct this analysis, a common image must be designed. This study addresses the first step of this experiment, the process of designing an ideal test image for use in the experiment. The objective of this paper is to determine the variables that must be measured by the test image and to document the process through which those measurement techniques are applied.

The goals of the experiment include the determination of the color gamut of flexography and gravure in a controlled environment. Secondary to this goal is to determine the effect of gravure's variable ink film thickness capabilities on the color of the final image. Lastly, the experiment would provide analysis of additional characteristics of each print process.

This study follows the design of the test image. This image will later be used to test the hypothesis that gravure's variable ink film thickness capabilities provide the process with a larger color gamut than flexography. Additionally, the test image produced in this project will test the secondary hypothesis that gravure provides greater shadow contrast due to the dot merger which occurs at around sixty percent. The following chapters of this paper will outline the methods used in the development process to ensure the extrapolation of the data necessary to test these hypotheses

Chapter Two

Literature Review

Very little, if any, information seems to exist on the subject of test image design. For this reason, most of the research conducted for this portion of the experiment was drawn from more common, related topics, such as fingerprinting and press characterization. Especially useful in the research of this subject was the Gravure Association of America's fingerprinting website (found at www.gaa.org/fingerprintcentral.html). This site offers a collection of articles and how-to's devoted to this topic.

Additional information was gathered from a variety of sources, including magazines, web sites, and textbooks related to gravure, flexography, package printing, color science and the evaluation of quality. This chapter organizes the relevant information together under two topics of concern in this study: color and quality.

COLOR AND ITS MANAGEMENT

The reproduction of color depends on a number of variables. Characteristics of the substrate, such as brightness, whiteness and gloss can all affect the final image. A common practice when printing on film is to reverse print the image on the backside of a clear plastic film and laminated it with a white film or a film with white screened backing image. Ink properties, including conditions related to the milling of pigments and the drying or absorptive properties of the vehicle can also have a significant impact on the perception of color in a printed piece. (Bennett, p.1 2000) However, if these variables can be controlled, then they are effectively eliminated. Thus, under controlled conditions the limitation in color gamut of the output device becomes the most significant contributing factor involved in accurate color reproduction.

In order to better understand these limitations, the nature of color reproduction must be examined. This provides us with a better understanding of the limiting factors which arise from the action of transitioning between a larger and smaller color gamut. Also in this chapter, I will examine the processes by which color management attempts to address device variation. Color management is an important aspect in the control of variables associated with this experiment. In order for the process data gathered from the test image to be accurately compared, it must be ensured that the gamut of the data file was in no way limited prior to its final imaging stage.

GAMUT

Color is produced through either an additive process or a subtractive process. Input devices, such as computer monitors, scanners and digital cameras use additive light to reproduce color. Output devices, such as printers, film output devices and plate output devices use subtractive light. These processes are described with the RGB and CMY color models, respectively. Both models attempt to describe and reproduce as complete a portion of the visible light spectrum as possible.

The human eye is capable of detecting minute shifts in color. This results in a large spectrum of visible light, the extent of which cannot be fully reproduced by any device or method in use today. (Bennett, p.1, 2000) The color gamut of a computer monitor differs from that of a scanner, which differs from that of an ink jet printer. Color gamut can differ even from one printing process to the next. This results in a plethora of overlapping color spaces, none of which are fully adequate for true-to-life color and none of which fully describe one another.

COLOR MANAGEMENT SYSTEMS (CMS)

In order to standardize the reproduction of color, a system for its management throughout a reproduction workflow becomes critical. These systems are known as color management systems. Through their use, images are able to better retain their original color characteristics across multiple workstations or devices. The foundation of all CMS' lies in the standards developed by the International Colour Consortium.

The ICC defines an architecture for the development of device profiles. These profiles consist of data tables defining the limits of a device's gamut in the color space (RGB or CMY) used by the device. The defined gamut can be translated, using the profile, into a profile connection space. (ICC, 6 pars., 2001) The PCS specified by ICC standards is CIE $L^*a^*b^*$ (also known as CIELAB or CIEXYZ). $L^*a^*b^*$ is a color space which defines the maximum possible portion of the reproducible color gamut. It describes color with regard to luminosity (L) red-green spectrum (a) and yellow-blue spectrum (b). (Bennett, p.1, 2000) Because CIELAB possess a wider gamut than either RGB or CMY, it makes an ideal color space for the translation of color data between an image's input color space and it's final output color space. This makes the development and understanding of each device's dependant color gamut critical.

Today, CMS' allow printers and designers to reproduce color with greater accuracy through the use of properly prepared device profiles. In an ideal color managed workflow, an image is captured through a digital capture device such as a scanner. The captured image is immediately translated from the scanner's native color space (a device-specific RGB gamut) into CIELAB by an input profile. The

workstation monitor being used to make color adjustments has a specific display profile, translating the RGB colors displayed on the monitor. All operations performed on that image are done within the CIELAB space, allowing the image to maintain the maximum possible gamut of color. Once the image has been prepared for output to a device such as an imagesetter, it is processed once again by a device-specific output profile, which translates the image from CIELAB into the destination press' native CMY color space, while retaining the maximum possible gamut of color. (Adobe, p.3, 2001)

Accurate color management requires the profiling of output devices and the characterization of those devices. In a fully developed CMS, output profiles might exist for all standard variables used in a printing company. This would mean developing a profile for specific combinations of ink, paper, and press configuration. (Harold, p.1, 2001) It is important that the press itself be characterized and set to known values. All variables should be accounted for in this process, including roller hardness and pressure, ESA settings, ink viscosity, anilox screen ruling, ad infinitum. In the context of this experiment however, these characteristics are of lesser significance. If properly controlled, they become unimportant in the development of color gamut profiles.

THE EVALUATION OF QUALITY

Quality is an expression that carries a heavy burden of expectation. It is loosely defined as “full customer satisfaction.” (Apfelberg, p.18, 1995) The American Society for Quality suggests that the word quality “...should not be used as a single term to express a degree of excellence in a comparative sense. (ASQ, 1 pars., 2001)” Rather, it is suggested, a product's should be examined from the

perspective of desired measurement, such as the end user, the product or the manufacturer. (Apfelberg, p.18, 1995)

CRITERIA

In order to properly evaluate a product for comparison, the evaluative criteria should be clearly defined. This requires the determination of the product's function and the key factors associated with and desired by that role. For the purposes of this study, the printed product will be evaluated from a spectral capabilities viewpoint.

Conditions associated with the accurate reproduction of color should be outlined and examined in order to accurately compare two printing processes. Those conditions that are of importance in a flexible packaging environment are: (Utschig, 3 pars., Sept. 2001)

- Solid density blocks
- Tone gradations
- Grey balance
- Color gamut
- Minimum and maximum type (serif and sans serif face)
- UPC barcode (vertical and horizontal orientation)

By incorporating this data at a known value in the test image, both processes can be examined to determine the accuracy with which they are capable of reproducing color. Numerical readings can then be taken for density and spectral values such as CIE L*A*B*. These quantitative values are of importance when

examining printed products, as they allow for standardization of data being examined.

SAMPLING

Proper sampling is an important key to reliable data collection. Between 30 and 100 samples should be chosen from a press run for proper statistical evaluation. Because the printing process is inherently variable, subgroup sampling procedures are recommended when examining process variability. (Apfelberg, p.80, 1995) In subgroup sampling, each data point represents an average value calculated from a group of three to five successive samples. This two-layer process reduces the variability of individual samples and allows for the auditor to look for general trends within the data collected. For this reason, the test image was designed for three line screen variations. This will group the results into three subgroups for evaluation.

Chapter Three

Methods & Procedures

RESEARCH METHODS

The research methods used for this study include specialized interviews, content analysis and descriptive research. The primary means by which this study was researched involved close work with Cal Poly Professor, Dr. Malcom Keif during the early planning stages of the project. Dr. Keif later provided significant feedback regarding the implementation of the specialized targets in the final image. In addition to the information garnered from Dr. Keif, significant assistance was received from Rudy Wiesemann, Technical Specialist to the Gravure Association of America. This proved invaluable when determining the characteristics necessary for evaluation.

Additional text resources, as outlined in Chapter 2 of this study, provided supporting documentation vital to the implementation process of the final image design. The resulting test image can be seen in the following chapter.

PROCEDURES

It was important that the test image be properly designed to gather the widest range of information from the process in one printable image. This required the inclusion of a variety of measurement targets that could be examined to provide a characteristic profile of the processes as well as a gamut profile for each machine used. These various elements were carefully chosen to maximize the data collection process. The size of the test image was of little concern, given a maximum cylinder circumference of 20 inches and a maximum web width of 30 inches. This relatively large printable area allowed for a number of image sizes and configurations to be examined.

I determined that a 10 by 20 vertical image would best fit the size requirements mandated by the various targets. The image is designed to run three across the cylinder, allowing it to be engraved or plated at variable line screens. By producing the image at 133 lpi, 150 lpi and 175 lpi, I will later be able to measure the effects of various line screens on the quality of each process. It is hoped that this will provide a clear picture of the ideal line screens for use in gravure and flexography. Additionally, this subgrouping will provide a better statistical sampling of the results. I believe that by producing the test image at varying line screen resolutions, more conclusive information regarding the point at which gravure cells begin to merge on the substrate can be determined. This data would be invaluable in proving or disproving the second hypothesis.

SCOPE

In order to successfully produce a valid test image, it was necessary to determine the full scope of data to be collected. A set of characteristics was chosen, drawing on characteristics of the respective printing processes as well as the needs specific to flexible packaging. These various characteristics, when measured on the test image, will build profiles of both processes being used. The final design of the test image was based on the following characteristics:

Solid density: This characteristic provides an evaluation of the process' ability to reproduce solids of a consistent density. This ability can be evaluated based on visual and quantifiable inspection. The visual evaluation would look for solid patterns with few or no gaps within the image. The quantifiable evaluation would examine the ink density for consistency throughout the image.

Tonal range: The ability of the process to reproduce a full range of tones, including highlight, mid-tone and shadow, is an important element of a process characterization. Any target used in the measurement of tonality should explore the full range from zero to 100 percent ink coverage. This will result in a profile of the upper and lower limits of the process' reproductive range. It would also provide evidence of any fall out which may occur in the mid-tones.

Gray balance: Measuring gray balance across the press sheet will provide immediate visual evidence of any tonal shifts which might be occurring on the press sheet. Elements designed to measure gray balance should accurately represent a neutral gray comprised of all four process floors and should be visually consistent. Gray balance measurements may also provide quantifiable data for the value of any inconsistency in density across the sheet.

Color gamut: As the primary focus of the experiment is to examine the color gamut of both processes, the tool used to determine this is the most important element of the image. An image or color patch of known spectral value can be reproduced on the test image and measured against a known original value. This calculation will determine the spectral differences between the two and will provide an outline of the maximum gamut of the process.

Type: For applications in packaging, type of various sizes is often necessary. It should be determined how accurately each process can produce type that is serif and sans serif in varying sizes. The ability to print type reverse on a black solid is also important to measure. By testing these elements, the ideal typographic range of the process can be determined.

Barcode: Package printing often requires the reproduction of a barcode. This image must meet stringent standards for size and quality in order to be properly read by barcode scanners. It is also important to determine the ideal orientation of the image on press.

Visual evaluation: Subjective evaluation is often considered an important component of any profiling or characterization testing. However, this often becomes a trap for the validity of the test. By incorporating a picture or photograph, the operator of the press being tested is subconsciously encouraged to print to the photograph, making adjustments outside of standard densities or $L^*A^*B^*$ values in order to achieve a realistic or lifelike quality in the photograph (Utschig, 4 pars., Sept. 2001). Any deviation from specified densities made by the operator would invalidate the results of the test. For that reason, subjective, visual evaluation should be achieved with the use of process color vignettes. These two-color gradient combinations will give an observer a realistic idea of process color combinations without distracting the operator.

IMPLEMENTATION

After determining the scope of information necessary, a series of specific targets were designed for the final test image. Each target was designed to measure one or more of the characteristics outlined above. The final assortment of targets were incorporated together, working within the constraints of a 10 x 20 inch image area. These elements were designed and incorporated using Adobe Illustrator. The final decision to build this image using the Illustrator application was a direct result of the file requirements of the printer's imaging suppliers. The program's vector image base and its ability to output multiple file-formats (native

Illustrator, Encapsulated Post Script, Adobe PDF and Adobe Post Script) also contributed to the program's selection.

In order to measure the characteristics deemed necessary, ten individual elements were designed. Each of these elements was created to address one or more of the process variables outlined above.

Gray bar: A gray bar of neutral density was placed across the width of the image. This will provide a measure of the ink density across the width of the image and ensure that density remains consistent. If either press or process suffers from fade off at the edge of the cylinder, this will provide visual confirmation.

Type: Set in Helvetica (for sans serif) and Garamond (for serif) in sizes ranging from 36 point at their maximum to 5 point at their minimum, two blocks of type were placed on the image. One of these blocks of text was set in black while the other was reversed out of a black solid. It was determined that type below 5 point would be unreliable in packaging applications and therefore unnecessary to test.

CMYK steps: A set of step-charts were procured from Cal Poly professor Brian Lawler in order to measure tonal range. These charts were used for Cyan, Magenta, Yellow, Black and a composite black. Each chart includes a 100 percent solid block printed alongside a tint, ranging from zero to 100. The blocks occurred only for odd numbered densities in order to reduce space used on the final image.

Barcodes: A barcode was created using the CODE 39 system. CODE 39 was chosen simply for availability of font and reader technology. The barcode was

placed in both vertical and horizontal orientations in order to determine if either process was unable to produce a readable image in a particular orientation.

IT-8 spectral target: A digital variation of the IT-8 standard spectral target was obtained, again from professor Brian Lawler. This image includes a set of color patches of known value and is compatible with Cal Poly's Graytag-Macbeth spectrometer system. This system includes software which will determine L*A*B* values for each color and compare it with the known original value of the image. This allows the machine to generate a profile of the presses color gamut.

Gray patches: A series of composite gray patches was obtained from Dr. Malcom Keif in order to measure the densities at which the process produces the most viable neutral gray. These patches vary in their composition, providing a range of CMY values mixed for varying shades of composite gray.

High key / low key gradients: In order to determine where the process' upper and lower tonal range is, two gradients were included. Measuring the high key range (from zero to 0 percent coverage) and the low key range (from 90 to 100 percent coverage) will provide some detail on the tonal range of the process.

CMYK gradients: By including a short length gradient of each process color, I will be able to quickly determine the zones in which tonal falloff might occur. This will provide a visual overview of the tonal range, to compliment the step-charts.

CMY vignettes: Providing a visual evaluation of the process' color reproduction is an important component. To achieve this without the use of a color photograph, process color vignettes were designed. Six gradients were

overlaid in pairs, running from zero to 100 percent coverage and from 100 to zero percent coverage. Each was set to overprint. These gradients formed three vignettes of process color combination (Cyan and Magenta, Yellow and Cyan, Magenta and Yellow).

Chapter Four

Results

RESULTS

During the design process, the test image was continually in review by Dr. Keif, who served as the project's primary advisor. A number of revisions were made to the image, based on suggestions made by Dr. Keif and others. The image development process consisted of three major drafts as well as a final revision.

FIRST DRAFT

The first draft of this image was created based on information received from Dr. Keif and Professor Brian Lawler. The work conducted with these two individuals involved a series of interviews to determine the range of data which would be necessary to evaluate in order to best achieve the project's goals. It was during this stage of development that Professor Lawler and Dr. Keif supplied me with their component targets (the color-step charts and gray patch targets, respectively). This draft of the project was developed in the Quark Xpress application.

This draft included cyan, magenta, yellow and black versions of the color-step charts, the three-part gray patch target and the IT-8 compatible spectral target.

SECOND DRAFT

After significant refinement was made to the scope of the project, it was determined that additional data would be required regarding each processes performance with packaging-specific variables, such as type and barcode performance. In this draft, I redeveloped the file using the Adobe InDesign application. This was done in order to provide better support for the creation of Adobe PDF files, however it presented problems with the output of useable Post Script information.

During this stage of development, the image grew to include a process-gray variation of the color-step target as well as serif and sans-serif text (not including the reverse text) and vertical and horizontal barcodes.

THIRD DRAFT

It was at this point that Rudy Wiesemann was contacted. On his suggestion, new elements were generated and revisions were made to existing elements. At this point, the experiment shifted slightly, to explore the evaluation of ink film thickness and continuous tone reproduction in gravure. To accommodate this required the addition of cyan, yellow and magenta gradients as well as process color vignettes. In this iteration, I recompiled the image in Adobe Illustrator, due to the poor workflow and output performance of previous applications used and feedback received from the prepress suppliers involved in the printing of the test image.

In addition to the elements included in previous versions of the image, this draft incorporated many new elements. This included the addition of minor elements, such as the reversed variation of the type and the addition of a full-width gray bar. More significant changes in this version included the addition of the process color vignettes, CMY gradients and high key (0 – 10 percent) and low key (90 – 100 percent) gradients.

REVISION

Minor revisions were made to the third draft of the image, based on feedback received from Dr. Keif in his evaluation of the image. Some changes to the construction of certain vector images were required to ensure successful output of

the file. Negligible adjustments were required to accommodate the printer and prepress suppliers.

FINAL DRAFT

[see Appendix B]

Chapter Five

Conclusions

DEVELOPING A PROCESS.

From the results of this phase of study, conclusions can be drawn about the process of designing a test image. Although many design aspects undertaken in this study addressed areas of concern specific to the original process study program, larger conclusions regarding the common needs of a test image and the process of developing such an image can be inferred.

Perhaps the most important lesson to be drawn from this study is to develop a specific focus prior to the start of the design. The designer of the test image should begin with an outline of the program's goals. When developing the concept for the test image, a series of questions should be asked. What is the image supposed to evaluate? Can this characteristic be measured? What is the most appropriate method of measurement for this application?

Throughout the process of designing this image, I had to redevelop and recompile the image in order to be certain that each element addressed a specifically outlined issue or concern. By determining the goals of the project well in advance of the design phase, these many revisions would have been avoided. Choosing specific elements of the final test program to be measured in the target will ensure that the test image is not overly broad. Too much data may become muddled during the analysis phase of the study and prevent real conclusions from surfacing.

Also important is the evaluation process. Two key components of this are continuous feedback and expert advice. To ensure that development of the image is proceeding in the proper direction, a feedback cycle must be developed into the design phase. By incorporating expert advice into this feedback cycle,

improvements that the image designer would not generate independently are brought to fruition. Those who are considered experts in the field being researched can offer information which may help avoid common pitfalls and hazards. This should greatly speed up the development cycle and allow for the implementation of more robust solutions for measuring specific characteristics.

There are many common elements to a test image. These specific measurement targets are often found in standard or commercially developed target images. They can provide shortcuts during the development phase by offering preformed solutions to measure common data sets. However, it should be noted that by a generalized test image is not specifically designed to address the needs of the experiment. While they may be suited to some projects, it may often be necessary to revise certain aspects of these test images in order to collect the information most relevant to the project. Additionally, certain elements of these generalized targets may be superfluous and may actually invalidate or taint the data obtained for a specific purpose.

An example of this sort of superfluous element is the highly prevalent target photograph. Steve Utschig points out that the inclusion of an image contributes heavily to the “conscious or unconscious tendency to try to ‘make the image look good.’” (Utschig, 4 pars., Sept. 2001) This tendency to print to the image can have significant implications on the proper characterization of the process, resulting in data of questionable validity. This example illustrates the importance of questioning the use of each element of the test image. No element should be included that does not serve a specific, defined purpose.

FURTHER RESEARCH

This study is only the first step in a much larger experiment regarding the quality and capabilities of gravure and flexography in the flexible package printing industry. The goals of this parent experiment are outlined in the first chapter of this document. By providing a test image, the questions posed there can now be addressed in a systematic method. Further development of the pressroom and analysis phases of the experiment is still required.

A research plan developed to address those questions can be found in the appendix of this document. It will provide a road map for the completion of subsequent experiments related to the broad goals for which this test image was designed.

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Appendix

APPENDIX A – RESEARCH PLAN

The purpose of this study is to compare the performance of gravure and flexography's capacity for color reproduction and image fidelity in a flexible packaging environment. The goals of the study are as follows:

1. To determine the color gamut of both processes with all variables in control except process.
2. To determine the impact of gravure's variable ink film thickness capabilities on image fidelity and color gamut.
3. To observe additional characteristics of each printing process.

In this study, I hope to prove the following hypotheses:

1. The gravure printing process supports a larger color gamut due to its ability to produce a variable ink film thickness.
2. Gravure provides greater shadow contrast due to the dot merger occurring at around sixty percent ink coverage.

The experiment designed to test these hypotheses will proceed according to the specifications listed below. The experiment will proceed in 5 steps:

1. Design: a common test image will be created to address specific objectives of the project.
2. Prepress: the test file will be engraved for gravure and imaged for flexography according to the specifications outlined below.
3. Press: the test image will be produced on a film substrate using both gravure and flexography, according to the specifications outlined below.
4. Analysis: the printed sheets will be examined in detail, according to the objectives outlined below.

SPECIFICATIONS

Prepress

Cylinder Engraving: (gravure)

The following rules should be observed during the engraving process, in order to reduce the number of variables between both processes:

- No correction or curves should be applied to the file prior to output.
- The file should be engraved one up, three across.
- Each of the three images should be engraved at different line screens, at 133 lpi against the cylinder's left edge, 150 lpi at the center image and 175 against the right edge of the cylinder.

Flexographic Platemaking: (flexo)

The following rules should be observed during the platemaking process, in order to reduce the number of variables between both processes:

- No correction or curves should be applied to the file prior to output.
- Standard screens (not hybrid) should be utilized.
- The file should be imaged one up, three across.
- Each of the three images should be imaged at different line screens, at 133 lpi against the plate's left edge, 150 lpi at the center image and 175 against the right edge of the plate.

Press

Fully imaged cylinders and plates will be provided to Seville Flexpack, per specifications above. The reproduction of the test image should follow the specifications outlined below according to subject. Approximately 50 sheets per image (per line screen variation) should be collected off press by Seville. In this manner, the total number of sheets should measure approximately 150 gravure images and 150 flexo images. These sheets should be considered "good" according to the specification for printing listed below.

Substrate:

- Images should be printed reverse on film with a white laminate backing.

Ink system:

- The same ink systems should be employed under both processes.
- The ink system should utilize a solvent-based vehicle under both processes.
- Pigments for flexo and for gravure should come from the same manufacturer and should be of the same batch.
- A set of labeled tap-out's for all inks should be delivered with the final image.

Printing:

- Accurate information regarding each press run must be recorded on the supplied data collection forms.
- In both processes, color measurements should be made in CIE L*A*B* values.
- The image can be considered "good" when gray bars are matched across the width of the press and measured L*A*B* values conform to supplied SWOP specifications (see ____).
- Gravure or flexo images may be run first, however the process produced second should be run using L*A*B* values of the first press run as target values.
- Under each process, the run should begin with over saturated densities. Color should be brought down to specification from that point.

Finishing:

- Final images should be slit according each line screen ruling.
- Sheeting is preferred, however this will be left to the discretion of

the printer.

Analysis

Sheets will be randomly selected for evaluation within each category of the six categories (gravure: 133 lpi, 150 lpi, 175 lpi; flexo: 133 lpi, 150 lpi, 175 lpi). Each of the target elements will be evaluated based on the criteria outlined below.

Gray bar:

- This will provide a measure of the ink density across the width of the image and ensure that density remains consistent.
- If either press or process suffers from a fade off at the edge of the cylinder, this will provide visual confirmation.

Type:

- The type blocks will be evaluated visually.
- Each will be inspected for its ability (at each type, size and reverse) to maintain clean, crisp and readable lines with few artifacts.

CMYK steps:

- Tints in each step-chart (CMYK + Composite gray) will be measured to ensure that they match the original, intended density.
- 100% solid's included in these charts may provide information to address the ink film thickness question posed above.

Barcodes:

- Both barcodes (horizontal and vertical) will be inspected for readability using a barcode scanner capable of reading CODE39 encoded data.

IT-8 spectral target:

- Will be measured using Cal Poly's Graytag-Macbeth spectrometer system.
- Will be measured for deviation from the original CIE L*A*B* values of the original.
- An output device profile will be generated using the Graytag-Macbeth software. This will be rendered in a visualization software to examine the color gamut of each device.

Gray patches:

- Densities will be measured to determine the density at which each process produces the most viable neutral gray.

High key / low key gradients:

- Measuring each (the high key range, from zero to 0 percent coverage and the low key range, from 90 to 100 percent coverage) will provide detail on the upper and lower limits of each process' tonal.

CMYK gradients:

- Will be visually inspected to quickly determine the zones in which tonal falloff may occur. This will provide a quick reference to compliment the step-charts.

CMY vignettes:

- Will be providing a visual evaluation of the process' color capabilities without the use of a photograph.

APPENDIX B – TEST IMAGE: FINAL DRAFT

