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The consequences of choosing and specifying brand colors directly from a screen – and the need for brand color management

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Abstract

This paper examines some of the implications of choosing brand colors directly from a software program, based on what the designer sees on the screen. The reason is that more and more graphic arts designers tend to choose colors directly from the screen and to a lesser extent from a physical color catalog such as the Pantone fans. Therefore, designers do not really know what color they have chosen until it is available in the final printed form and this can bring unpleasant surprises. The starting point for this study was the digital solutions from Adobe CC and the web service Pantone Connect. The focal point was sRGB, as Pantone recommends, which also is the standard for internet and mobile devices. Initially, the problem with using a small color space as sRGB to select and define brand colors was investigated. Examples of Pantone colors outside sRGB gamut but still available for the designer to choose without any warnings, have been sought. For example, if the designer chooses Pantone Green C as a brand color, the result would be a color difference of 10.5 ΔE_{00}. The CIELAB values for a color defined in sRGB were compared to the CIELAB reference values for the same color as it will appear as a printed spot color. This gives a color difference ΔE_{00} between how the color appears on the screen versus the physical color as it appears on a print, printed as 1-color solid spot color. Pantone Connect's feature for converting colors from sRGB to Pantone Solid spot color is also investigated. As an example, entering sRGB values for cyan (0/255/255) resulted in a proposal for Pantone 311 C as Best Match, giving a color difference of 17 ΔE_{00} between the reference values for Cyan and the reference values for the proposed Pantone 311 C. In addition, the feature to extract color code values from an uploaded photo was examined. An iPhone screenshot image of Pantone 1505 C (orange) was uploaded to Pantone Connect, which interpreted the color as being Pantone 1585 C giving a color difference of 6.3 ΔE_{00}. The overall conclusion is that it is very uncertain and unpredictable to choose colors directly from a screen. The color differences between the color as it appears on the screen and the color as it appears on the final print can be very large and thus be the cause of the customer's dissatisfaction, even if the customer is partly responsible. As a consequence of the lack of management and control in this area, brand color management is introduced as a new technical concept. It is an extension of traditional color management, so it also includes color selection, color specification, color description and an extended form of color control.

Keywords: sRGB, spot colors, Pantone Connect, color difference, color reproduction

1. Introduction and background

Traditional color management is concentrated on the four Cs: Consistency, Calibration, Characterization, and Conversion (Adams, Sharma and Suffoletto, 2006). These are primarily processes that take place inside a printing company. However, many other important color management processes before and after these four Cs are not included in traditional color management. While all processes after the four Cs, including the color reproduction (printing) and color control, are richly covered by international process standards, like ISO 12647-1:2013, other parts of ISO 12647, and ISO 17972-4:2018 (International Organization for Standardization, 2013; 2018), and guidelines and specifications from industry organizations, e.g. Fogra, bvdm, GATF, GRACoL and Idealliance, it seems that there are virtually no technical guidelines for processes before the four Cs in traditional color management. Namely Color Choice, Color Specification, and Color Description. These are processes typically performed by the brand owner and the designer.

Textbooks for designers are mainly focused on the creative process of choosing colors/hues including which colors fit well together, how to make different color themes, and what the different colors symbolize, e.g. Eiseman (2000), Drew and Meyer (2006). It has not yet been possible to find any textbook aimed at designers that focuses on technical color specification, definition and reproducibility. Although Finkle (2019) on his web blog warns against choosing brand colors that are out of gamut. In addition, none of the well-known textbooks for the printing industry includes these design subjects (Green, 1999; Berns, 2000; Kipphan, 2001; Adams, Sharma and Suffoletto, 2006); some textbooks, however, have brief remarks regarding Pantone colors that cannot be reproduced in CMYK. Fogra (2009) addresses that color matching at the beginning of the production process is not yet defined by a particular standard. Fred Bunting (1998) argues that RGB values that produce the exact color you want on one device will look quite different on another device. However, this argument is just used for implementing color management.

Thus, there seems to be a lack of technical knowledge in this particular area; to select and specify brand colors that can be reproduced across platforms and especially choosing colors from a software program that displays colors in sRGB. Thus, this area does not appear to be subject to the same controlled conditions as all subsequent processes in e.g. print production or media production across media platforms. There is a need to include these first processes into the traditional color management processes, which this study will suggest.

In this first color choice step, the designer and brand owner must decide which color to choose. Initially which hue (red, violet, purple, blue, green, yellow, orange, brown, black, white, or metallic). If designers have the perception that they can choose freely from every conceivable color, the foundation is laid for a difficult production and a dissatisfied brand owner. At this first point, designers want a color that expresses a certain feeling or a certain set of emotional values that a specific company (the designer's customer) posses.

Therefore, color reproducibility is typically secondary or absent to the designer's mind at this stage. The fact, that the chosen color later must be reproducible in print (on paper, plastic, metal, or other substrates), on screens (computer screen, smartphone screen, tablet, TV, etc.), and perhaps even as wall paint, painted chairs and tables – yes, in every conceivable physical and virtual situation – is rarely included in the designer's considerations at this point (Pedersen, 2016). A completely new study (Chung and Liu, 2022) states that brand color reproduction and its conformity assessment require aims and tolerances and designers should specify these.

This color choosing process can be done in several ways. Either from a physical sample or object (e.g. a previous print, a fruit or something else), from a physical color catalog (like a Pantone fan) or from a software program (viewed through a computer screen).

Often, the designer chooses colors based on personal preferences and personal taste. In many cases, they choose colors that are bright and chromatically saturated. However, most of these brand colors cannot be reproduced in printing technologies using the process colors CMYK (Pedersen, 2016; 2018). In addition, many of these colors cannot even be displayed on RGB screens, which a "Gamut Warning" attempts to warn the designer about in Adobe CC. However, these warnings are often ignored, as designers do not know what the warning refers to.

Thus, the problem is passed on to the next link in the value chain, the print providers that now face an unsolvable problem. How to reproduce an irreproducible color. Already here, the future dissatisfaction of the brand owner and designer is founded. Neither the brand owner, nor the designer will ever get to see color they thought they had chosen. Therefore, this color selection process is crucial for all subsequent processes. It becomes central how designers choose the brand color for a brand.

However, over the last decade, we have seen more and more designers and design agencies opting out of investing in physical Pantone color guide decks. Either to save money or because they think a digital solution is easier, or both. Since Pantone has developed into a fashion company, about 200 new colors are released every year, including "The color of the year". That is why professional designers need to invest in at least six physical Pantone fans (Pantone, 2014; 2019) every year: Formula Guide (Coated & Uncoated), Color Bridge Guide (Coated & Uncoated), and CMYK (Coated & Uncoated). However, for a one-man business, 700 to 800 euros is a lot of money to spend each year for a new set of Pantone fans.

In March 2022, an apparent dispute between Adobe and Pantone resulted in that Pantone Color Libraries no longer will be part of the Adobe CC software package. Instead, designers now have to buy a subscription to Pantone Connect that can act as a plug-in for Adobe CC (Pantone, 2022). Thus, designers must subscribe to both Adobe CC and Pantone Connect.

It can thus be expected that even more designers and brand owners in the future will choose their colors directly from their software application. None of the 75 Graphic Design students at the Danish School of Media and Journalism (DMJX) University College has a set of Pantone fans; they choose colors directly from the screen, and this will increase the risk of an inappropriate color choice.

As previous studies have shown, designers and brand owners tend to choose brand colors that cannot be reproduced satisfactorily in CMYK (Pedersen, 2016; 2018). It is also a well-known fact that computer screens do not always display colors correctly, so what will happen if colors increasingly are selected directly from what is seen on a screen?

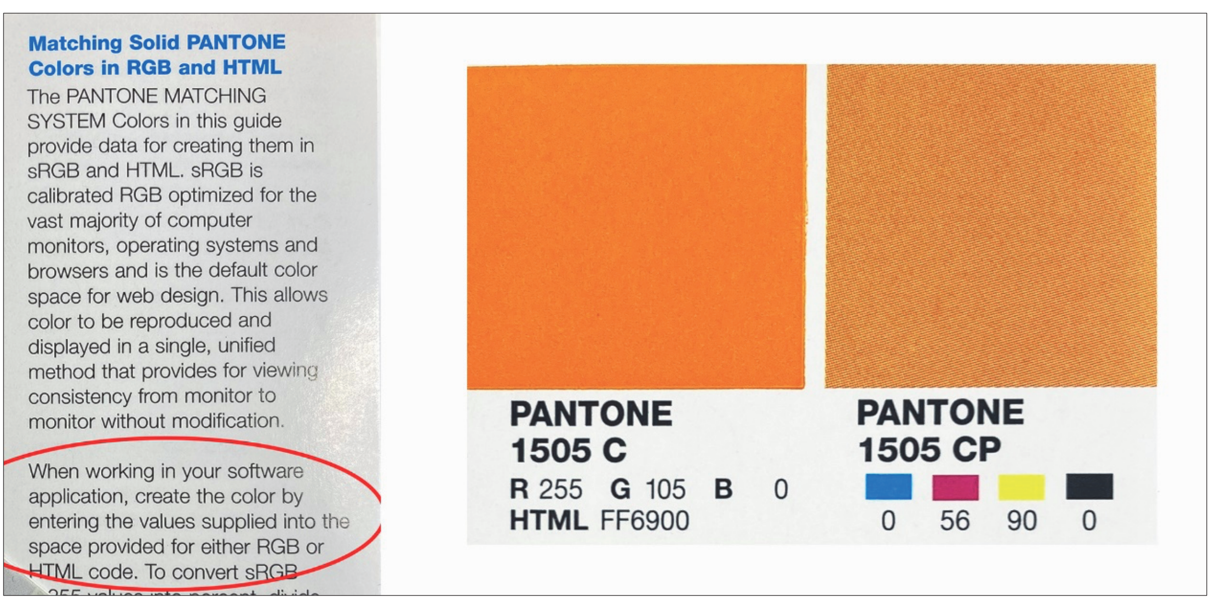
Unfortunately, the designers do not get much help. They are even directly misled. In the same way that Pantone has always specified CMYK values for those Pantone colors that cannot be reproduced satisfactorily in CMYK (Pedersen, 2016), for years Pantone has also specified sRGB values for all their Pantone colors, even for those colors that cannot be displayed through sRGB. Pantone even recommends that the designer starts by entering sRGB values when working with a Pantone color (Figure 1).

Even though sRGB is the standard for web colors and mobile devices (Stokes, et al., 1996; International Electrotechnical Commission, 1999; 2003), AdobeRGB color space is the default in Adobe CC applications, like InDesign and Photoshop. Moreover, the graphics arts industry recommends eciRGB (ECI, 2022; Kleeberg, et al., 2018) since this color space is larger than sRGB and AdobeRGB. Besides, both sRGB and AdobeRGB have a white point D65 which is different from the recommended D50 and therefore eciRGB ensures a more uniform color conversion to CMYK and spot colors in print production (Kleeberg, et al., 2018).

There is only one case where sRGB seems to be the sensible choice, namely when the artwork only needs to be published and displayed through the Internet and mobile devices. If a designer does artwork for both print and web, it could be obvious to recommend working in sRGB, as this will ensure that colors appear uniform across platforms and media although it will be a compromise that excludes many colors. All colors outside the sRGB gamut will be changed and thus be “wrong”.

However, if the designers enter the specified sRGB values for e.g. Pantone 1505 C, they will have specified the color incorrectly from the start, without being aware of it. And if the color subsequently is printed as “correct” spot color, there will be a large color difference between the color they have seen on the screen and the color they see as the printed spot color.

This study will examine the consequence of choosing colors from sRGB as Pantone recommends. For example, what will happen if Pantone’s sRGB values for Pantone 1505 C is entered into an Adobe CC application, meaning what color difference will there be between the sRGB version and the reference spot color Pantone 1505 C?



a) *b)*

Figure 1: Pantone’s recommendation to start with sRGB (a) and the recommended sRGB values for PMS 1505 C, from the Pantone Color Bridge fan (b) (Pantone, 2014)

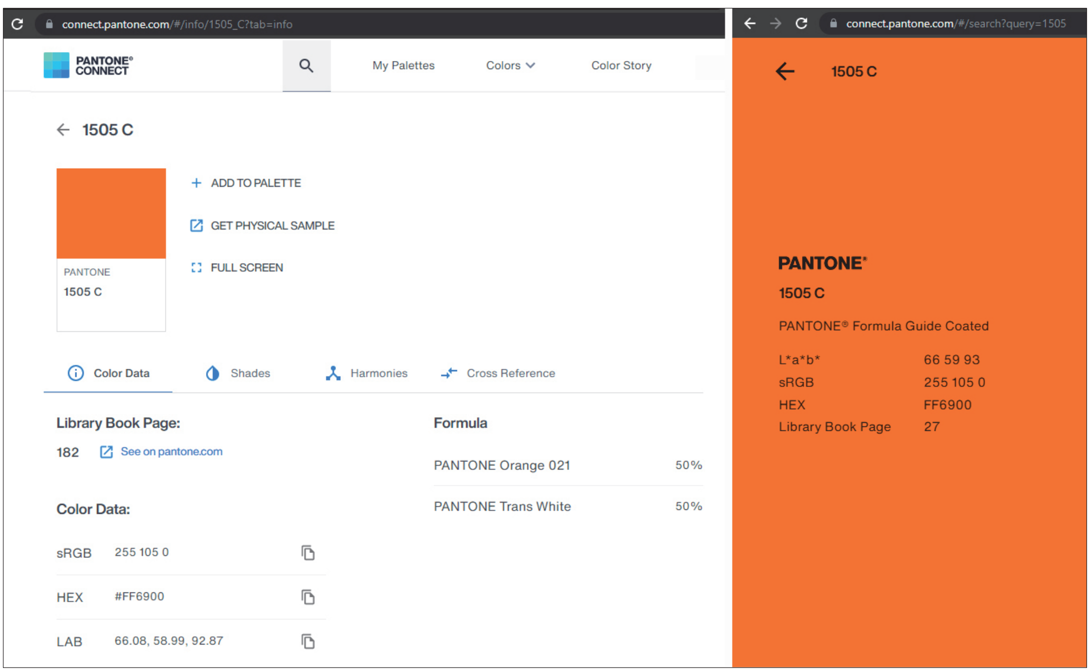
When Pantone specifies both CIELAB values and sRGB values for a spot color, does that mean that the CIELAB values for these sRGB values are equal to the CIELAB values for the reference spot color?

How large color differences ΔE_{00} can be expected for spot colors outside the sRGB gamut?

2. Methods

First, a CIE a^*b^* diagram was drawn where the three RGB color spaces sRGB, AdobeRGB and eciRGB were plotted. This diagram was used to search for areas outside of sRGB where spot colors are likely to have a large color difference. CIELAB values for this gamut mapping were found via Adobe CC, Color Picker, where RGB values were entered, e.g. red: 255 0 0, after which CIELAB values for this were read out (Table 1).

Then, Pantone's web service Pantone Connect was used to search for specific Pantone spot colors in this out-of-gamut area. The reference values (CIELAB and sRGB) were extracted and used in the CIE a^*b^* diagram to plot the Pantone colors (Figure 2) and calculate the color differences.



a) b)

Figure 2: The split image shows the Pantone Connect (Pantone, 2022) search results for Pantone 1505 C: (a) Color Data mode, and (b) full screen mode; the latter method is used when the designers know what Pantone color they want

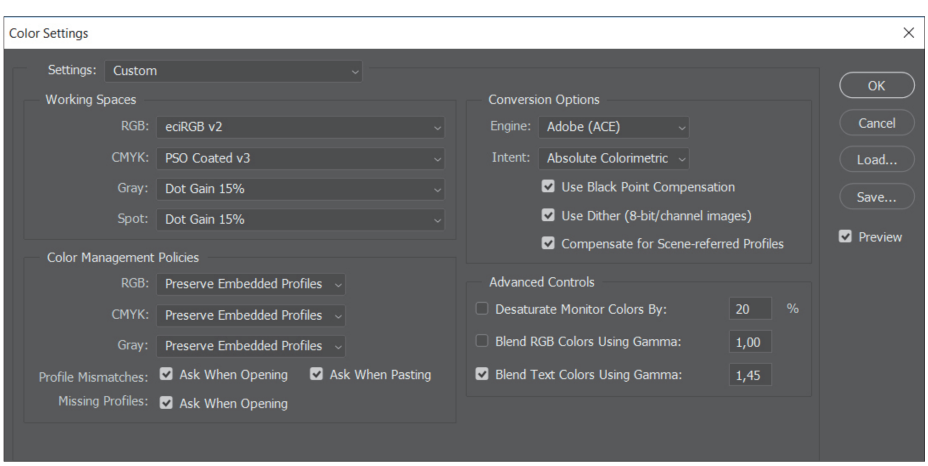
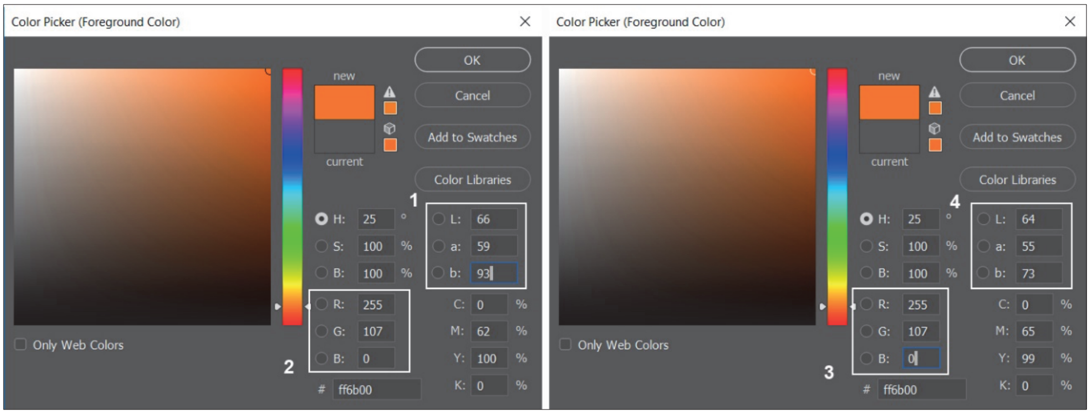


Figure 3: Adobe CC set up: open Color Settings > Working Spaces > Select the appropriate RGB (sRGB, AdobeRGB or eciRGB), and set Rendering Intent to Absolute Colorimetric



a) *b)*

Figure 4: Split image shows the process (a) from CIELAB to sRGB: (1) open Color Picker > enter Pantone's reference values (CIELAB) for Pantone color, (2) the corresponding sRGB values for these CIELAB values are shown > Cancel, and (b) from sRGB to CIELAB: (3) open Color Picker > the found sRGB values are entered, (4) the corresponding CIELAB values for these sRGB values are shown

The CIELAB values for the reference sRGB values were found via the Adobe CC application Photoshop, Color settings according to Figure 3, and process according to Figure 4. CIELAB values for a reference color and for the sRGB version of this reference color were imported into Excel, where the color difference ΔE_{00} was calculated. This color difference value expresses the difference between the optimally printed spot color and the color that a calibrated and profiled screen will display. Thus, the results of this study presuppose that the screens are calibrated, profiled, and otherwise comply with the requirements for viewing conditions, as described in ISO 3664:2009 (International Organization for Standardization, 2009). Otherwise, the results will be even more unpredictable.

3. Results

3.1 Colorimetric reference values for mapping RGB gamuts and Pantone spot colors

In Table 1, CIELAB values for three RGB gamuts are shown. These values are used to plot the gamut edge in a CIE a^* b^* diagram, in Figure 5.

By an immediate assessment of the values in Table 1, it appears that sRGB is the smallest color space while eciRGB is the largest. This also appears to be the case in Figure 5.

The 33 spot colors shown in Figure 5 are all colors that are either on the edge or outside the sRGB gamut. The individual color differences as determined by the process described in section 2 are shown in Table 2, which also shows color difference values for AdobeRGB and eciRGB. Although it appears that Pantone 320 is inside the AdobeRGB gamut, the values in Table 2 show that the color is outside. The reason is that Figure 5 is a 2D representation of a 3D color space and thus the illustration is not quite reliable (Lindbloom, 2007). Although Fogra recommends a maximum color difference of 2.5 ΔE_{00} for spot colors (Bertholdt, 2010), the difference of a maximum of 3.0 ΔE_{00} (Pedersen, 2016) is used in this study, as colors are compared across print and screen media.

If the designers select a color by entering the specified sRGB values, they will get a result depending on what Color Settings they have (sRGB, AdobeRGB, or eciRGB) in Adobe CC application. For example, if the designer

Table 1: CIELAB values for gamut mapping RGB in a CIE a^* b^* diagram, shown in Figure 5

	sRGB			**AdobeRGB**			**eciRGB_V2**		
	*L**	*a**	*b**	*L**	*a**	*b**	*L**	*a**	*b**
Red (R)	54	81	70	63	90	78	63	96	109
Green (G)	88	−79	81	83	−128	87	82	−128	82
Blue (B)	30	68	−112	30	69	−114	33	47	−109
Cyan (G+B)	91	−51	−15	86	−83	−22	86	−96	−26
Magenta (R+B)	60	94	−60	68	101	−51	69	99	−47
Yellow (R+G)	98	−16	93	98	−16	104	97	−11	108

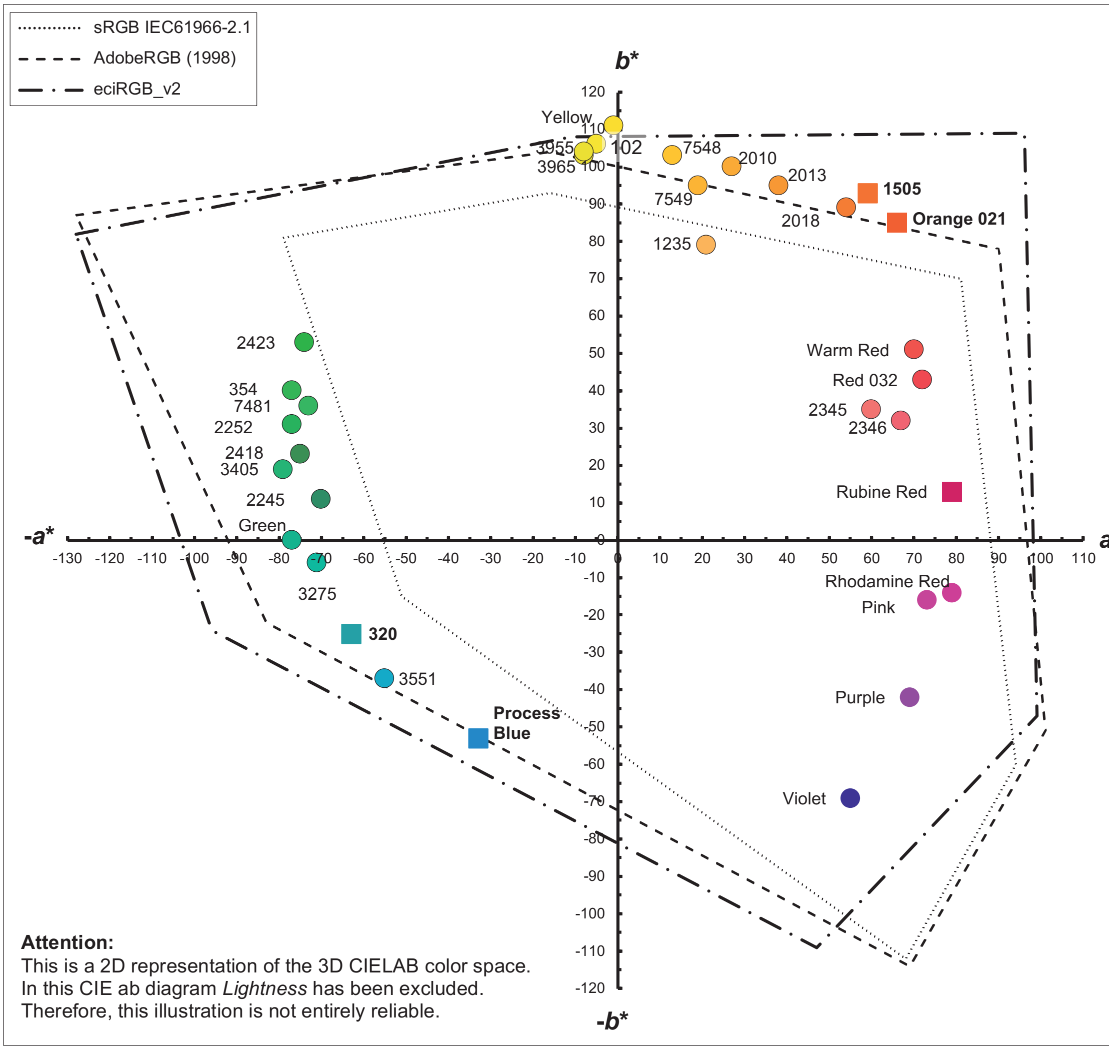


Figure 5: CIE a b* diagram showing 3 RGB gamuts and 33 Pantone Solid Coated spot colors, the five squares are colors that are outside both sRGB and AdobeRGB and with ΔE_{00} beyond 3, according to Table 2*

enters the sRGB values for Pantone 1505 C the resulting CIELAB values are 64/56/73 if Color Settings is set to sRGB, and 66/59/79 if AdobeRGB is applied. Entering the sRGB values will give an ΔE_{00} of 5.9 if Color Settings is set to sRGB, and an ΔE_{00} of 4.5 if Color Settings is set to AdobeRGB.

Even if the designer defines the color as 1505 C and enters the correct CIELAB reference values for this color, the screen will still display the sRGB version or the AdobeRGB version or another RGB version of this color and the difference will be surprisingly large when compared to the printed spot color version of 1505 C.

3.2 Entering sRGB values in an AdobeRGB working space

So far, these studies have been exclusively about the cases where the designer has deliberately set their Color Settings as recommended when entering the reference sRGB values. However, many designers have set up AdobeRGB as their default color space. If the designer is not aware of this problem or does not know anything about the different RGB color spaces, the designer will probably enter Pantone's recommended sRGB values into the AdobeRGB working space. The result of this approach is given in Table 3.

3.3 Extracting sRGB and CIELAB values from a photo

Pantone Connect also offers an option to extract color code values from a photo that needs to be uploaded. However, if the photo is in sRGB, because the designer has used their mobile device to take the photo, the colors are not captured correctly, and the screen does not show the correct color. Thus, the result is not necessarily valid.

Table 2: 33 spot color reference CIELAB and their equivalents determined from sRGB reference values in three RGB gamuts, and the resulting color differences, the color differences ΔE_{00} beyond 3 are marked in red

Pantone solid coated spot color	Pantone connect reference L^*	a^*	b^*	sRGB L^*	a^*	b^*	ΔE^*_{ab}	ΔE_{00}	AdobeRGB L^*	a^*	b^*	ΔE_{00}	eciRGB_V2 L^*	a^*	b^*	ΔE_{00}
Process Blue	48	−33	−53	52	−11	−45	23.7	11.0	49	−23	−51	4.2	48	−31	−52	0.7
2418	45	−75	23	49	−45	29	30.9	10.7	45	−71	24	1.2	45	−75	23	0.0
Green	58	−77	0	62	−46	9	32.5	10.5	59	−72	1	1.5	58	−77	0	0.0
320	53	−62	−25	58	−33	−16	30.8	10.4	54	−51	−23	3.3	53	−59	−25	0.9
2245	45	−70	11	49	−42	17	28.9	10.3	45	−65	12	1.4	45	−70	11	0.0
3551	58	−55	−37	62	−28	−28	28.7	9.8	59	−46	−35	2.9	58	−55	−37	0.0
3405	59	−79	19	63	−52	26	28.2	9.4	59	−79	19	0.0	59	−79	19	0.0
3275	61	−71	−6	65	−45	2	27.5	8.9	61	−70	−6	0.2	61	−71	−6	0.0
2252	57	−77	31	60	−54	37	24.0	8.0	57	−77	31	0.0	57	−77	31	0.0
354	60	−77	40	63	−57	45	20.8	6.9	60	−70	40	1.8	60	−77	40	0.0
1505	66	59	93	64	56	73	20.3	5.9	66	59	79	4.5	66	59	93	0.0
2423	58	−74	53	61	−58	57	16.8	5.8	58	−74	53	0.0	58	−74	53	0.0
7481	63	−73	36	65	−58	41	15.9	5.5	63	−73	36	0.0	63	−73	36	0.0
Orange 021	61	66	85	60	65	71	14.1	4.7	61	66	75	3.4	61	66	85	0.0
1235	81	21	79	80	20	62	17.1	4.6	81	21	79	0.0	81	21	79	0.0
Yellow	89	−1	111	89	0	87	24.0	4.4	89	0	97	2.5	89	0	102	1.6
2010	79	27	100	77	24	80	20.3	4.3	79	27	89	2.5	79	27	97	0.7
2018	68	54	89	66	51	74	15.4	4.3	68	54	80	2.9	68	54	86	0.9
2013	75	38	95	73	34	77	18.5	4.2	75	38	86	2.4	75	38	95	0.0
7548	84	13	103	83	11	84	19.1	3.7	84	14	93	2.2	84	13	99	0.8
3955	88	−8	104	88	−8	86	18.0	3.5	88	−8	95	1.7	88	−8	100	0.7
3965	87	−8	103	87	−7	85	18.0	3.4	87	−7	94	1.7	87	−8	99	0.7
102	90	−5	106	90	−4	88	18.0	3.4	90	−4	97	1.6	90	−5	102	0.7
7549	80	19	95	79	19	81	14.0	3.3	80	19	89	1.3	80	19	95	0.0
2346	64	67	32	62	65	28	4.9	2.4	64	67	32	0.0	64	67	32	0.0
2345	67	60	35	65	57	31	5.4	2.3	67	60	35	0.0	67	60	35	0.0
Rhodamine Red	52	79	−14	50	79	−17	3.6	2.3	52	79	−14	0.0	52	79	−14	0.0
Rubine Red	44	79	13	45	71	13	8.1	2.1	46	72	16	3.0	45	74	15	1.9
Warm Red	59	70	51	57	69	49	3.0	1.9	59	70	51	0.0	59	70	51	0.0
Purple	48	69	−42	47	68	−44	2.4	1.3	48	69	−42	0.0	48	69	−42	0.0
Pink	51	73	−16	50	72	−18	2.4	1.3	51	73	−16	0.0	51	73	−16	0.0
Red 032	55	72	43	54	70	41	3.0	1.2	75	72	43	0.0	55	72	43	0.0
Violet	19	55	−69	21	50	−67	1.0	2.1	20	50	−67	1.8	23	41	−62	5.4

Figure 6 shows an example of how it works. Via Pantone's Connect app for iPhone, the Pantone 1505 C is displayed in full screen mode. A screenshot of this is taken, and uploaded to the web service Pantone Connect. The web service estimates the color to be Pantone 1585 C.

However, there is a color difference of 6.3 ΔE_{00} between these two colors. Since Pantone 1505 C cannot be displayed satisfactorily on a screen with sRGB (cf. Table 2 and 3), the uploaded photo is not a representation of Pantone 1505 C but the closest, however unknown color, within the sRGB gamut. This unknown color captured in the photo was thus interpreted as being Pantone 1585 C.

3.4 Choosing the most saturated colors in sRGB via Pantone Connect

The previous examples raise the question of how saturated colors can actually become if designers are working in sRGB. The primary colors red, green and blue, as well as the secondary colors cyan, magenta and yellow should be the most chromatic colors in sRGB. The values for these colors are shown in Tables 1 and 4, and they are used to draw the gamut edge in Figure 5.

In Table 1, the sRGB values for the primary and secondary colors are entered into Adobe CC, Color Picker, after which the CIELAB values for these sRGB values are read. The same sRGB values are entered into

Table 3: The reference CIELAB values for 33 spot colors and their equivalents determined from sRGB reference values when sRGB values are entered in an Adobe RGB color working space, the color differences ΔE_{00} beyond 3 are marked in red

Pantone solid coated spot color	Spot color reference L^*	a^*	b^*	Pantone sRGB reference L^*	a^*	b^*	ΔE_{00}	Color difference ΔE_{00}
Process Blue	48	−33	−53	52	−11	−45	11.0	4.1
2418	45	−75	23	49	−45	29	10.7	3.3
Green	58	−77	0	62	−46	9	10.5	2.6
320	53	−62	−25	58	−33	−16	10.4	3.6
2245	45	−70	11	49	−42	17	10.3	3.0
3551	58	−55	−37	62	−28	−28	9.8	2.7
3405	59	−79	19	63	−52	26	9.4	2.2
3275	61	−71	−6	65	−45	2	8.9	2.2
2252	57	−77	31	60	−54	37	8.0	2.5
354	60	−77	40	63	−57	45	6.9	3.5
1505	66	59	93	64	56	73	5.9	6.9
2423	58	−74	53	61	−58	57	5.8	4.4
7481	63	−73	36	65	−58	41	5.5	4.5
Orange 021	61	66	85	60	65	71	4.7	7.0
1235	81	21	79	80	20	62	4.6	2.9
Yellow	89	−1	111	89	0	87	4.4	3.2
2010	79	27	100	77	24	80	4.3	4.6
2018	68	54	89	66	51	74	4.3	5.3
2013	75	38	95	73	34	77	4.2	4.7
7548	84	13	103	83	11	84	3.7	3.8
3955	88	−8	104	88	−8	86	3.5	1.8
3965	87	−8	103	87	−7	85	3.4	2.1
102	90	−5	106	90	−4	88	3.4	2.5
7549	80	19	95	79	19	81	3.3	4.8
2346	64	67	32	62	65	28	2.4	4.0
2345	67	60	35	65	57	31	2.3	3.8
Rhodamine Red	52	79	−14	50	79	−17	2.3	6.4
Rubine Red	44	79	13	45	71	13	2.1	9.2
Warm Red	59	70	51	57	69	49	1.9	5.0
Purple	48	69	−42	47	68	−44	1.3	4.9
Pink	51	73	−16	50	72	−18	1.3	5.8
Red 032	55	72	43	54	70	41	1.2	6.1
Violet	69	24	−29	69	23	−29	0.8	2.9

Table 4: Corresponding CIELAB values for the sRGB values and their comparison with the CIELAB values for reference spot color and Pantone Connet's suggestion for nearest PMS color, with color differences

Reference spot color	R	G	B	L^*	a^*	b^*	Nearest PMS color	L^*	a^*	b^*	ΔE_{00}
Yellow	255	255	0	98	−16	93	3945 C	90	−9	92	6.0
Orange	255	127	0	68	46	75	151 C	70	47	79	1.9
Red	255	0	0	54	81	70	2347 C	49	75	67	5.2
Magenta	255	0	255	60	94	−60	2385 C	54	69	−29	10.5
Purple	210	30	210	51	78	−51	Purple C	48	69	−42	4.1
Violet	70	0	150	21	50	−65	Violet C	19	55	−69	2.0
Blue	0	0	255	30	68	−112	2736 C	23	36	−73	9.6
Cyan	0	255	255	91	−51	−15	311 C	71	−35	−27	17.0
Green	0	255	0	88	−79	81	2271 C	65	−68	51	18.0

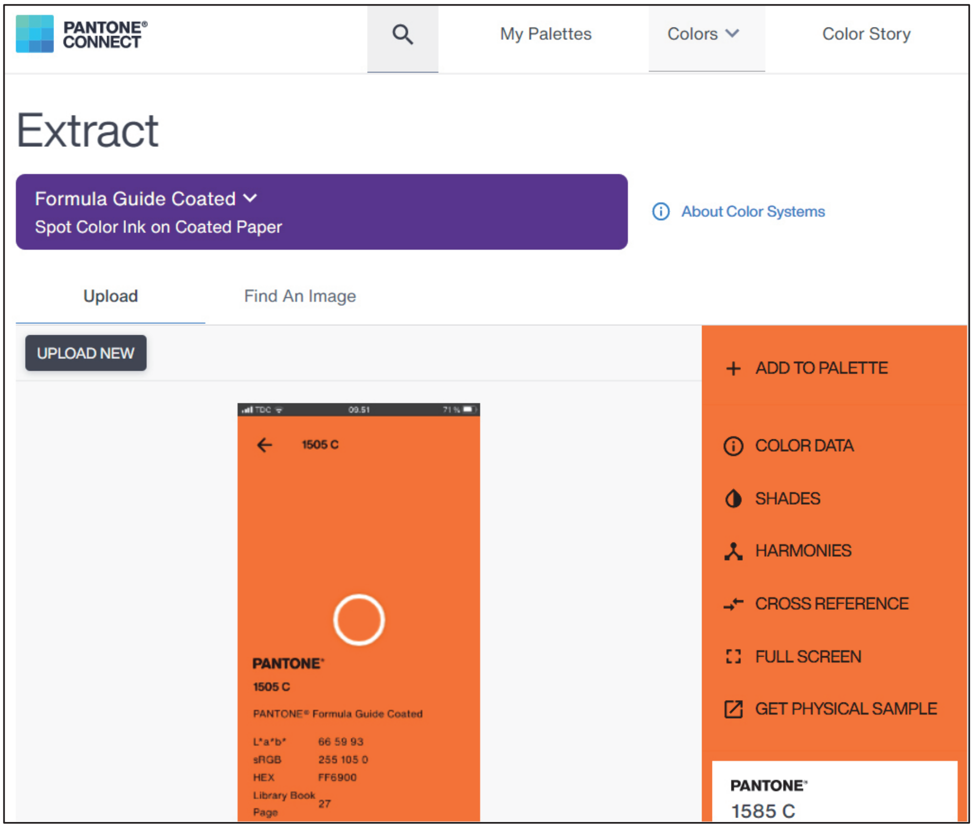


Figure 6: Uploading a photo of Pantone 1505 C, which is interpreted as being Pantone 1585 C by Pantone Connect

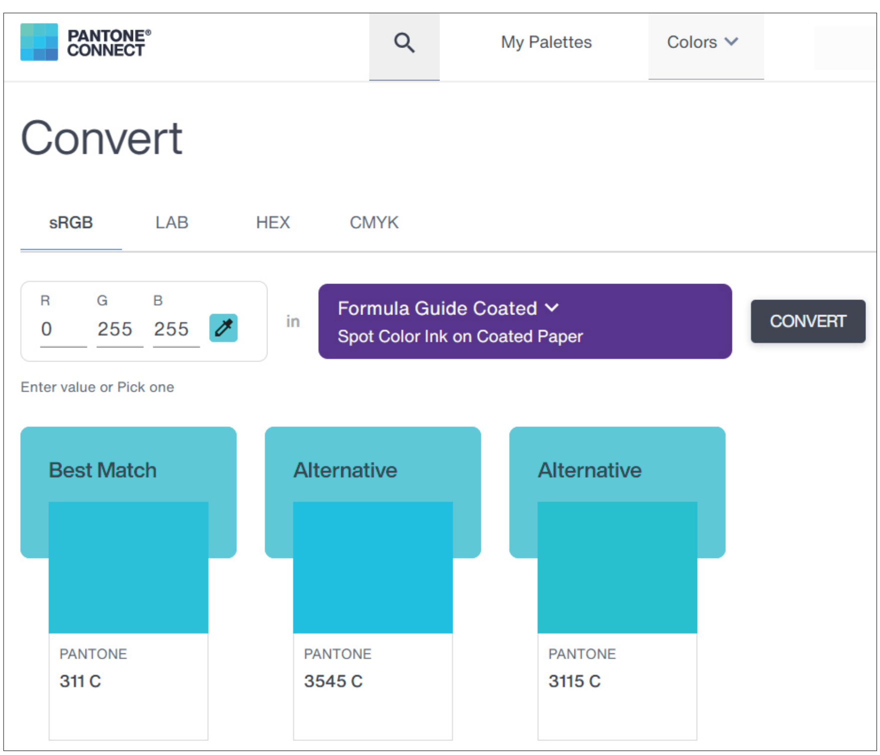


Figure 7: The sRGB values for Cyan (0/255/255) are entered, after which Pantone 311 C is suggested by Pantone Connect

Pantone Connect, Convert, after which this web service suggests the nearest Pantone color (Figure 7). The CIELAB values for the proposed Pantone spot color is compared to the CIELAB values for the sRGB colors, after which a color difference is calculated. In Table 4 the six colors from Table 1 are complemented by three more colors: orange, purple and violet.

In the example from Figure 7, Pantone Connect will suggest Pantone 311 C if the designers enter sRGB values for Cyan. This will give a color difference of 17 ΔE_{00} as shown in Table 4. However, that information does not appear in Pantone Connect. Thus, it is associated with great uncertainty to convert colors from sRGB to Pantone Solid spot colors by using the Pantone Connect web application.

3.5 The need for brand color management

As can be seen from the examples from this study, the processes of color selection, color specification and color description are not subject to the same controlled conditions as all subsequent color management and production processes.

In Brand Color Management, which hereby is introduced as a new concept, the four traditional Cs of color management are expanded to nine Cs, thus including the entire color selection process also including the decision on which acceptable color differences the brand owner will be willing to accept – or have to accept, as described in previous studies (Pedersen, 2016; 2018). Thereby, all the process, from the initial color choice to the final consequences of this color choice is covered. The nine Cs of brand color management from color selection to the final control of the reproduced color are illustrated in Figure 8, with each step of brand color management briefly explained in the following sections.

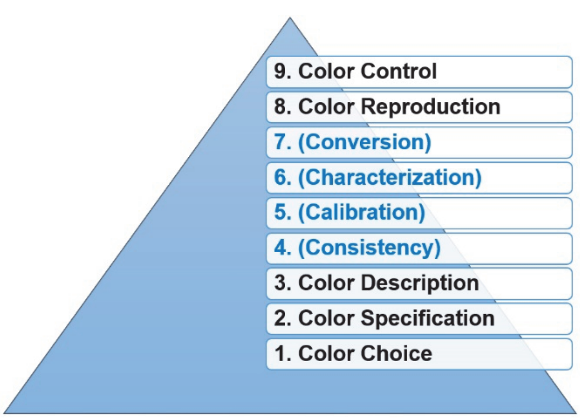


Figure 8: The nine Cs of brand color management, the terms in parentheses are the traditional four Cs in color management

3.5.1 Color choice

In this first step, designers and brand owners are focused on finding a color/hue that represents the company or the upcoming campaign as described in the Introduction. Thus, the first considerations are focused on, whether it should be a red, violet, purple, blue, green, yellow, orange, brown, black, white, or metallic color, including the degree of blackness, tints and brightness. Once the hue is selected (e.g. orange), the next step begins.

3.5.2 Color specification

In this second step, the chosen color must be specified in more detail (which orange?). The goal is to identify and name the color (e.g. Pantone 1505 C) as described in sections 3.2, 3.3 and 3.4. This step should also include examinations of whether the chosen color can be reproduced satisfactorily across technologies, including different printing methods, substrates, and color system, like CMYK (coated and uncoated), RGB (sRGB), RAL, NCS, Munsell, and possibly other relevant systems. Already in this second step, it is necessary to decide how large a color difference (ΔE_{00}) the brand owner is willing to accept.

The answer to this question can often be found by calculating the color difference between coated and uncoated (PMS 1505 C vs 1505 U) and between spot color and process color (Pantone 1505 C vs 1505 CP and 1505 U vs 1505 UP). This specific part is described in previous studies (Pedersen, 2016; 2018). Thus, this color specification step is also the step that should consider the present study's discussions regarding the choosing of colors from screen (e.g. Pantone 1505 C vs the sRGB version of this color).

3.5.3 Color description

In the third step, there is a need for technical descriptions of the color in a brand manual. However, at this point, it is possible that the designers and brand owners have had to choose a different color due to the expected color differences that would have been unacceptably large if the first choice of color were reproduced. Eventually, the chosen brand color must be described technically for the various reproduction technologies, described in section 3.5.2. This information should be present in the corporate brand manual, visual identity guide or design guide, as described in an earlier work (Pedersen, 2016).

The intention of this step is to ensure that various industries (e.g. the printing industry, the online/web industry, paint, etc.) is able to reproduce the brand color in their different technologies.

3.5.4 The four Cs of traditional color management

The steps four to seven are the four steps comprising the well-known Cs of traditional Color Management: Consistency, Calibration, Characterization and Conversion (as mentioned above and described in e.g. Adams, Sharma and Suffoletto, 2006). Thus, there is no need for further descriptions in this study.

3.5.5 Color reproduction

This eighth step in brand color management is the actual reproduction of the chosen brand color. This step includes prepress, where the digital file is prepared for the selected printing method, including the use of relevant ICC profile and proofing. Moreover, it includes the actual print production, including setup and proof check.

This area is richly described in various process standards (e.g. series of ISO 12647) and in guidelines from industry organizations such as bvdm and Idealliance. Thus, there also is no need for further descriptions in this study.

3.5.6 Color control

In this ninth and final step of brand color management, the reproduced color is measured, controlled and it is checked, whether the color difference lies within the tolerances described in the brand manual. Although this step is also part of the eighth step, this color control step is so central that it should receive special attention. If the press setup process is focused on making the print look like a contract proof or to comply to a process standard, there is a risk that focus will be removed from how the printed brand color looks like.

If the chosen brand color is printed as a halftone combination of the four CMYK process colors, measurements should also be made inside the printed image on the place where the brand color is printed as described in a previous study (Pedersen, 2018). The measurements should reveal, whether there is an incorrect tone value increase, gray balance, or color conversion (color management).

This way, it gives a real color difference value of the printed version of the brand color compared to the reference for this brand color. Apart from that, measurement of colors and measurement conditions are already described in various process standards such as series of ISO 12647 and ISO 13655:2009 (International Organization for Standardization, 2013; 2009) and if the first eight steps are performed as recommended, there is no need for further elaboration of this last step.

4. Discussion

As stated in the introduction, the purpose of this study was to find out how large color differences designers are risking when choosing a brand color directly from a software program via a computer screen. This study shows examples of color differences of up to 11 ΔE_{00} when the designer enters sRGB values for a Pantone color (Process Blue, Table 2) and up to 18 ΔE_{00} if the designer enters sRGB values into Pantone Connect, convert and applies the proposed Best Match (Pantone 2271 C, Table 4). Even in cases where the designer enters a Pantone color's sRGB values into a larger color space such as AdobeRGB, it will result in unpredictable large color differences of 9.2 ΔE_{00} (Rubine Red C, Table 3). Finally, the example in section 3.3 shows that the ability to extract color code values from an uploaded photo is unpredictable and risky. The example results in a color difference of 6.3 ΔE_{00}.

The basic risk of choosing colors from screen is that the screen and sRGB cannot display the color, that the designers' software states they have chosen. Thus, when the designers choose the most clear and chromatic saturated green color (RGB 0/255/0) they are told that they have chosen Pantone 2271 C. If this subsequently is described in a brand manual and a printing company thus prints Pantone 2271 C as a spot color, there will be an unsatisfactory, large color difference between the screen version and the print version of 18 ΔE_{00} (see Table 4).

Naturally, these results are not unambiguous and accurate for what will happen every time designers choose colors from screen. The goal has been to find the large color differences and thus the high risks. For many Pantone colors that are not bright and chromatically saturated there might be no significant color differences. At the same time, the risk and the mentioned color differences will only apply when the designer's artwork is used across print and digital media. When the artwork is only to be used on the internet and displayed via screens, this discussion might not be relevant. Even though, it is difficult to imagine that a brand color will only be displayed on a screen and never on a physical media.

It is unfortunate that Pantone recommends designers to start by entering sRGB values when working with a color. Especially when there are no longer any warnings that the selected color is out of gamut. Likewise, it is unfortunate that the many options in Pantone Connect do not include gamut warnings and color difference information. Finally, it is misleading when Pantone both specifies CIELAB values for the spot color next to the sRGB values, without any warning that this spot color is out of sRGB gamut. As the color data information now appears, Pantone sets the sRGB values to be equal to the CIELAB values. It may be advisable to bring an out of gamut warning.

4.1 Practical implications

The results can initially be used to draw attention to the risk of choosing colors directly from screen. Especially when choosing bright and chromatically saturated brand colors that might be reproduced across media platforms. Unlike the Pantone Color Manager software and Adobe CC's previous Color Picker tools, Pantone Connect does not display color warnings for colors outside of gamut. Therefore, the designers themselves must be aware of the risk and this study's method can be used to investigate whether a given color is outside gamut. Thus, the method must already be used in the first three steps of brand color management, namely when choosing, specifying and describing a new brand color. Introducing a brand color management model also draws attention to the responsibilities of designers and brand owners. It shows an overview of the entire process from color choice to color measurement control of the reproduced color, and it shows the need for communication between designers, brand owners and print providers.

5. Conclusions

The conclusion is that it is associated with high risk when choosing colors directly from a software program via a computer screen. The result is unpredictable and there is a risk of passing on incorrect information to the next link in the value chain, especially if the chosen color is a very bright and chromatic saturated color.

Designers and brand owners therefore have to use physical color swatches when choosing a brand color. For example, if they choose the virtual version of Pantone 1505 C from the screen, they must check how this color really looks like in a Pantone fan deck.

The new model for brand color management can help to focus on especially the first three steps: color selection, color specification and color description.

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