

### 19.3.1 Process Control Data Collection & Documentation

Throughout the press run, the press crew should measure and record, on a standardized form, spreadsheet, or database, the process control parameters and appropriate mechanical control parameters. This information is used, real-time, to control the printing process. There are two additional uses of this data:

- Internal Communication** – Collect data on key process and mechanical control parameters in a spreadsheet. In addition to the actual quality measurements, include columns for important identifying information such as: design code, order number, date, substrate, press, ink color, roll number, etc. These additional columns allow the data to be sorted into meaningful subgroups, facilitating a better understanding of the process capability. This database provides the foundation of knowledge required to pursue process improvement, which is detailed in Print Section 19.5.
- External Communication** – A database of run data enables the printer to provide the customer job-specific “Certificate of Analysis” data – detailing the quality achieved on any given production run. Additionally, the printer is able to provide the customer a quarterly analysis by design (run-to-run quality analysis) or design-family quality analysis. It also makes it easier to locate and isolate “out of spec” material from the production floor or from inventory. A comprehensive database, and employees who understand how to sort and statistically analyze the data, can be a powerful sales tool. Summarizing process control data can clearly communicate to existing customers, or potential customers, a company’s competitiveness in the marketplace, what the company is capable of, and why it is better than the competition – in quantitative terms. It provides an additional “yard stick” to compete on – instead of simply price and delivery.

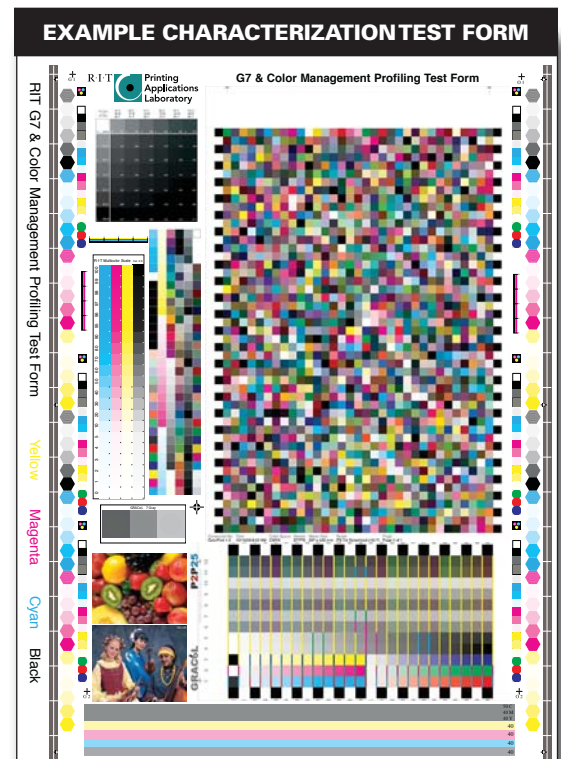
EXAMPLE PROCESS DOCUMENTATION																					
PROFILING FOR COATED SUBSTRATES ----- MATTE STOCK																					
RUN: 1		78 Fahrenheit - 52% humidity																			
Plates: 150 lpi		Oven Temp Set @ 245F										Speed 900 fpm									
Substrate: Mohawk Matte -- 32" width		Relative Density																			
Inks: Flint Process Inks For Coated		Operator Side Density										Gear Side Density									
Deck	Color	Code	Anilox #	Liq. Vol. LPI / Vol.	Target Density	Init pH	Init Visc Zz	After 4 hrs pH	After 4 hrs Visc Zz	100	50	30	5	1	100	50	30	5	1	Stickyback	Print Contrast
2	Black	RFK 191	4	800/3.4	1.40	7.8	23	7.8	20	1.41	0.84	0.63	0.24	0.18	1.47	0.85	0.61	0.24	0.14	1020	47
4	Cyan	RFB 462	30	800/1.9	1.25	7.1	22	7.1	21	1.4	0.72	0.54	0.2	0.06	1.33	0.72	0.55	0.19	0.05	1920	60
5	Magenta	RFR 600	42	800/1.9	1.25	7.8	25	7.8	21	1.22	0.68	0.47	0.17	0.10	1.22	0.72	0.55	0.24	0.12	1920	60
7	Yellow	RFY 326	38	800/1.9	1.00	7.6	20	7.6	20	1.01	0.75	0.53	0.18	0.06	1.01	0.74	0.57	0.21	0.03	1020	51
						Trap	Y/M	63%													
							Y/C	88%													
							MC	71%													

19.3.1: Process Documentation: Documenting key run variables makes it easier to achieve similar print results run-to-run.

### 19.4 Press Characterization

The press characterization trial utilizes the IT8.7/4 characterization target and applies only to process-color image reproduction. The IT8.7/4 target, printed during the press characterization trial, is used for color management calibration within the prepress system. The data derived from the printed IT8.7/4 target is used to create an ICC profile, which is then used to calibrate monitors, proofers, and other color output devices to simulate the printing condition. It defines the relationship between input data and the printed result.

Characterization data is of little value unless the printing condition being characterized is known and can be repeated. In order for the various devices upstream to accurately simulate the appearance of the printed image, the characterization trial must adhere to the aim points and tolerances established during the press fingerprint trial. These aim points and tolerances must also be maintained during future production runs.



19.4: Press Characterization: The IT8.7/4 target is the key test element required for a press characterization trial.

The fingerprint trial establishes the aim points and tolerances the printing condition is able to achieve, when optimized, under normal production conditions. The press operator is responsible for achieving the aim points, within established tolerances, on the characterization trial and all future production runs. Without this repeatability, the characterization trial is of little value. Aim points and tolerances should be established during the fingerprint trial for key process-color quality attributes such as: solid ink density, dot gain, print contrast, gray balance and ink trap. Refer to Print Section 20.4 for additional information on critical process color print characteristics.

The result of a successful press characterization is optimized color separations and proofs that accurately predict the printed result – leading to less make-ready time, reduced production waste, and improved press speeds while satisfying the customer’s quality expectation.

### 19.4.1 Characterization Test Target: IT8.7/4

FIRST supports using the industry standard, IT8.7/4 characterization target. This target is the result of collaborative efforts of several standards committees, and represents the best technical approach to a standardized target. The target can be formatted in a variety of ways to be read by various color measurement devices and sized to fit a variety of press sizes. Typically, the IT8.7/4 target is evaluated using an automated scanning spectrophotometer instead of manual measurements with a hand-held spectrophotometer. This not only saves time but also allows for the efficient measurement of multiple samples. Therefore, it is the responsibility of the application creating the target to provide the mapping between the physical location and the ID number of each patch as well as to confirm that each patch is larger than the aperture of the measurement device. FIRST recommends the printer confirm the target format and measurement device compatibility prior to printing.

There are two layouts of the IT8.7/4 target, the “visual-layout” (also referred to as the “ordered format”) and the “randomized-layout”. Both contain the same combinations of CMYK patches, just in a different pattern. The randomized-layout target should be used for print characterization analysis. By randomizing the locations of the various CMYK combinations, ink takeout across the target area is more uniform. Errors introduced by press anomalies will be randomized with respect to CIELAB color space. The ordered, or visual, layout may be useful for those applications where manual measurement is required. FIRST recommends utilizing the full print width of the web to incorporate multiple randomized IT8.7/4 targets. Ideally, the target should be oriented in two directions with a 90-degree rotation.



The IT8.7/4 target, both ordered and random layouts, contain the following elements:

1. **Solid Ink Patches:** Used to measure the colorimetric properties of yellow, magenta, cyan and black.
2. **Tint Patches:** Contain known tint values of the four single colors (CMYK). Twenty tint patches are included for each process color.

**Table 20.1.4**

<b>ANSI 2.30 – 1989: Color Viewing Conditions</b>	
<i>Parameter</i>	<i>Specification</i>
Lighting	5000 Kelvin bulbs (D50)
Light Source	Color Rendering Index $\geq 90$
Viewing Surface	Luminance = 204 +/- 44 foot candles
Viewing Area Color	Neutral Gray: Munsell N8 or equivalent
Angles of Illumination	Minimize Glare

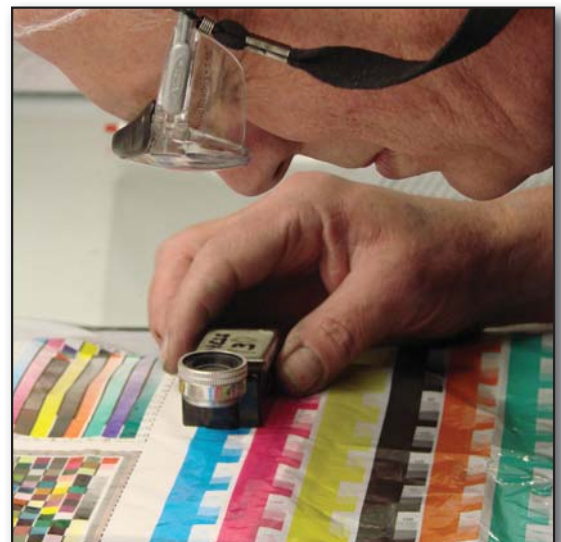
**Instrument Agreement:** The light source used in the light booth should be the same as the equipment illuminant setting. For example, if the measurement equipment (spectrophotometer) is using D65 instead of D50, the light booth should use 6500-Kelvin bulbs (D65) instead of 5000 Kelvin bulbs (D50).

**Communication:** Regardless of the viewing conditions used, it is important to communicate the viewing conditions to all parties receiving data measurements.

### 20.1.5 Magnifier & Tape Measure

**Magnifier:** Use 10X and 30X magnifiers to visually examine the printed image detail. Characteristics evaluated with a magnifier include: dots for roundness, halo(s), donuts, slurring, color-to-color register, ink lay smoothness, and sharpness. A magnifier should be located press-side.

**Tape Measure:** Use a tape measure to verify image repeat, cut-off, web or sheet width, and critical package elements such as glue zones. Use a tape measure, in the scale appropriate for the press, to determine the amount of misregistration in order to correct the press more precisely.



*M. Beuscher*

**20.1.5: Magnifier:** A magnifier enables the press operator to visually examine the detail of the printed image.

## 20.2 Using Process Control Test Elements

**Application:** If repeatability and consistency are important to the customer, then space must be allocated on the sheet, web, or printed product for appropriate process control test elements. Measuring at set-up and throughout the run enables the printer to produce repeatable, consistent, and accurate results on every job. The test elements used to measure the print characteristics outlined in Print Section 20.3 line work and 20.4 process color work, can be used for the print optimization and fingerprint trials as well as on every “live” job to facilitate process control. The test elements included will vary based on the process variable being optimized or the print characteristics that are pertinent to the job being printed and space constraints. Generally, all of the test elements

### EXAMPLES OF CONTROL TARGETS ON LIVE PACKAGING



discussed in Print Sections 20.3 & 20.4 should be included in a fingerprint trial to provide the most comprehensive information on the current process capability. Using similar test elements on all press trials as on live production jobs enables the printer to verify current print conditions and flag any changes since the press was last fingerprinted.



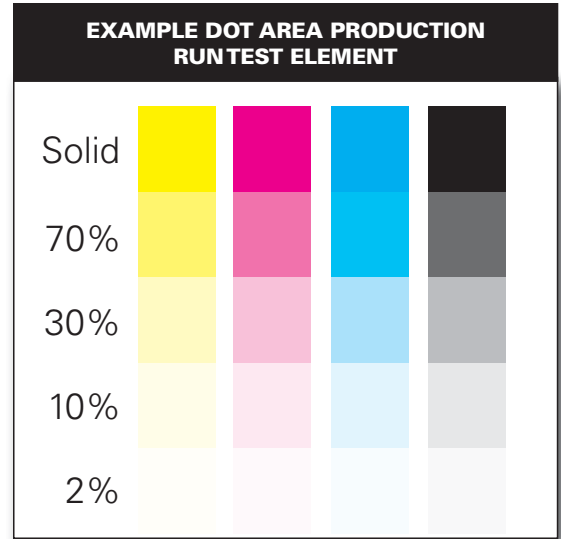
**20.2: Placement of Control Targets:** Control targets can be placed in folds, glue flaps, the waste matrix and, when necessary, on the “live” print area of the package.

**Placement:** In order for the printer to be able to deliver the desired print results, the customer and designer must include key test elements in the graphic design. Some packaging lends itself to placing test elements under flaps, in a glue zone or on the waste matrix. Other packaging requires the test elements to remain visible on the finished package. Therefore, each print application should determine where to place the individual test elements.

**Format:** Print Sections 20.3 & 20.4 describes the key print characteristics for both line and process work and the test element used to measure each characteristic. Previous editions of FIRST have supplied the FIRST control target. Beginning with this edition, all of the test elements discussed in Print Sections 20.3 & 20.4 will be supplied for construction into a suitable control target, optimization, or fingerprint test design for each print application. The test

**Production Runs:**

- **Selecting Tint Patches:** On production runs, it is critical to measure and control both dot gain and solid ink density. At a minimum, for each color, a solid patch and the tint patch that is most sensitive to pressure adjustments, as determined during the press fingerprint trial, should be included on all production runs. Space permitting, it is desirable to include additional tint patches to allow for better control and monitoring of the printed image. Consult the printer to identify the appropriate tint patches. Refer to Print Section 19.2 for additional information on the press fingerprint trial.
- **Types of Tone Scales:** FIRST recommends using tone scales to control both the platemaking process as well as the printing process. There are multiple approaches, as described below, and depending on the application, one or more may be appropriate.

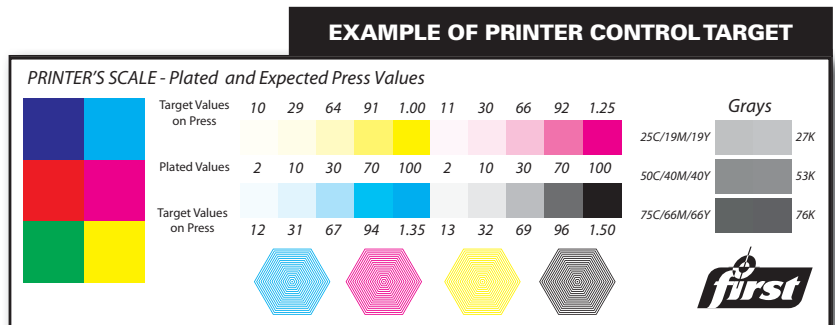


In flexographic platemaking the final dot percentage on the finished plate is often not the same as the input digital dot percentage. Depending on the imaging and processing techniques, the halftone dots may shrink significantly. This can lead to confusion as to the size of the halftone dots on the finished plate where the labeled values and the actual values are different. Additionally, cutback curves and/or color management adjustments may modify the dot percentages that are sent to the imaging device thereby changing the values from the input digital values.

To facilitate process control, tone scales can be imaged two ways: “linear,” where the desired values are achieved on the printed plate; and “adjusted,” where the values are different from the input digital values due to a purposeful adjustment. These two approaches are explained more fully below. Regardless of the approach, if a patch is labeled with a value indicating its dot area, it should match the final plated dot area.

For the printer, it is vital to have a control bar (set of patches) imaged consistently with known values on every job in order to print in a consistent and repeatable manner. The values for the desired plate tint patches should be discussed and agreed upon with the printer.

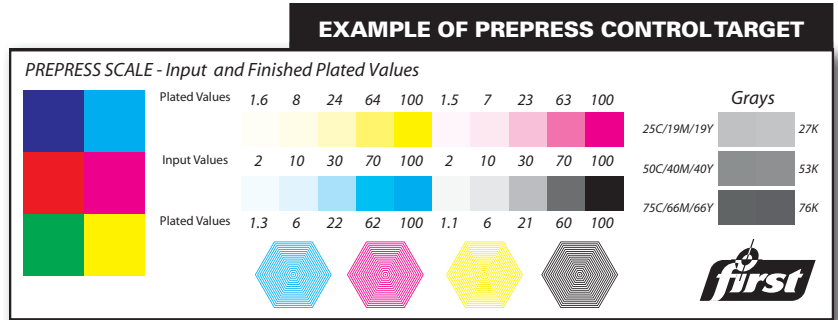
1. **Printer (Linear) Scale:** The Printer Scale is a control scale used by the printer to monitor and control press settings, components, and materials. Using a linear scale is particularly useful for the printer when multiple prepress providers and platemaking systems supply the printer. With multiple suppliers, many varied compensation curves may be used during output. The Printer Scale must be labeled with known finished values rather than input (mask or film) values. For example, on the Printer Scale a tint labeled “30%” must measure ~ 30% (within accepted tolerances) on the plate after exposure, processing and finishing. By providing “linear” values, the printer has the necessary tool to monitor and control dot reproduction regardless of the platemaking variables. The Printer Scale must be included on every optimization, fingerprint and characterization run to facilitate proper press set-up and run conditions.



**20.4.3d: Printer Control Target:** The critical difference between the Printer and Prepress control target is the dot size placed in the file (and output onto the plate) for each dot area patch.

**2. Prepress (Adjusted) Scale:**

The Prepress Scale is created under the same conditions as the live image; any near neutral calibration curves, characterization curves, dot gain compensation, or bump curve, etc. that is applied to the image should also be applied to the Prepress Scale. This scale represents the live image and is used by the prepress provider, platemaker, and printer to confirm the appropriate compensation has been applied to the live image. The Prepress Scale can be printed with the job or removed from the plates prior to printing – the printer and customer must decide whether or not to leave it on the job. Regardless, the Prepress Scale must be plated in order to be measured on the finished plate as part of the plate’s CoA. By verifying both the Printer and Prepress Scales on the plate, the platemaker can easily determine if the platemaking process is in control or not, as well as determine if the appropriate adjustment has been made to the live image.



The target values must have production tolerances placed around them for both the prepress/platemaking process and the printing process. Both scales must also be included on the contract proof.

Using both Printer and Prepress Scales provides an important “check and balance” mechanism. Mistakes and unacceptable variations in prepress/platemaking can be easily identified and corrected prior to going to press. When the print does not match the proof, the printer is able to quickly determine whether the problem is a printing problem or prepress problem. If the Printer Scale is printing within the agreed upon tolerances, then the printer can be confident the press is set-up correctly. If not, then adjustments to the press must be made to achieve the target range identified in the Printer Scale. The goal is to obtain the desired print result while minimizing press downtime and waste.

- **Labeling Tone Scales:** Each type of scale must be clearly labeled in the file and on the plate to avoid confusion. For example, label “Printer”/“Linear” and “Prepress”/“Profiled”/“Adjusted” next to the corresponding scales. With both tone scales, the printer may choose to have values for each patch placed in the file above or below the patch for clarity. There are two approaches for labeling tint patches. The printer may choose either labeling approach or both:
  1. Label each patch with the plated tint value. FIRST recommends labeling the plated tint value on the Prepress Scale because it is a QC tool for the prepress/platemaking process.
  2. Label each patch with the expected printed tint value. For example, if the 30% plated tint patch is expected to print as a 55% tint on press, the label for the 30% plated tint patch should be 55%. The expected printed tint value is determined during the press fingerprint trial.
- **Tone Scale Placement:** Placement of tone scales is dependent on product design and layout. Ideally, a Printer Scale should be placed on both the operator and non-operator side of the press so the press operator can control pressure settings across the press. FIRST recognizes this is not always possible. Typically, the Prepress Scale is located in a non-print area of the plate and removed prior to printing; therefore, only one is required on each plate.

**Thickness: Caliper & Gauge**

IMPORTANCE	Caliper is the thickness of a single sheet of paper, paperboard, or combined board. Gauge is the term used to reflect the thickness of a single layer of film. Paper is reported in mils or thousandths of an inch, paperboard in points, and film in gauge. 1 mil = 0.001"; 100gauge = 0.001"; and 20 point = 0.020". Thickness is important because wide variations can cause the final print impression to be uneven. For paper substrates, caliper and smoothness are inversely related. Higher caliper papers tend to be rougher while lower caliper papers tend to be smoother.
PROCEDURE	<b>Paper:</b> Tappi T411 om-89; Tappi T551; ASTM D645; ISO 534. <b>Paperboard:</b> Tappi T411 om-89; Tappi T551; ASTM D645; ISO 534. <b>Corrugated:</b> Tappi T411 om-89; ISO 3034. <b>Film:</b> Tappi T411 om-89.
SPECIFICATION	Established by the customer and measured using a micrometer.
TOLERANCE	<b>Paper:</b> +/- 5% of target caliper. <b>Paperboard:</b> +/- 0.001" (0.0025cm) of target caliper. <b>Corrugated:</b> +/- 0.005" (0.013cm) of target caliper. <b>Film:</b> +/- 10% of target gauge.

**21.1.2.2 Surface Properties – Influencing Print Quality**

**Brightness**

IMPORTANCE	Brightness is the measurement of blue light (457nm) reflectance. Higher numbers on a 0-100 scale indicate a brighter surface. Most white papers have a brightness of 60% - 90%. The brightness of a substrate will influence the intensity of printed color, and the perception of print contrast. High brightness substrates can improve bar code contrast and scannability. Brightness is influenced by the fillers and pigments added during substrate manufacturing as well as by the addition of optical brighteners.
PROCEDURE	<b>Paper:</b> Tappi T452 om-98; ISO 2470: 1999. <b>Paperboard:</b> Tappi T452 om-98; ISO 2470: 1999. <b>Corrugated:</b> Tappi T452 om-98. <b>Film:</b> Tappi T452 om-98.
SPECIFICATION	Established by the customer.
TOLERANCE	<b>Paper:</b> +/- 2% <b>Paperboard:</b> +/- 3% <b>Corrugated:</b> +/- 3% <b>Film:</b> +/- 3%



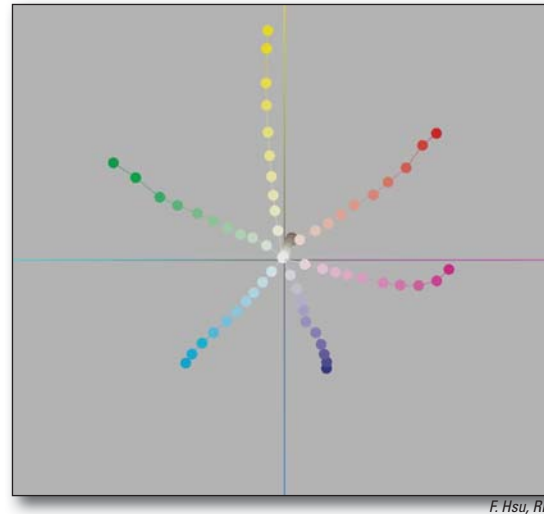
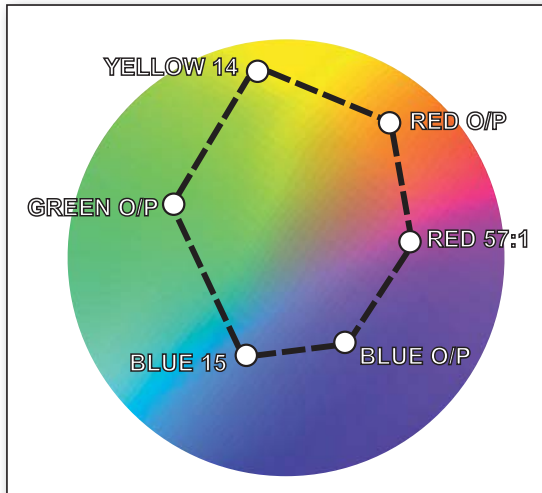
*D. Clark, RIT*

**21.1.2.2a: Brightness:** The brightness of a substrate influences the intensity of the printed color and the perception of print contrast.

### 21.2.4 Optimizing the Process Color Gamut

The 4/color process color gamut of a printing press is usually smaller than that of other output devices (proofing systems, displays, etc.). Therefore, maximizing the color gamut of the printing system is critical. Maximize the printable gamut by optimizing the ink formulation (strength), anilox engraving, and plate & mounting tape materials to achieve the highest possible densities while minimizing dot gain and maintaining gray balance. Refer to Print Section 20.4.1 - 20.4.4 for detailed information.

When optimizing the color gamut, the goal is to increase chroma ( $C^*$ ) while maintaining hue angle ( $h^\circ$ ) and lightness ( $L^*$ ). In practice, all three components change at different rates as the ink strength is increased. The key is to not let hue angle and lightness change too much. Often, as ink strength increases, at some point there will be a “hooking” of the hue angle, resulting in a significant shift in the hue of the ink. Printing at this level presents two problems: undesirable color change resulting in a reduction in the size of the color gamut; and, a condition where as ink strength varies there are large swings in hue and overall color. It is better to operate at an ink strength where normal variations result in minor hue angle changes. Additionally, it is important to evaluate the overprint colors (red, blue, and green) to minimize changes that may occur in the overprints while the individual process colors perform acceptably.

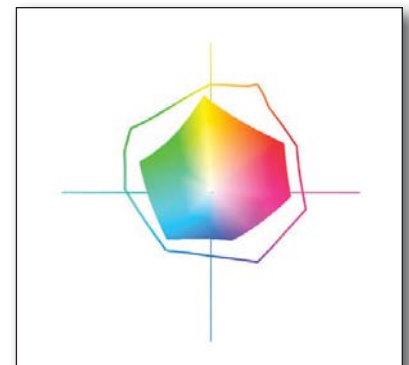


F. Hsu, RIT

**21.2.4: Process Color Gamut:** This graph illustrates the printable color gamut achieved using FIRST recommended process ink pigments.

### 21.2.5 Printing with an Expanded Color Gamut

Expanded gamut refers to any process that expands the range of reproducible colors beyond that typically available with standard four-color process printing (CMYK). Expanded color gamut can be achieved by increasing solid ink density, increasing the whiteness & reflectance of the substrate, or by adding extra ink sets. Expanding the color gamut by increasing ink density is limited, as the hue angle of the ink tends to curve away from pure with increased ink film thickness. Adding extra ink sets is what is generally referred to as “expanded color gamut” printing. This technology can expand not only to the outer edges of the color gamut with the most saturated colors, but also expand to include the purest pastels and semi-saturated colors that are often missing using traditional CMYK technology. It is important to recognize there are currently no industry standards relating to expanded color gamut. FIRST recommends using single-pigment inks when adding extra ink sets. The printer may choose to use a commercial system with pre-defined ink sets or create a custom



**21.2.5a: Expanded Gamut:** Adding additional inks to the traditional CMYK, 4/c process printing, expands the printable color gamut.