Improving Image Quality by Using ICC Profile in Litho-Offset Printing

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ABSTRACT

Color plays a crucial role in things we use and buy, and for those who design, making sure color is applied, shown, and printed correctly is an important part of their job. Because the majority of the phases in the design process are now completed digitally, designers are depending more heavily on their computers and monitors to ensure color accuracy. Designers must first achieve the highest level of color fidelity possible.

So, what exactly is an ICC Profile? ICC profile is a set of data that characterizes a color input or output device, according to the International Color Consortium (ICC). The profiles usually explain the color characteristics of a specific device.The profiles typically describe the color attributes of a particular device. Simply, every device that displays color can be assigned a set of profile, and these profiles define the color gamut that will be displayed by these devices.

We can use an ICC Color Profile to simulate how one device sees colors using a different device. We can use the ICC Profile to convert colors between devices so that they match. Soft proofing is the term used in the printing industry to describe this procedure. Soft proofing allows us to view a depiction of how a physical print will look on our screen before printing it. If we discover a flaw, we can fix it by making more alterations to the image until it resembles (as closely as feasible) the original.

This research aims to study the effect of applying ICC profile on the quality of the printed image in litho-offset ,where the researcher prepares a print surface (plate) added to it a characteristic file and another without ,printing the two surfaces on the same printing machine under the same conditions on the same kind of paper, and after printing the measurements are made for the density of the ink film and the dot gain and compare the results with one of the international standard specifications of the printing industry (ISO)

Key Words: ICC Profile,Soft Proofing, Density, Dot Gain

Introduction:

Color plays a crucial role in things we use and buy, and for those who design items like these for a living, ensuring color is accurately applied and one of the most important aspects of their work is how it is portrayed. Because the majority of the phases in the design process are now completed digitally, designers are depending more heavily on their computers and monitors to ensure color accuracy. To achieve the highest level of colour accuracy, designers must first get familiar with a modest set of data known as the ICC Profile, which plays a minor but critical part in the design process.

The ICC profile is based on the use of an ICC profile. Each print component must have its own profile, in order to improve the print result

All printing materials have their own surface, paper may be matte or half glossy, also white or textured. Also, the type of ink used varies from company to company, so it is highly recommended to use the ICC profile associated with paper and printing machine and ink.

The only ICC profile you should use is the file that matches the paper, ink and printing machine set, and if the ICC profile is not suitable for the type of paper used or ink, switch to different paper or ink that fits the file used.

Research Problem

The problem of the search lies in the many difference that occurs in the result of printing between what the customer sees on the screen and the result obtained which reaches in some

times the refusal of the customer to receive the job, or waste of time and raw materials and thus increase the cost of the calculated value, and may be the reason for this difference the inappropriateness of the materials or machine used in printing in the production of the desired form

Research Importance

The importance of research can be determined in reducing the time and cost in the printing process and obtaining a high quality and satisfactory result for the customer according to the type of machines and materials found in the printing press, where it can be created many ICC Profile files in each printing press according to the types of materials and machines in it, and these files are saved within the operating system so that the file can be used then

Research Objective

This research aims to use icc profile to print correctly and accurately without problems and waste time and materials, resulting in a lower cost of the final print.
The application of ICC Profile on the file gives a clear view of whether the machine that will be used in production with existing materials can produce the required colors from the client or not.

Research Questions

1- Does the use of the ICC color profile reduce production time and cost in the printing process and reduce the difference between the client and the printing press?
2- Does using ICC color profile improve the quality of printed images?

Research Methodology

The researcher used the experimental descriptive method where she conducted a printing experiment using one of the characteristic files and the same experiment without using any special files, then printing the two files and conducting the measurement process on the print and comparing the results with one of the standard ISO specifications to see the difference and which is better.

Background:
Which ICC Profile Should I Use?

This guide will show you how to choose the right ICC Profile for printing. To do so, though, you must first understand what a Color Space is. Both are intertwined, and if you don't know what a Color Space is, you won't know which ICC Profile to employ. When printing or distributing your images, it's critical to select the correct Color Space. Yes, it is correct. The importance of the Color Space can't be overstated.Yes, it is correct. The Color Space is significant because it has an impact on what others see. Many photographers, however, will rely on luck. Let's start with a definition of a Color Space, then go on to the ICC Profile.

Understanding Color Space

The Color Space determines the range of colors in an image. To take a simple example, if we had a color space that only included Red and Blue, any photos using that color space wouldn't be able to display Green. Instead of displaying Green, you would see a different color like red or blue or a combination of the two.
While this is an extreme example that would never occur, it is common in editing to produce colors that are outside of one or more of the Color Spaces. An image can be displayed in a variety of color spaces.
Some of them are quite enormous, while others are quite small. sRGB is an example of a color space you may have come across. This is a tiny color space that is utilized as an Internet standard. Most modern screens and devices can handle the majority of the colors in the sRGB Color Space. The image below attempts to depict examples of various Color Spaces.

Out of Gamut Colors

There is a limit to the number of colors that a device can produce when we reproduce an image as a print or on screen. The outline of a Color Space for 2200 Matt Paper can be seen in the illustration above. It's worth noting that it doesn't even cover the sRGB Color Space, implying that it can't reproduce all of the colors in sRGB.

When we have a color that is outside of the range of what something can produce, it is said to be Out of Gamut.

When a color is out of gamut for a device, it cannot simply ignore it. It still has to show something. It solves this problem by replacing the color with the closest match it can find.

When there aren't a lot of Out of Gamut colors in an image, you might not notice the difference. However, if there are a lot of them, it can cause color shifts in an image.
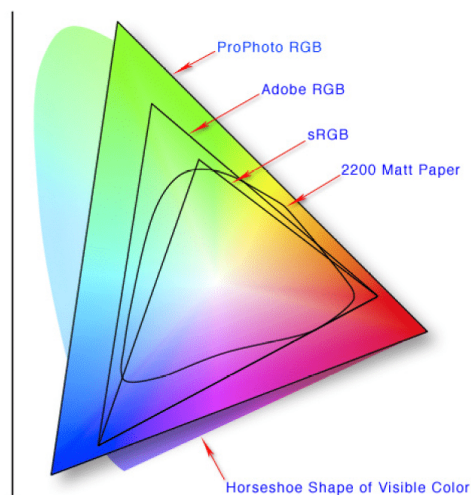
Which Color Space to Use

Now that we've covered Color Spaces, you might be wondering how to put this knowledge to use. When editing photographs, try to use a large Color Space such as Adobe RGB or ProPhoto RGB. Using a diverse palette of colors can help prevent the loss of subtle detail that may rely on subtle transitions between colors.It can also aid in preventing unwanted color shift and keeping photographs looking natural. However, when we share an image with someone else, we must assume that their device can only display a limited Color Space, such as sRGB. That is why the internet uses the sRGB standard. It is a small Color Space, and most modern devices are capable of handling all of its colors.

Most image editing software allows you to convert the Color Space of an image. Consider a few common examples.

Color Spaces When Printing

When printing, you may encounter the issue of Out of Gamut colors. Photo papers and printers have a limited gamut or range of colors that they can reproduce as well. You can even think of it as a different color space. Out-of-gamut colors are also handled by the printer in the same way that they are by a screen.

It will substitute the closest color it can produce in their place. As with the screen, this can cause color shifts in the image, resulting in print that does not match the screen.

The issue then becomes determining which colors your printer and paper combination can reproduce and whether there are any Out of Gamut colors. The ICC Color Profile is the solution to this problem.

Using ICC Color Profiles in Printing

We can use an ICC Color Profile to simulate how one device sees colors when viewed through another device. The ICC Profile enables us to translate colors between devices and ensure that they match. This is known as Soft Proofing in the printing industry. Soft proofing allows us to see arepresentation of how a physical print will look on our screen before we print it.We can then look for

colors that are out of gamut to see if they are causing a color shift.

If we find a problem, we can fix it by making additional adjustments to the image so that it matches (as closely as possible the original finished image). These are proofing adjustments that are only applied to the image that is printed. This means you'll need to work on a copy image, also known as a proof copy.When the proof copy is not soft proofed, it is not uncommon for it to look dreadful on the screen.

Which ICC Profile to Use

Returning to the question of which ICC Profile to use.

A print is made up of two parts: the paper and the printer. The combination of the two determines the color range (or gamut) in the print. You can change the color range by changing the paper or the printer.

One common error that many people make when printing is deciding they don't like the soft proof. They then switch to a different ICC Profile because they believe it will look better. Instead, they should be adjusting the proof copy to match the original image.

Your soft proof will be inaccurate if you choose an ICC Profile for a different paper and/or printer combination than the one you are currently using. Your software is simulating a completely different paper and printer combination. However, the problem is exacerbated by the fact that your printer also employs the ICC Profile when printing.

Printers Use ICC Profiles

When you print an image, you have two options as to how your printer manages colours:

1. You can allow the printer to manage the colours. The printer then does it's best to reproduce accurate colours. However, because it does not know which paper you are using, it cannot make any colour adjustments. Color and tone shifts may occur depending on the image and paper used.
2. 2. The ICC Profile can be used by the software you use to manage and accurately reproduce the image. The ICC Profile provides the printer with the information it needs to accurately represent the image's colours and tones. This method also necessitates that the printer not attempt to perform any colour management.

The ICC Profile is the more accurate of the two options for printing.

Assume you did not use the proper ICC Profile for your paper and printer combination. You are providing the software with instructions on how to reproduce colours and tones, but they are incorrect instructions.

The only ICC Profile you should use is the one that is compatible with your paper and printer.

If the paper you're using doesn't have an ICC Profile for your printer, try a different one. The only other option is to have a custom profile created.

ICC profiles from ECI (old versions)

Below you will find ICC profiles for printing conditions that have not yet been updated to the current ISO 12647-2:2013 standard, as well as older versions of some ECI ICC profiles. These profiles are only provided to allow you to process older files. In all other cases, it is strongly advised to use only the most recent versions of the ICC profiles from ICC.

The download archive **ECI Offset 2009** contains the following ICC profiles:

- ISO Coated v2 (ECI)
- ISO Coated v2 300% (ECI)
- PSO LWC Improved (ECI)
- PSO LWC Standard (ECI)
- PSO Uncoated ISO12647 (ECI)
- ISO Uncoated Yellowish
- SC Paper (ECI)
- PSO MFC Paper (ECI)
- PSO SNP Paper (ECI)
- PSO Coated NPscreen ISO12647 (ECI)

- PSO Coated 300% NPscreen ISO12647 (ECI)
- PSO Uncoated NPscreen ISO12647 (ECI)

ISO 12764-2

| | L * a * b * - Color values according to ISO 12647-2: 2004 / DAM 1 | | | | | | | | | | | |
| | Paper type 1 and 2 | | | Paper type 3 | | | Paper type 4 | | | Paper type 5 | | |
	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
Black	16	0	0	20	0	0	31	1	1	31	1	2
Cyan	54	-36	-49	55	-36	-44	58	-25	-43	59	-27	-36
Magenta	46	72	-5	46	70	-3	54	85	-2	52	57	2
Yellow	87	-6	90	84	-5	88	86	-4	75	86	-3	77
Red M+Y	46	67	47	45	62	39	52	53	25	51	55	34
Green C+Y	49	-66	24	47	-60	25	53	-42	13	49	-44	16
Blue C+M	24	16	-45	24	18	-41	37	8	-30	33	12	-29

| | Tonal values in Sheetfed and Heatset Web offset printing in% | | | | |
	Paper type 1	Paper type 2	Paper type 3	Paper type 4	Paper type 5
Black	1.85	1.75	1.75	1.25	1.20
Cyan	1.55	1.45	1.43	1.00	1.00
Magenta	1.50	1.40	1.33	0.95	0.95
Yellow	1.45	1.25	1.26	0.95	0.90

| | Paper types according to DIN ISO 12647-2:2004 / DAM 1 | | | | | |
Paper type	Description	Mass-per-area g/m^2	L*	a*	b*	Characterization
1	Gloss-coated, wood-free	115	93	0	-3	FOGRA 39L
2	Matte-coated, wood-free	115	92	0	-3	FOGRA 39L
3	Gloss-coated, web	70	87	-1	3	FOGRA 28L
4	Uncoated, white	115	92	0	-3	FOGRA 29L
5	Uncoated, slightly yellowish	115	88	0	6	FOGRA 30L

| | Tonal values in Sheetfed and Heatset Web offset printing in % | | | | | |
| Tone value file / film in % | Paper type 1 and 2 | | Paper type 3 | | Paper type 4 and 5 | |
	CMY	K	CMY	K	CMY	K
40	53.0	56.0	56.0	59.0	59.0	62.0
80	90.7	91.5	91.5	92.3	92.3	93.0

Machines and Materials

Printing Press: Heidelberg SM 74-2 H, Sheetfed offset machine, 2 colors, 2008, Size 74 x 52 cm
Printing Ink: Litho-offset printing inks, produced by SunChemical
Substrate: Coated paperwith glossy surface, 135 gm/sqm.
Name of used screen: is screening Heidelberg
Resolution: 2540
Screen ruling: 175 Lpi
Angles: Black 105, Magenta 45, Cayan 165, yellow 0
Rip: prinect Meta dimension
Soft wear: prinect
Layout: prinect signastation

Research results

Density values for magnta andblack

With no ICC profile		WithICC profile		
Black density	Magnta density	Black density	Magnta density	Sample No.
1.70	1.35	1.73	1.40	1
1.71	1.35	1.71	1.39	2
1.70	1.35	1.70	1.40	3
1.70	1.34	1.70	1.40	4
1.70	1.35	1.70	1.40	5
1.72	1.35	1.72	1.40	6
1.69	1.36	1.69	1.39	7
1.70	1.34	1.70	1.42	8
1.73	1.34	1.73	1.42	9
1.70	1.35	1.70	1.39	10
1.70	1.34	1.70	1.40	11
1.69	1.32	1.69	1.41	12
1.71	1.34	1.71	1.41	13
1.72	1.35	1.72	1.41	14
1.72	1.35	1.72	1.40	15
1.70	1.34	1.70	1.40	16
1.70	1.33	1.70	1.39	17
1.71	1.34	1.71	1.41	18
1.69	1.33	1.69	1.40	19
1.71	1.34	1.71	1.40	20
1.69	1.35	1.69	1.41	21
1.69	1.34	1.69	1.40	22
1.69	1.36	1.69	1.39	23
1.69	1.35	1.69	1.40	24
1.70	1.36	1.70	1.40	25
1.69	1.38	1.69	1.39	26
1.69	1.36	1.69	1.38	27
1.69	1.34	1.69	1.37	28
1.70	1.33	1.70	1.39	29
1.71	1.35	1.71	1.40	30
49.35/30=1.6	40.38/30=1.3	51.07/30=1.7	41.94/30=1.4	
1.85	1.50	1.85	1.50	ISO VALUE

Dot Gain values of magnta and black at 40% and 80% when using no ICC profile

Magenta dot gain at 80%	Magenta dot gain at 40%	Black dot gain at %80	Black dot gain at %40	Sample No.
15	22	15	24	1
15	23	15	25	2
16	24	15	26	3
15	25	14	25	4
15	22	15	25	5
15	24	15	25	6
15	22	15	24	7
15	23	14	25	8
17	24	15	25	9
16	24	17	27	10
15	25	17	26	11
15	22	15	25	12

15	24	15	26	13
15	22	14	25	14
15	23	15	25	15
17	24	15	24	16
15	22	14	25	17
15	23	15	26	18
16	24	14	25	19
15	25	15	25	20
15	23	17	27	21
17	24	17	26	22
16	24	15	25	23
15	25	15	26	24
15	22	14	24	25
15	24	15	25	26
15	23	15	26	27
17	24	14	25	28
15	22	15	25	29
15	23	15	25	30
462/30=15.4	701/30=23.4	451/30=15	757/30=25.2	
10.7	13	11.5	16	ISO VALUE

Dot Gain values of magnta and black at 40% and 80% when using ICC profile

Magenta dot %gain at 80	Magenta dot gain at %40	Black dot gain at %80	Black dot gain at %40	Sample No.
15	23	15	24	1
15	23	14	24	2
14	21	14	24	3
14	21	13	23	4
14	19	13	22	5
14	20	12	22	6
14	20	13	22	7
14	22	12	22	8
14	20	13	23	9
14	21	13	22	10
14	20	13	21	11
13	19	12	21	12
13	21	12	23	13
15	23	15	24	14
15	23	14	24	15
14	21	14	24	16
14	21	13	23	17
14	19	13	22	18
15	23	12	22	19
14	21	13	23	20
14	21	13	22	21
14	20	13	21	22
14	22	14	24	23
14	20	14	24	24
14	21	13	23	25
14	20	13	22	26
13	19	13	21	27

13	21	12	21	28
15	23	12	23	29
14	21	15	24	30
422/30= 14	629/30=21	395/30=13	608/30=20	
10.7	13	11.5	16	ISO VALUE

Results:

By analyzing the results, it's clear that:

1) The average of magnta density if using ICC Profile was 1.4
2) The average of magnta density if you don't use ICC Profile was 1.3
3) The average magenta density in ISO 12647-2 was 1.5
4) The average of black density if using ICC Profile was 1.7
5) The average of black density if ICC profile is not used was 1.6
6) The average black density in ISO 12647-2 was 1.85
7) If you do not use ICC Profile, the dot gain value of the magenta at 40% value was 23.4
8) If you do not use ICC Profile, the dot gain value of the magenta at 80% value was 15.4
9) If you do not use ICC Profile, the dot gain value of the black at 40% was 25.2
10) If you do not use ICC Profile, the dot gain value of the black at 80% was 15%
11) If using ICC Profile, the dot gain value of the magenta at 40% value was 21
12) If using ICC Profile,the dot gain value of the magenta at 80% value was 14.
13) If using ICC Profile,the dot gain value of the black at 40% was 20
14) If using ICC Profile, the dot gain value of the black at 80% was 13
15) The black dot gain value in ISO 12647-2 at 40% is 16
16) The black dot gain value in ISO 12647-2 at 80% is 11.5%
17) The magenta dot gain value in ISO 12647-2 at 40% is 13
18) The magenta dot gain value in ISO 12647-2 at 80% is 10.7

Analysis of Results

1. Thedensity of Magent are corded a higher density value when using ICC Profile, where it recorded a value of 1.4, which his the value closest to ISO, while if ICC profile is not used, the density was 1.3, and the density value in ISO12476-2 was 1.50
2. The density of Black recorded a higher density value when using ICC Profile, where it recorded a value of 1.7, which is the value closest to ISO, while if ICC profile is not used, the density was 1.6, and the density value in ISO12476-2 was 1.85
3. If you use ICC Profile, the black dot gain at 40% was 20 which is closest to the ISO value, while if icc profile is not used, the value was 25.2, while the value in ISO 12647-2 was 16.
4. If you use ICC Profile, the black dot gain at 80% was 13 which is closest to the ISO value, while if icc profile is not used, the value was 15, while the value in ISO 12647-2 was 11.5
5. If you use ICC Profile, the Magenta dot gain at 40% was 21 which is closest to the ISO value, while if icc profile is not used, the value was 23.4, while the value in ISO 12647-2 was 13.
6. If you use ICC Profile, the Magenta dot gain at 80% was 14 which is closest to the ISO value, while if icc profile is not used, the value was 15.4, while the value in ISO 12647-2 was 10.7.

Recommendations

The researcher recommends;

1- Using ICC profile where it gave better results and values closer to ISO 12647-2 and also better quality for printed images
2- The need to make different ICC profile suitable to the nature of the materials and machines in the printing press, because if you used ICC profile and the materials used such as paper or ink are not suitable for this file you will not get the desired result.

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