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Extended Gamut Printing in Flexographic Packaging and the Impact of Brand Management

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EXTENDED GAMUT PRINTING IN FLEXOGRAPHIC PACKAGING AND THE IMPACT ON BRAND MANAGEMENT

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Abstract

Flexography is the dominant print process in regards to the reproduction of packaging products. Packaging, particular the color and graphics, is an essential tangible element for brand owners striving for brand management. Extended gamut printing is a printing technique that can produce high color saturations on packaging samples, which can have positive implications for brand management. Currently, most information on extended gamut printing is proprietary, making it very difficult for non-print industry members to obtain and utilize information relating to the benefits of extended gamut printing. The aim of this study was to provide evidence that packaging samples with extended gamut printing can positively impact brand management. Both flexible packaging and folding carton samples were analyzed in this study by taking color measurements (through the CIE L*a*b* color space) and calculating chroma to determine color saturation. Process color packaging samples were included for comparison purposes. Extended gamut folding carton and flexible packaging samples yielded chroma values 27.12 and 31.11 higher, respectively, than their process color sample counterparts. In other words, extended gamut printing yields high chroma values, which has positive implications for brand management. The results of this study can provide brand owners with insight on methods for reproducing printed packaging to benefit brand management. This study also shows the color saturation benefits of extended gamut printing, which can entice brand owners to utilize this method for either brand colors or any graphics on a packaging sample.

Acknowledgements

Thank you to Dr. Paul D. Fleming and Dr. Alexandra Pekarovicova for the support provided for the completion of this thesis. Thank you for displaying passion and dedication to research to pass along to students such as myself. You have been huge influences on my undergraduate career; teaching me so much about the world of print technology, while also pushing me to do my best, ultimately helping shape me into the student I am today. My journey at Western Michigan University would not have been the same without you. I would like to extend my thank you to the Lee Honors College for providing undergraduate students with such rewarding experiences to help them in their future careers or further academic studies.

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Chapter 1

Introduction

1.1: Background

"Brand" is one of the most widely used terms in the business realm; it is a critical component of creating value within a company or organization (Miller, 2005). A brand is how organizations differentiate their product from other organizations' products. Brands can convey emotions, experiences, values, beliefs, perceptions, etc. with consumers, and are basically the driving force behind purchases in the marketplace. Furthermore, brands can act as metonyms for organizations, and can create long term associations and relationships between organizations and consumers. Brand owners manage their brands through the construction of customer relationships, by first creating brand perceptions, affinities, associations, and so forth with consumers. Brand management involves both intangible and tangible elements; intangible elements such as emotions and experiences, and tangible elements such as a product and its packaging. In fact, packaging, particularly that with high quality graphics and colors, can be one of the biggest determinants for purchase. Packaging can make a brand instantly recognizable, making it simple for consumers to make quick purchase decisions based on prior knowledge. Packaging can also set a product apart from its competitors at the point-of-purchase through high visual appeal, whether that be high quality graphics or eye-popping colors. As a result, brand owners want their packaging to be printed with great graphics and color quality, which is easily attainable through flexographic printing.

Flexography, often referred to as "flexo," is one of the major printing processes, and involves printing from a raised image carrier. Flexography is one of the older printing processes,

with origins tracing back to 1890. Over the past 126 years, flexography has rapidly evolved, and is now the industry leader when it comes to package printing. Flexography is the dominant form of printing for many types of packaging, thanks to its high quality graphic reproduction, incredible versatility, and economic advantages. Most packaging that consumers come into contact with was printed by a flexographic printing press, utilizing several methods of producing eye-catching brand colors to draw the consumer in. These methods include spot color printing, extended gamut printing, and process color printing; packaging is printed with one of, or some combination of, these three processes. Extended gamut printing is certainly an economical process of great interest to brand owners. The idea of extended gamut printing is utilizing additional colors with the standard four process colors. Extended gamut printing has the ability to produce highly saturated colors that really create the visual appeal many brand owners are seeking with their packaging. Color can be evaluated through the CIE L*a*b* color space, a simulation of human color perception, to determine precise numeric information about a color.

1.2: Problem Statement

Information and research on extended gamut is typically proprietary, making it difficult to evaluate the true impact that extended gamut printing can have for a customer. While research has been done on the field, it is typically done on comparing different extended gamut sequences to see which yields the best print. Furthermore, it is extremely difficult to find any studies that explain the benefits of extended gamut printing to audiences outside of the printing industry. Extended gamut printing can be extremely beneficial for brand owners, however information is simply not readily available to provide these brand owners with the advantage of utilizing extended gamut printing for flexographic packaging.

1.3: Research Objectives

While assumptions can be and have more than likely been made on the topic, the goal of this study is to provide empirical evidence that extended gamut printing positively influences brand management through high color saturations. For this purpose, the CIE L*a*b* color space will be utilized to determine the color saturation values of different extended gamut prints on various flexographic packaging samples. In doing so, this can provide non-print industry audience members with insight into the benefits of extended gamut printing and why it can be a valuable asset to their packaging reproductions.

Chapter 2

Literature Review

2.1: Theoretical Background of Brand Management

2.1.1: Interaction Between Brands and Consumers

Brands drive consumer purchasing habits. In other words, consumers make a lot of purchasing decisions based solely on the brand behind the product. Brand can, and does, result in the purchase of one good over another. Dymott (2010) states "brands are a significant part of almost every business… and [make] selling a product to a consumer with little understanding of a given market easier" (Dymott, 2010). Brands help provide familiarity for consumers who lack knowledge of a particular market segment.

If recognition of brand name alone plays such a large role in consumer purchases, brands will want to ensure their product is instantly recognizable at the point of purchase. Furthermore, brand owners will want their brand to have positive associations with consumers to create and sustain relationships with the consumers—this is the concept of brand management. Brand management involves a myriad of concepts, including (but not limited to) building customer relationships, brand recognition, brand associations, and brand loyalty. While brand management deals greatly with perception and recognition, it also incorporates several tangible elements, such as the product itself, the price of the product, and the product's packaging. Packaging is the medium between the consumer and the brand at the point of purchase. "Packaging is the capstone of brand expression… [it] seals or kills the deal. Within seconds, the package has to help the consumer find the brand on shelf and communicate a number of key messages" (Richards, 2009). The packaging informs the consumer of product specifications and provides a

sensory experience, while subsequently evoking the consumer to perceive quality through prior brand knowledge, ultimately initiating a sale. "Thanks to impressive print packaging, brands can seduce customers into an impact purchase at the point of sale" (King, 2016). This further demonstrates the role that packaging plays in brand management. Packaging can drive sales, which jumpstarts the process of creating customer relationships, brand associations, and brand loyalty, which is the overarching goal of brand management. Several elements of package design aid packaging's role in brand management, but for the purpose of this study, color will be the primary focus.

2.1.2: The Role of Packaging Color in Brand Management

"Brand owners want a harmonization of brand colors across all substrates, applications and geographies to communicate their brand equity to consumers worldwide" (Aurenty, 2013) Color is one of, if not the most, important factors affecting brand management and brand recognition—much research has been done on the role of color's role at the point of purchase. For example, a 2015 study by Pira International rated 32 different attributes of packaging performance using a panel of brand managers. The panel rated each attribute from one to ten based on how important that attribute is to packaging performance. Brand color received a rating of 8.9 out of 10, and finished as the second most important performance attribute. The full results of this study are depicted in Figure 1. Color creates brand

Packaging performance scorecard

Top 10 packaging performance attributes

		Scorecard
1	Recognisable	9.1
2	Brand colour(s)	8.9
3	Preservation of quality	8.9
4	Appeal to the target consumer	8.9
5	Product protection	8.7
6	Shelf stand-out	8.6
7	Quality image	8.5
8	Ease of use	8.4
9	Relevant	8.3
10	Recyclable	8.0

Source: Pira International Ltd

Figure 1: Packaging Performance Scorecard
Source: Pira International, 2015

associations and meanings, especially in regards to packaging, as packaging colors provide consumers with an aesthetic experience to link with a brand name (Kauppinen-Räisänen, 2014). Furthermore, Satyendra Singh, a researcher at the University of Winnipeg, noted that "People make up their minds within 90 seconds of their initial interactions with [products]. About 62-90 percent of the assessment is based on colors alone" (Singh, 2006). As a result, brand owners want to ensure strong colors for consumers to purchase their product.

A majority of studies regarding color and packaging yield similar findings. Concerning packaging, graphics and color play a significant role with consumers. The consumer's first impression of an in-store product is "based on packaging, especially the graphics and color" (Mohebbi, 2014). A 2014 study at the Centre for Relationship Marketing and Service Management in Helsinki, Finland found that packaging color heavily influences purchasing behavior, especially for those consumers making hurried purchasing decisions (Kauppinen-Räisänen, 2014). As evidenced by the aforementioned studies and literature, packaging color is one of the first things a consumer will notice at the point-of-purchase. As a result, brands would benefit from making their packaging color stand out from others; making their brand colors "pop." This visual stimulation can be accomplished through higher color saturations. "Color value and saturation dominate the color hue role in brand perception by customers" (Ghaderi, 2015). In other words, accurate and saturated color reproductions essentially dictate consumers' brand recognition and brand perceptions, ultimately proving the need for saturated colors in correspondence with brand management. It is up to brand owners to find the correct method of printing their packaging to achieve the desired color saturations that so heavily influence consumers.

2.2: Theoretical Background of Flexographic Printing

Flexography is the primary print process used to print packaging. Flexography is the top process for corrugated packaging and flexible packaging, while it is the second-most utilized process for folding cartons (Freedonia, 2016). Table 1 provides the precise market share percentage that flexography holds with different packaging segments. Flexography can produce high quality graphics at high speeds at a reasonable cost, while having the ability to print on a wide variety of substrates. These benefits have allowed flexography to rise to the top of the packaging industry.

Table 1: Flexographic Packaging Market Ownership (2014)

Market Segment	*Percent produced via Flexography*
Corrugated Packaging	69%
Folding Carton	23%
Flexible Packaging	89%

Source: Freedonia Custom Research, 2016

2.2.1: Schematic Overview

Flexography is based on the principle of printing from a flexible, raised (relief) surface. The printing plates utilized in flexography are typically made of photopolymer or some other flexible material such as rubber or plastic. Image areas on a flexographic printing plate are raised; the raised area is the only part of the plate that comes into contact with the substrate surface during printing. These plates are created from digital artwork files through several processes such as photomechanical, photochemical, or laser engraving. Within a flexographic printing press, the printing plate is mounted on a plate cylinder. The printing unit of a flexographic press has the same basic set up displayed in Figure 2. The fountain roller accepts

ink from the ink fountain, and then transfers the ink to the anilox roll. The anilox roll contains tiny, recessed cells that the ink fills up—excess ink is wiped away by the doctor blade. From there, the anilox roll deposits the ink in its cells to the printing plate on the plate cylinder. The substrate passes between the plate cylinder and the impression cylinder; the impression cylinder applies pressure to "push" the substrate on to the ink-covered printing plate, thus creating a printed image on the substrate. Jobs that require multiple colors will have separate printing plates, and print units on press, for each color, and will follow the aforementioned process at each print unit. In flexography, the substrate is typically a large web (roll) of material that enters the printing press through a delivery system. The web moves from print unit to print unit, adding new colors and drying the previous ones at each respective unit, resulting in a finished printed image.

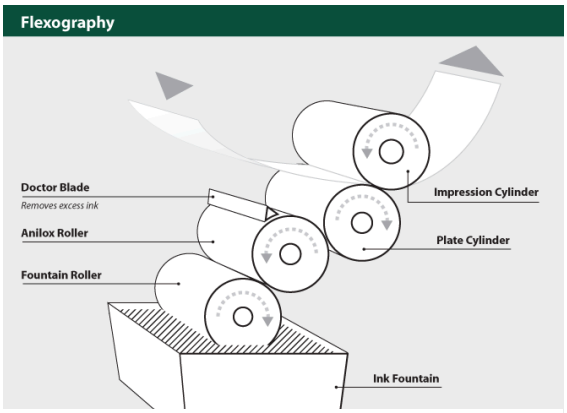


Figure 2: Flexographic Print Unit Configuration
Source: Climate Civic Institute, 2014

2.2.2: Printing Press Architectures

The flexographic printing press comes in a variety of forms. There are "three different architectures for web-fed flexographic printing presses, depending on the arrangement of the printing units" which are central impression, stack, and in-line flexo presses (Bobst, 2016). These different configurations can also be suited for particular web-widths (i.e. wide-web or narrow-web). Packaging typically requires wide-web presses, as narrow-web is usually reserved for tags and labels. Flexographic presses sport various numbers of print units, with some presses utilizing up to ten, meaning ten colors could be applied to a job in one pass through the press. The different press architectures may result in varying amounts of print units, and may

exclusively produce a specific product type. For example, “wide web central impression presses with a range of 6 to 10 colors dominate the flexible packaging segment of the industry” (Tuccitto, n.d.). Familiar flexible packaging products could include potato chip bags, paper towel plastic wrap packaging, or dog food bags. Meanwhile, folding cartons, which would be most household “box” products, are commonly printed on wide-web in-line presses.

2.2.3: Inks and Substrates

Inks utilized in flexographic printing fall under three main categories: solvent based, water based, and UV curable inks. In general, flexographic inks are fast drying inks with low viscosities (due to press specifications). The flexographic industry demands that printing inks provide consistent ink quality, high color strength, good gloss, good printability, and high resistance properties for the end-use; qualities important for achieving the saturated colors that aid brand management (Meyer, 2006). Solvent based inks are most common in packaging applications; these inks require strict viscosity control to ensure consistent and stable color throughout the press run. UV curable inks are becoming more popular with flexible packaging and folding cartons, as these inks “enable packaging printers to improve print quality, mileage and press performance… [with] greater adhesion to a wider range of substrates and improved performance on many variable printing techniques” (Spaulding, 2009). Due to the many applications of packaging, flexographic printing is suitable for a plethora of substrates. Paper, paperboards, films, foils, and plastics are all utilized in the packaging realm.

2.2.4: Markets and Products

Much like the wide variety of substrates available in flexography, a wide range of market segments and products are possible with flexography. Tags and labels, folding cartons, flexible packaging, corrugated, newspaper, and envelope are just some of the market segments

flexography can tackle. As previously stated, flexography is arguably the leader in packaging, which accounts for many everyday items such as:

- Folding cartons: cereal boxes, macaroni boxes, small pharmaceutical boxes
- Flexible packaging: chip bags, candy wrappers, cookie packaging
- Corrugate packaging: shipping containers, beer cases

Of course there are thousands of other examples of flexographic packaging as well. The printing industry is an ever-changing industry, and flexography is no exception. As a result, the market for print media is always changing. Figure 3 shows the production volume of different flexographic market segments. As evidenced in Figure 3, flexible packaging is expanding, while folding carton and corrugated has regressed. The rise in flexible packaging has a lot to do with consumer preference. Consumers are now looking for convenience and portioning, and flexible packaging is able to accommodate these desires (Freedonia, 2016). The rise of flexible packaging has also resulted in a diminishing market for folding cartons. While flexography still has a relatively strong presence in folding cartons, these trends indicate that may not be the case in the future. Regardless, Figure 3 still indicates a sizeable volume of folding carton production, validating their relevance to the study at hand. Overall, flexography should continue to dominate the market on packaging, making it

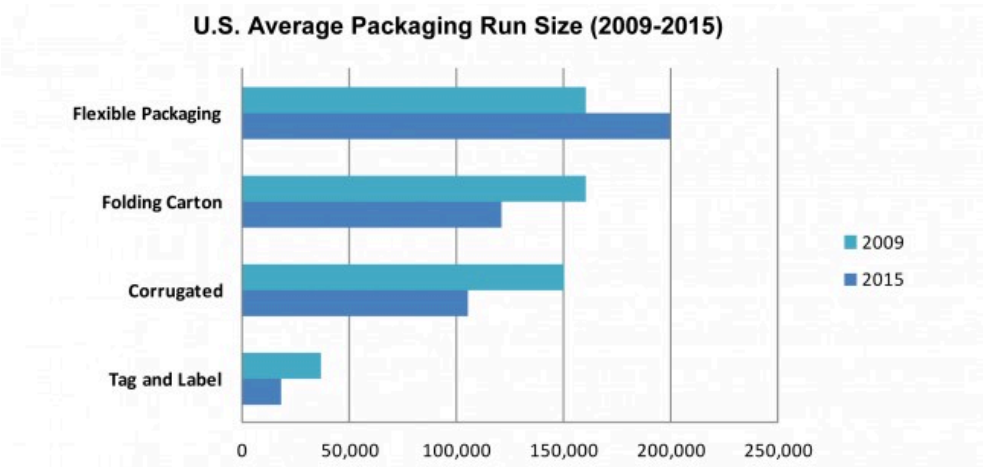


Figure 3: Average Packaging Run Size
Source: Freedonia, 2016

the ideal print process to study in regards to extended gamut printing's impact on brand management.

2.2.5: Advantages

"One reason that flexography presses are used for [packages] is because flexographic presses are capable of producing great quality packaging on many different substrates at the least expensive cost" (Freddo, 2006). Within this quote, Chris Freddo, vice president of New York Label and Box Works, perfectly summed up the main advantages of flexography in relation to packaging: versatility, quality, and cost. Versatility relates the ability to produce high quality print on a wide variety of substrates. Due to the compressibility and flexibility of the image carrier, flexography is able to print on virtually any packaging substrate. Across these substrates, flexography is able to achieve high quality colors and graphics, making it ideal for the goal of brand management. The high volume of packaging produced via flexography validates the claim that flexography produces high quality prints, due to the fact that brand owners would most likely seek a different printing process if flexography was not meeting their branding demands. Furthermore, flexography is able to print at very high speeds, averaging around 750 feet per minute (Hrinya, 2015). The press speeds contribute to flexography being one of the most economical printing processes. The fast-plate making process, smaller press sizes, and high press speeds compared to other printing processes all make flexography an advantageous printing option. While flexography is still the primary producer of packaging, it does face competition from other printing processes as well, particularly digital, requiring that industry professionals and press manufacturers continually look for ways to improve the process.

2.3: Color

2.3.1: Color Gamut Overview

A color gamut, quite simply, is "the range of colors that can be produced by the device as specified in some appropriate three, or more, dimensional color space" (Fairchild, 2005). In relation to flexographic printing, the color gamut would be all of the colors that are reproducible with the ink colors on the press. For example, the color gamut of a press utilizing only one color would be all of the tints of that one particular color. As colors are added to the press, those individual colors with their tints are added to the gamut, as well as the colors that can be reproduced by mixing the ink colors. In essence, the more colors a printing press is utilizing, the larger the color gamut capabilities of that printing press.

2.3.2: CIE L*a*b* Color System

The Commission Internationale de l'Eclairage (CIE) is "the primary organization responsible for standardization of color metrics and terminology" (Sharma, 2003). CIE was founded in Berlin in 1913 for the purpose of characterizing colors seen by the human eye. CIE is responsible for establishing color data and color matching functions. In other words, CIE has given humans the ability to add quantitative values and data to color by creating different color spaces. In relation to the printing industry, a particularly significant CIE color space is the L*a*b* space, or CIELAB. CIELAB assigns three separate values on a color to help quantitatively define any perceivable color, the three values being L*, a*, and b*. This color space is based on a three-dimensional model, meaning it can only be represented properly within a three-dimensional space. An illustration of the CIELAB space is shown in Figure 4. The L* value relates to the lightness of a color, where 0 equals pure black and 100 equals pure white. The a* value defines a color in terms of its position between red and green. Negative a* values

indicate green while positive a* values indicate red. Lastly, the b* value defines a color in terms of its position between blue and yellow. Negative b* values indicate blue and positive b* values indicate yellow. CIELAB is the ideal color space to reference when evaluating brand management, because it is a device-independent color space based on physiological characteristics of color that aligns with human color perception.

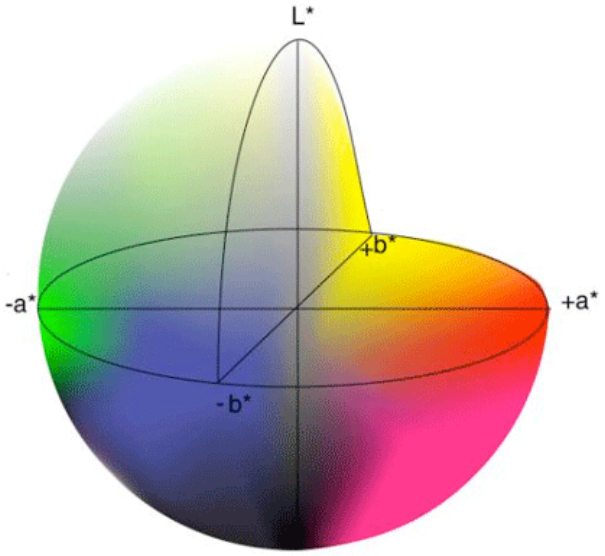


Figure 4: CIELAB Color Space
Source: e-FlexoGlobal, 2008

2.4: Process Color Printing vs. Extended Gamut Printing

Process color printing utilizes the four process colors based on the subtractive color theory of light: cyan, magenta, yellow, and black (CMYK). While once the dominant form of printing, process color printing can no longer sufficiently keep up with the demands that brand owners have for their color reproductions. Brands today rely heavily on spot colors to reproduce their colors accurately. Quite simply, process color printing is extremely limited in the amount of colors it can accurately reproduce. CMYK can only successfully simulate between 45 and 60 percent of the Pantone color library, a dominant source of brand spot colors, while extended gamut printing can reproduce upwards of 90 percent (Ward, 2014).

Extended gamut printing utilizes the four process colors plus additional colors, and is a rapidly growing area of printing. In a survey of 286 printers/converters, over 80% of respondents rated extended gamut printing as an important to extremely important property they would like to

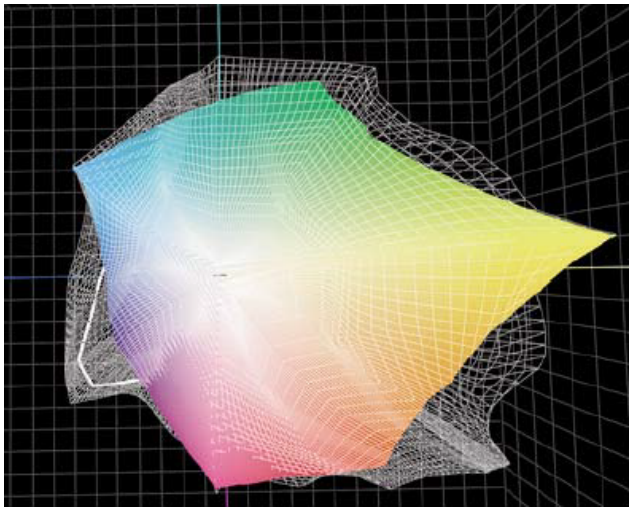


Figure 5: CMYK vs. CMYKOVG Gamut
Source: Sheth, 2013

see improved on press (Kannurpatti, 2016). As a result, much research can still be done on the area of extended gamut printing. A common form of extended gamut is CMYK plus orange, violet, and green (CMYKOVG). The implementation of these additional colors creates a larger color gamut for the flexographic printing press, such as that depicted in Figure 5. The colored area in Figure 5 represents a CMYK gamut, while the wireframe represents a CMYKOVG gamut; it can be seen that the wireframe extends beyond the edges of the colored area. More importantly however, when discussing the impact on brand management, the use of extended gamut printing in flexography should create the opportunity for "deeper, more saturated ("eye-popping") colors than with four-color processes" along with better simulated and more consistent brand colors (Tolliver-Nigro, 2007). A 2015 study by Packaging Products Corporation found that extended gamut printing achieved higher quality prints than process color, as well as higher print densities (Testa, 2015). While providing beneficial information on extended gamut printing, the limitation of Testa's study however, is that density is not necessarily an indicator of color saturations. High color densities can be the product of too much ink being deposited on the substrate, which can actually negatively affect color. Chroma remains the best indicator of color saturation. Another 2013 study on extended gamut printing found that chroma values were higher for CMYKOVG prints, as opposed to CMYK (Sheth, 2013), however this study focused on different extended gamut ink sequences rather than evaluating specific brand colors in flexographic packaging. Overall, studies and information on

extended gamut printing are mostly proprietary, making it difficult to find available resources on the topic. Studies that are available, such as those by Testa and Sheth, simply evaluate the quality of the extended gamut print, without relating it to specific applications or drawing inferences and/or other conclusions, particularly in relation to brand management.

Chapter 3

Methodology

This study utilizes extended gamut empirical color data to make conclusions on brand management based on theoretical research. This study can be broken down into three primary steps:

1. Obtaining and inspecting packaging samples for extended gamut printing
2. Measuring color data on the packaging samples plus chroma calculations
3. Draw connections between empirical data and theoretical research

3.1: Sampling

The first procedure was to obtain flexographic folding carton and flexible packaging samples printed with both extended gamut and process color. Hundreds of packaging samples were collected from various suppliers across a 5-month period. The purpose was to find samples in four different packaging categories:

- Extended Gamut Folding Cartons
- Extended Gamut Flexible Packaging
- Process Color Folding Carton
- Process Color Flexible Packaging

Each sample was inspected with a printer's loupe to verify that the sample was indeed printed via flexography. Printer's marks, such as those depicted in Figure 6, were inspected to determine if the brand colors of the package were printed with spot colors, extended gamut print, or process colors. Spot color samples were discarded. Samples that did not reveal ink colors on printer's marks were inspected with the loupe to determine if any extended gamut or process color

printing had been used in production. The final sample set included seven of each packaging category. Seven was the number of process color folding cartons found in the entire collected set, and therefore served as the sampling number for each category. For the other three categories, seven samples were randomly selected from the entire set that fit the category's criteria.

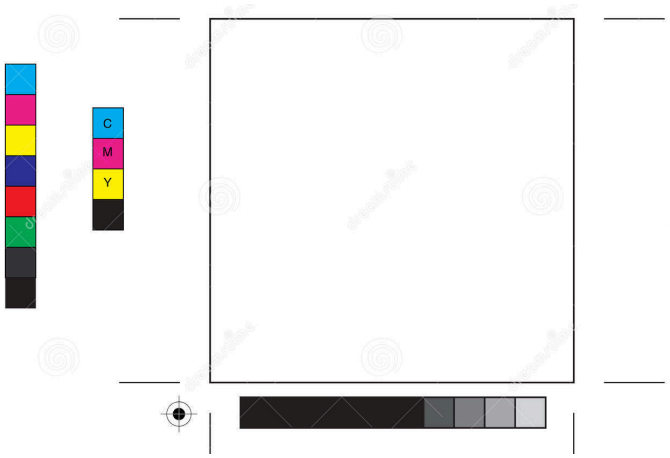


Figure 6: Printer's Marks
Source: Dreamstime, 2016

3.2: Measurement & Calculations

L*a*b* data was gathered from each packaging sample by taking 25 measurements with a calibrated X-Rite eXact standard spectrodensitometer. Measurements were all performed under consistent conditions with the same instrument, and the measurement period was from March 21, 2016 to March 23, 2016. Average L*a*b* values were calculated for each sample from the 25 measurements, and those averages were then utilized to calculate the chroma of each sample. Chroma was calculated using the following formula:

$$C^* = \sqrt{(a^{*2} + b^{*2})}$$

Where C* is the chroma and a* and b* are the redness/greenness and yellowness/blueness values, respectively, of the CIELAB color system.

The average L*a*b* values and calculated chroma are found in Chapter 4: Results & Discussion.

3.3: Analysis of Empirical Data

To determine the impact that extended gamut printing in flexographic packaging has on brand management, chroma was the primary indicator. After calculating chroma for each sample, all chroma values were inspected to draw conclusions. Process color samples were included in the analysis as a comparison factor. Chroma values for extended gamut prints would seem trivial if there were no standard for comparison, they would simply be meaningless data. By including process color chroma values, the advantage of extended gamut printing can be empirically represented, making it easier to draw conclusions.

Chapter 4

Results and Discussion

4.1: Brand Colors on Folding Cartons

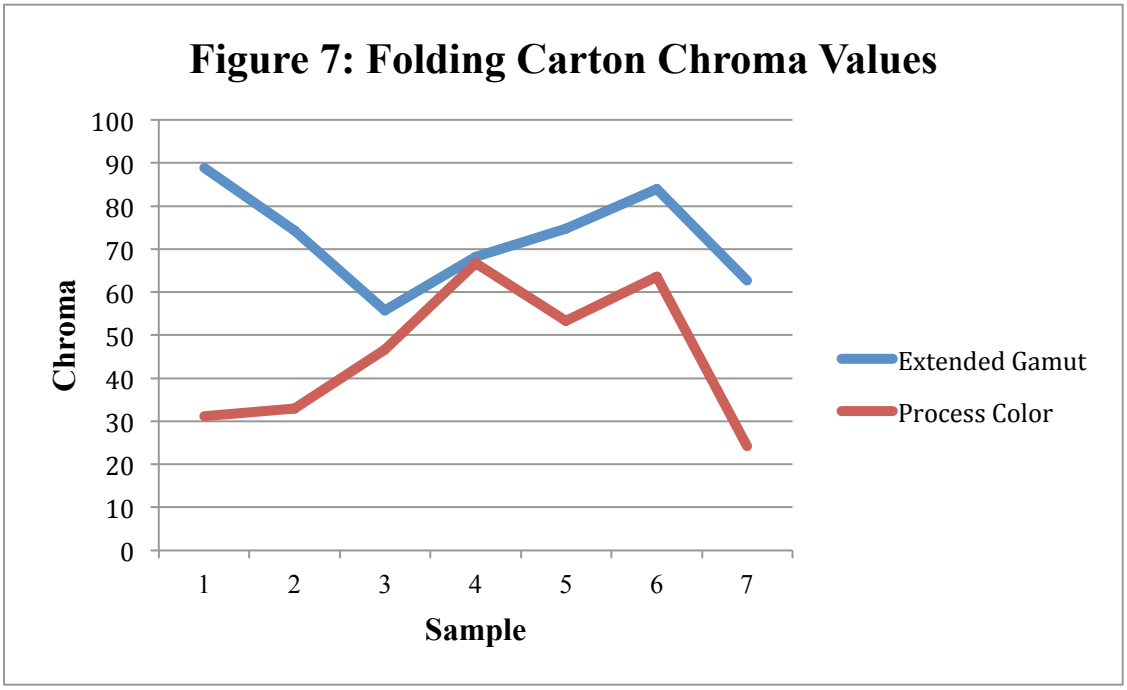
L*a*b* values provides quantitative data to help match color reproductions. The a* and b* were utilized to calculate chroma, which indicates the saturation of a printed color. The chroma values of folding cartons printed with an extended gamut are displayed in Table 2. With these seven samples, the chroma values ranged from 55.75 to 88.89, with a median of 74.33 and a mean of 72.65. Meanwhile, Table 3 provides the chroma values of folding cartons printed with process colors. The chroma values of these seven samples ranged from 24.23 to 66.69, with a median of 46.64 and a mean of 45.53. The process color samples yielded greater chroma variations, which could be attributed to the gamut of CMYK. In other words, some of these brand colors may have fit into the CMYK gamut better than others, resulting in more variable data. A comparison of the extended gamut samples and the process color samples is illustrated in

Table 2: Extended Gamut Folding Carton Average L*a*b* and Chroma

Sample	*L**	*a**	*b**	*Chroma*
1	81.22	-2.86	88.84	88.89
2	66.70	73.54	10.83	74.33
3	22.17	7.91	-55.19	55.75
4	38.73	66.20	-16.32	68.18
5	44.76	60.79	43.39	74.69
6	77.23	20.11	81.58	84.02
7	59.90	-2.47	62.63	62.68
Average Chroma = 72.65				

Figure 7. As evidenced by the chroma data, and the graph in Figure 7, it is clear that the extended gamut folding cartons yielded overall higher chroma values.

Table 3: Process Color Folding Carton Average L*a*b* and Chroma				
Sample	*L**	*a**	*b**	*Chroma*
1	17.52	-7.19	-30.40	31.24
2	40.17	18.88	27.10	33.02
3	48.64	-16.47	-43.63	46.64
4	39.49	56.74	35.06	66.69
5	45.20	-12.68	-51.77	53.30
6	33.50	6.97	-63.21	63.59
7	53.91	-12.35	-20.85	24.23
Average Chroma = 45.53				



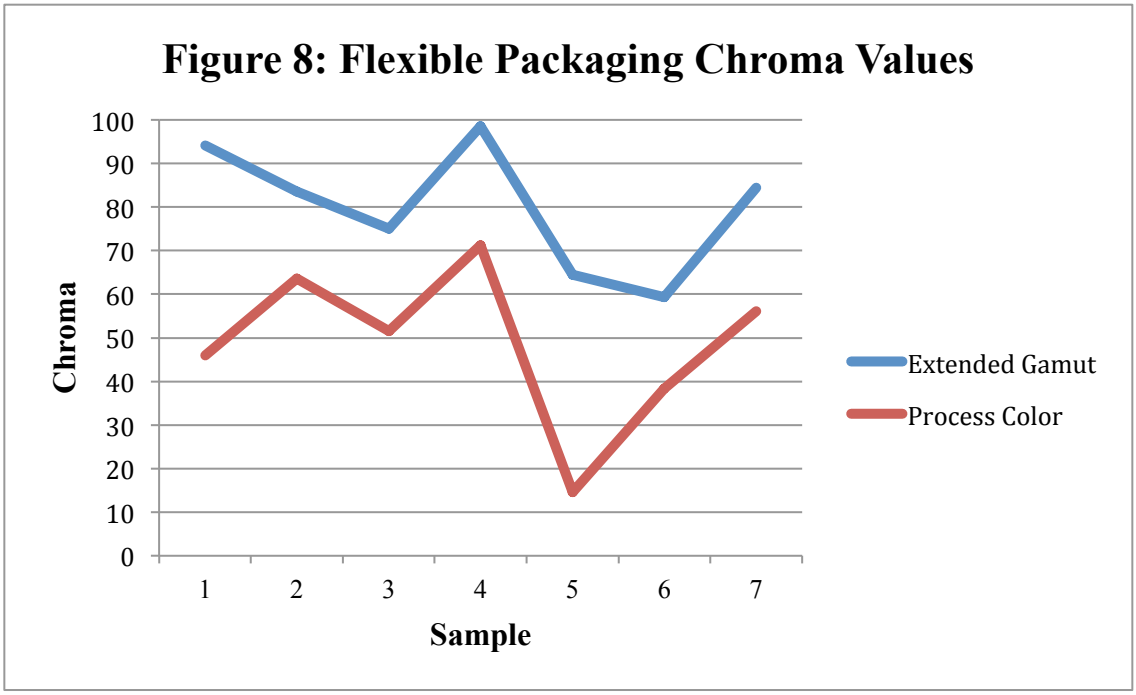
4.2: Brand Colors on Flexible Packaging

Table 4: Extended Gamut Flexible Packaging Average L*a*b* and Chroma				
Sample	*L**	*a**	*b**	*Chroma*
1	61.37	55.82	75.71	94.06
2	44.15	76.14	34.32	83.52
3	69.05	-65.77	36.20	75.07
4	60.05	67.05	72.14	98.49
5	26.44	52.77	-37.04	64.47
6	39.68	56.58	-17.84	59.33
7	52.32	-74.93	38.80	84.38
Average Chroma = 79.90				

The same procedure was followed for the flexible packaging samples. Table 4 provides the L*a*b* and chroma data for the extended gamut flexible packaging samples. As Table 4 shows, the chroma values ranged from 59.33 to 94.06, with a median value of 83.52 and a mean of 79.90. The data for the process color flexible packaging set is displayed in Table 5. It can be seen that the range of chroma values for this sample set was between 14.60 and 63.59, with

Table 5: Process Color Flexible Packaging Average L*a*b* and Chroma				
Sample	*L**	*a**	*b**	*Chroma*
1	80.63	-45.40	7.14	45.96
2	33.50	6.97	-63.21	63.59
3	43.24	-51.58	1.79	51.61
4	41.43	63.62	32.15	71.28
5	22.59	-14.57	0.91	14.60
6	83.26	-35.26	15.08	38.35
7	45.73	-11.67	-54.88	56.11
Average Chroma = 48.79				

a median of 51.61 and a mean of 48.79. The flexible packaging findings relate to the folding carton findings, in the sense that the process color had more variation and a wider range. Again, this could be attributed to some brand colors fitting into the CMYK gamut than others. Furthermore, the extended gamut samples produced significantly higher chroma values than their process color counterparts. A graphical comparison of the flexible packaging data can be found in Figure 8.



4.3: Overall Comparison

When comparing the datasets of all four sample categories, it is clear that the extended gamut samples produced higher chroma values than the process color samples. Overall, the lowest chroma value belonged to the process color flexible packaging (14.60), while the highest chroma value belonged to the extended gamut flexible packaging (94.06). The lowest sample set average chroma was situated with the process color folding cartons, while the highest average chroma belonged to the extended gamut flexible packaging sample set. In both extended gamut and process color, the flexible packaging yielded the highest chroma values. This could most likely be attributed to the substrate properties. Flexible packaging employs many types of films and foils, which could have significantly higher gloss or brightness than the paper and paperboard substrates found within folding cartons. These optical properties of the substrate could contribute to the difference in flexible packaging and folding carton chroma values. Furthermore, flexible packaging substrates are typically nonporous, resulting in the ink staying on the surface. On the other hand, paper substrates seen in folding cartons are porous, causing ink to absorb into the surface, resulting in a lower color gamut.

Chapter 5

Conclusions

5.1: Final Conclusions and Implications

Based on the data collected in this study, it can be determined that extended gamut printing certainly produces high color saturations, especially when compared to process color printing. Color is one of, if not the most important factor of packaging, making the printing process extremely vital for brand management. Color on packaging needs to be accurate, vibrant, but also economical for the brand itself. High color saturations on packaging are a prominent factor in determining whether a consumer is going to purchase a certain product. Once a consumer's eye is captured by the saturated colors of a product's packaging, that consumer is going to make a decision to purchase that product, which ultimately jumpstarts the process of brand management. These high color saturations are also an indicator of packaging quality, and "the success [of a product] is directly related to the quality of its packaging" (Freddo, 2006). In other words, these color saturations can end up making or breaking the success of a product at the point-of-sale. As evidenced by the results of this study, extended gamut printing will help achieve high color saturations, and when coupled with flexography, will create high quality packaging in an economical manner. Based on the theoretical research done for this study on color, packaging, flexography, and brand management, paired with the empirical findings of this study, it can be concluded that extended gamut printing positively impacts brand management for brand owners.

The implications for this study can be beneficial, by providing strong evidence that extended gamut flexographic packaging can have positive impacts on brand management. Brand

owners can take the information in this study, and utilize it to determine how they want their packaging to be reproduced by a print facility. This study could be particularly useful for startup companies or unfamiliar brands, who may be seeking a way to help their packaging stand out against instantly recognizable brands who certainly utilize spot colors on their packaging. The extended gamut printing would be cheaper than using spot colors, and can still produce high color saturations that create great visual appeal for consumers at the point-of-purchase. This study could also provide insight into the benefit of extended gamut printing over four-color process printing. Even for brands who are committed to spot colors for reproducing their brand color, extended gamut printing could be used for non-brand colors to help all packaging graphics to "pop," resulting in even more consumer appeal. Overall, this study can help provide new ideas for printing packaging to brand owners, or validate what they are currently practicing.

5.2: Limitations

Because extended gamut information is typically proprietary, it was difficult to obtain a lot of extended gamut packaging samples. The sampling portion of the procedure was a lengthy process due the lack of public extended gamut information. Companies within the print industry were not willing to share information on their extended gamut prints, including the sharing of packaging samples. As a result, the sample size of this research study may not be representative of the flexographic packaging as a whole, however the theoretical research backing this study would imply that the sample size represents adequately. Furthermore, only two niche segments of the packaging segment were considered for this study. Tags and labels, corrugated packaging, as well as packaging produced from other printing processes (i.e. lithography and gravure) were not considered for this study.

5.3: Recommendations

Further studies relating extended gamut printing on packaging and brand management can expand on the methodology utilized in this research project. For example, tags/labels and corrugated packaging could be included in future studies relating to extended gamut printing and brand management. As referenced in the limitations section, future studies could also expand into packaging printed via other printing processes. Due to the variation in chroma values between the folding cartons and flexible packaging samples, future studies could evaluate substrate properties and see how they incorporate into the relationship between extended gamut printing and brand management. For example, optical properties of the substrate, such as gloss, brightness, and opacity, could all be measured to see how that impacts the chroma of different packaging samples. Future studies could also incorporate primary research, such as surveys or focus groups, to evaluate brand management implications.

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