Reflectance Measurements of Pigmented Colorants

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Technical Report PCG-06-02
Cornell Program of Computer Graphics
September 6, 2006

In this report, we present the results of an experimental study on the appearance of artists' paint over time. Paint samples were handmade to ensure material quality, using various pigment colorants and adhesive binding media. We present the results of our diffuse reflectance measurements, which show very significant perceptual differences in two different domains: how the appearance of paint changes over time; and how the appearance of one pigmented colorant varies when dispersed in different materials.

Acknowledgements

This work would not have been possible without the contributions and support from many individuals. The authors would like to thank Stan Taft for his commentary in the early stages of this research. Fabio Pellacini proved to be a great resource for hashing through ideas, as well as aiding in the implementation of the rendering code in graphics hardware. James Ferwerda was very helpful in the discussion of color science and visual perception. We thank Steve Westin for assisting in the setup of the equipment in the light measurement laboratory and Victor Kord for lending his expertise on artists' materials.

This research was supported by the Program of Computer Graphics, the Department of Architecture and the National Science Foundation ITR/AP 0205438.

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1 Background

1.1 Introduction

Our study measured the appearance of artists' paint, which is dependent on both time and the material that binds the colorant to a surface. The work encompassed a vast amount of handmade paints made from varying pigmented colorants and adhesive binding media. A typical paint sample is seen in Figure 1. Diffuse reflectance measurements were taken over the visible spectrum after the samples were freshly painted, after one day, one week, one month, three months, and six months after they were painted. Further details supplementing this report can be found in [Bud07].

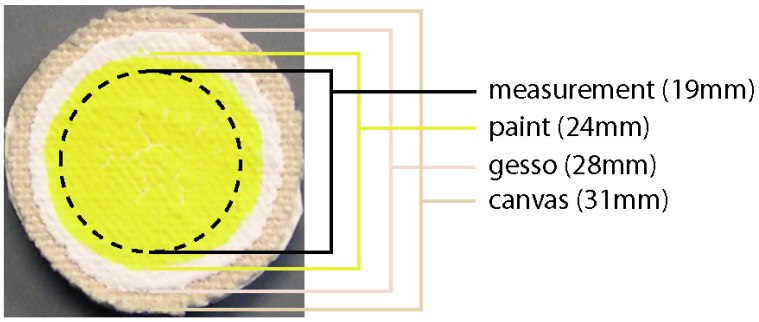

Figure 1: A typical painted sample–Chrome yellow in gouache after 1 day. Given are the dimensions for an average painted sample. The measurement range is the area in which the diffuse reflectance is measured.

The 11 pigments used in our study are shown in Figure 2. A *tint* of each of the 10 non-white pigments was also made (50% colored pigment, 50% Titanium dioxide white). Hence, there are a total of 11 pure pigments + 10 tints = 21 pigmented mixtures. The pigmented mixtures were dispersed in the following binding media: acrylic, casein, distemper, encaustic, gouache, oil, tempera, and watercolor. Each of these was applied to primed cotton canvas, mounted on Fome-Cor© board.

Diffuse reflectance was measured with the Optronics Single Monochromator (OL 750-M-S) and Integrating Sphere Reflectance attachment (OL 740-70) in the Cornell Program of Computer Graphics Light Measurement Laboratory. Each sample's re-

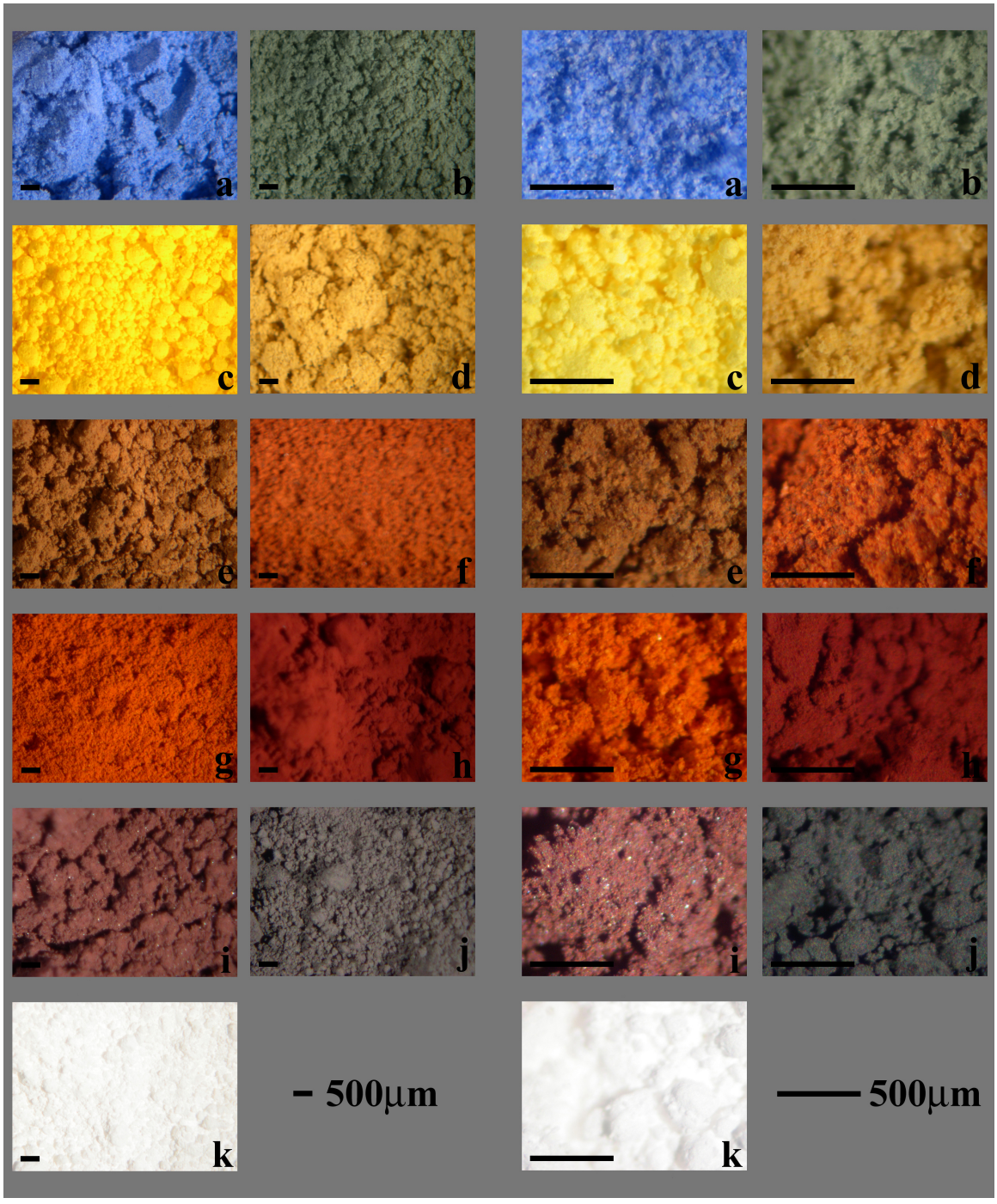

Figure 2: Left: Magnified view of pigments used in research. Right: magnified further. (a) Lapis lazuli, (b) Cold glauconite, (c) Chrome yellow, (d) Gold ochre, (e) Raw umber, (f) Burnt sienna, (g) Red ochre, (h) Hematite, (i) Cold hematite, (j) Lampblack, (k) Titanium dioxide.

flectance was measured over the visible spectrum (350-700nm) in 10nm increments, for a total of 36 wavelength-dependant reflectance values for each sample.

Ultimately, each of the 168 samples was measured at six intervals in time for a total of 1008 time-dependent reflectance spectra (each of which contains the 36 wavelength-dependent reflectance values).

1.2 Color Spaces

The spectral data from the paint sample measurements was converted into various color spaces (XYZ, Munsell HVC, $L^*a^*b^*$, and RGB). All of the conversions were done using the CIE Standard D_{65} illuminant. XYZ values are computed from the measured spectra of each sample via:

$$\begin{aligned} X &= k\sum_{i=0}^{35} E(\lambda_i)R(\lambda_i)\bar{x}(\lambda_i) \\ Y &= k\sum_{i=0}^{35} E(\lambda_i)R(\lambda_i)\bar{y}(\lambda_i) \\ Z &= k\sum_{i=0}^{35} E(\lambda_i)R(\lambda_i)\bar{z}(\lambda_i) \end{aligned} \tag{1}$$

where

$\lambda_i = 350 + 10i$ is the current wavelength in nanometers

$E(\lambda_i)$ is the illuminant's energy (D_{65}) at wavelength λ_i

$R(\lambda_i)$ is the reflected light from the paint sample at wavelength λ_i

$\{\bar{x}, \bar{y}, \bar{z}\}$ are the standard observer color matching functions (found in [Gla95])

$k = \dfrac{100}{\sum_{i=0}^{n-1} E(\lambda_i)\bar{y}(\lambda_i)}$ is the normalizing factor

The Munsell color space is a perceptually uniform space defined by perceptual stud-

ies. XYZ values are typically converted into Munsell HVC (hue, value, chroma) via a three-dimensional look up table. Fortunately, there is free software available [Gre06] to perform this transformation from GretagMacbeth (the company who currently produces the Munsell Book of Color [Mun]).

The $L^*a^*b^*$ space is another perceptually based color system that is frequently used. It is computed mathematically from XYZ:

$$\begin{aligned} L^* &= \begin{cases} 116\left(\frac{Y}{Y_n}\right)^{\frac{1}{3}} - 16 & , \ \frac{Y}{Y_n} \geq .008856 \\ 903.3\left(\frac{Y}{Y_n}\right) & , \text{ otherwise} \end{cases} \\ a^* &= 500L^*\left[f\left(\frac{X}{X_n}\right) - f\left(\frac{Y}{Y_n}\right)\right] \\ b^* &= 200L^*\left[f\left(\frac{Y}{Y_n}\right) - f\left(\frac{Z}{Z_n}\right)\right] \end{aligned} \tag{2}$$

where

$$f\left(r\right) = \begin{cases} r^{\frac{1}{3}} & , \ r \geq .008856 \\ 7.787r + \frac{16}{116} & , \text{ otherwise} \end{cases}$$

By design, the Euclidean distance between any two colors, A and B, in the $L^*a^*b^*$ color space may be computed from the magnitude of the vector between the colors:

$$E^*_{ab} = \sqrt{(L^*_A - L^*_B)^2 + (a^*_A - a^*_B)^2 + (b^*_A - b^*_B)^2} \tag{3}$$

The important feature of this space is that two pairs of colors with the same distance metric between them are almost perceptually different by the same amount.

Linear RGB is computed from XYZ by post multiplying by the 3x3 conversion matrix M (which can be found in [Lin06]):

$$[RGB] = [XYZ][M] \tag{4}$$

2 Results

2.1 Reflectance Data

For brevity, in our work, each of the 1008 time dependent reflectance spectra is denoted as (binder)_(pigment)_(time), where the items in parenthesis are given by Table 1. For example, a wet sample of Lapis lazuli in acrylic is labeled as a_ll_w.

Also, tints are indicated by a subscript t after (pigment). For example, a wet sample of a tint of Lapis lazuli in acrylic is a_ll$_t$_w.

Table 1: Shortened notation used in our work.

Binding media		**Pigment**		**Time interval**	
a	acrylic	ll	lapis lazuli	w	wet
c	casein	cg	cold glauconite	0	1 day
d	distemper	cy	chrome yellow	1	1 week
e	encaustic	go	gold ochre	2	1 month
g	gouache	ru	raw umber	3	3 months
o	oil	bs	burnt sienna	4	6 months
t	tempera	ro	red ochre		
w	watercolor	h	hematite		
		ch	cold hematite		
		lb	lampblack		
		td	titanium dioxide		

The complete set of color conversions from the 1008 reflectance spectra follows. The actual spectra are included along with this work in *spectra.zip*.

Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L*	a*	b*	R	G	B
a_ll_w	19.16	20.16	49.27	2.65PB	5.04	8.06	52.02	0.21	-37.02	0.07	0.21	0.49
a_ll_0	10.04	10.50	28.19	2.54PB	3.76	7.06	38.73	0.67	-33.74	0.02	0.11	0.28
a_ll_1	10.95	11.66	31.34	2.02PB	3.95	7.46	40.67	-0.76	-34.99	0.02	0.13	0.31
a_ll_2	11.23	11.81	32.17	2.41PB	3.97	7.60	40.91	0.20	-35.73	0.02	0.13	0.32
a_ll_3	11.32	12.00	31.51	2.15PB	4.00	7.31	41.22	-0.44	-34.28	0.03	0.13	0.31
a_ll_4	11.14	11.92	31.08	1.81PB	3.99	7.25	41.10	-1.23	-33.88	0.02	0.13	0.31
a_cg_w	19.49	22.36	21.14	0.46G	5.28	2.33	54.41	-8.39	5.03	0.18	0.24	0.19
a_cg_0	13.67	15.62	11.46	5.36GY	4.50	2.76	46.47	-7.06	12.81	0.15	0.17	0.10
a_cg_1	13.75	15.73	11.60	5.52GY	4.52	2.77	46.62	-7.25	12.68	0.15	0.17	0.10
a_cg_2	13.94	15.95	11.81	5.56GY	4.55	2.77	46.91	-7.28	12.64	0.15	0.17	0.10
a_cg_3	14.04	16.05	12.13	5.73GY	4.56	2.70	47.03	-7.17	11.98	0.15	0.17	0.10
a_cg_4	13.97	16.01	12.11	5.88GY	4.56	2.73	46.99	-7.41	11.94	0.15	0.17	0.10
a_cy_w	69.69	73.15	10.57	4.77Y	8.74	12.68	88.52	0.73	87.85	1.08	0.70	0.00
a_cy_0	69.02	71.94	9.69	4.55Y	8.68	12.96	87.94	1.79	89.47	1.08	0.68	-0.01
a_cy_1	68.39	71.50	9.04	4.68Y	8.66	13.16	87.73	1.31	91.18	1.07	0.68	-0.01
a_cy_2	66.85	70.27	8.51	4.90Y	8.59	13.20	87.13	0.50	91.87	1.04	0.67	-0.02
a_cy_3	65.12	67.84	9.13	4.60Y	8.47	12.71	85.93	1.81	87.76	1.02	0.65	-0.01
a_cy_4	62.31	64.30	10.04	4.27Y	8.29	11.99	84.12	3.14	81.82	0.98	0.61	0.01
a_go_w	39.26	34.72	15.27	6.09YR	6.38	7.31	65.53	21.26	36.15	0.66	0.28	0.11
a_go_0	30.06	26.11	9.34	6.53YR	5.65	7.55	58.15	21.34	39.19	0.53	0.20	0.06
a_go_1	30.15	26.19	9.49	6.46YR	5.65	7.51	58.21	21.39	38.84	0.53	0.20	0.06
a_go_2	29.96	26.10	9.54	6.58YR	5.65	7.43	58.14	20.99	38.55	0.52	0.20	0.06
a_go_3	30.01	26.13	9.46	6.58YR	5.65	7.48	58.16	21.11	38.85	0.52	0.20	0.06
a_go_4	30.03	26.14	9.83	6.41YR	5.65	7.35	58.17	21.13	37.74	0.52	0.20	0.07
a_ru_w	11.63	11.00	10.67	1.87YR	3.84	1.49	39.58	8.91	3.17	0.15	0.10	0.10
a_ru_0	8.48	7.86	6.25	5.11YR	3.28	2.08	33.68	9.50	8.11	0.12	0.07	0.05
a_ru_1	8.39	7.78	6.24	5.10YR	3.26	2.04	33.51	9.37	7.89	0.12	0.07	0.05
a_ru_2	8.43	7.86	6.33	5.54YR	3.28	1.98	33.69	8.96	7.82	0.12	0.07	0.06
a_ru_3	8.61	8.05	6.60	5.37YR	3.32	1.92	34.08	8.87	7.39	0.12	0.07	0.06
a_ru_4	8.65	8.12	6.70	5.60YR	3.33	1.88	34.23	8.62	7.27	0.12	0.07	0.06
a_bs_w	11.82	10.37	11.49	9.89RP	3.74	2.47	38.50	14.88	-1.00	0.17	0.08	0.11
a_bs_0	9.02	7.78	6.20	0.76YR	3.26	2.81	33.52	14.78	8.04	0.14	0.06	0.05
a_bs_1	9.00	7.77	6.30	0.49YR	3.26	2.75	33.50	14.72	7.62	0.14	0.06	0.06
a_bs_2	9.17	7.97	6.47	0.78YR	3.30	2.70	33.91	14.34	7.65	0.14	0.06	0.06
a_bs_3	9.18	8.01	6.64	0.56YR	3.31	2.61	34.01	14.08	7.13	0.14	0.06	0.06
a_bs_4	9.16	8.03	6.55	1.12YR	3.31	2.60	34.05	13.75	7.55	0.14	0.06	0.06
a_ro_w	15.12	11.89	9.25	6.41R	3.98	5.03	41.03	25.31	9.99	0.26	0.08	0.08
a_ro_0	13.26	10.43	6.70	9.57R	3.75	5.08	38.61	24.12	14.83	0.24	0.07	0.06
a_ro_1	13.41	10.58	6.87	9.47R	3.77	5.04	38.86	24.06	14.56	0.24	0.07	0.06
a_ro_2	13.46	10.69	7.01	9.59R	3.79	4.93	39.05	23.53	14.35	0.24	0.07	0.06
a_ro_3	13.41	10.67	7.06	9.56R	3.79	4.88	39.02	23.38	14.13	0.24	0.07	0.06
a_ro_4	13.37	10.65	7.05	9.62R	3.79	4.84	38.99	23.20	14.09	0.23	0.07	0.06

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Table 2: Paint sample color conversions.

	X	**Y**	**Z**	**H**	**V**	**C**	**L***	**a***	**b***	**R**	**G**	**B**
a_h_w	8.94	7.14	6.40	4.58R	3.13	3.54	32.13	20.14	4.86	0.15	0.05	0.06
a_h_0	8.93	7.31	6.41	5.96R	3.17	3.23	32.51	18.40	5.46	0.15	0.05	0.06
a_h_1	8.93	7.33	6.45	5.96R	3.17	3.20	32.55	18.22	5.37	0.14	0.05	0.06
a_h_2	9.29	7.72	6.83	6.30R	3.25	3.09	33.40	17.58	5.32	0.15	0.06	0.06
a_h_3	9.34	7.77	7.02	5.69R	3.26	3.06	33.50	17.59	4.76	0.15	0.06	0.06
a_h_4	9.21	7.65	6.89	5.78R	3.24	3.06	33.25	17.56	4.83	0.15	0.06	0.06
a_ch_w	9.05	8.52	9.69	0.64R	3.41	1.13	35.05	8.42	-1.69	0.11	0.08	0.09
a_ch_0	7.29	6.80	6.86	9.48R	3.06	1.24	31.35	8.48	1.68	0.10	0.06	0.06
a_ch_1	7.39	6.91	7.02	9.15R	3.08	1.22	31.59	8.41	1.46	0.10	0.06	0.06
a_ch_2	7.65	7.20	7.26	0.23YR	3.14	1.20	32.25	8.11	1.70	0.10	0.06	0.07
a_ch_3	7.64	7.18	7.29	9.89R	3.14	1.18	32.22	8.11	1.52	0.10	0.06	0.07
a_ch_4	7.70	7.26	7.32	0.45YR	3.16	1.18	32.39	7.98	1.70	0.10	0.06	0.07
a_lb_w	5.36	5.58	7.39	8.17B	2.76	0.72	28.32	0.83	-5.57	0.05	0.06	0.07
a_lb_0	5.44	5.71	6.54	3.55G	2.80	0.42	28.67	0.26	-1.70	0.06	0.06	0.06
a_lb_1	5.38	5.64	6.50	4.61G	2.78	0.41	28.50	0.28	-1.83	0.06	0.06	0.06
a_lb_2	5.60	5.86	6.72	3.02G	2.83	0.38	29.06	0.45	-1.74	0.06	0.06	0.06
a_lb_3	5.61	5.89	6.81	5.67G	2.84	0.41	29.14	0.31	-1.96	0.06	0.06	0.06
a_lb_4	5.54	5.82	6.67	3.60G	2.82	0.41	28.95	0.31	-1.73	0.06	0.06	0.06
a_td_w	86.92	92.56	99.12	9.5GY	9.61	1.05	97.05	-1.56	0.13	0.90	0.94	0.91
a_td_0	88.12	93.48	98.22	7.7GY	9.64	1.05	97.42	-0.94	1.37	0.93	0.94	0.90
a_td_1	88.42	93.81	98.96	7.96GY	9.66	1.03	97.55	-0.96	1.10	0.93	0.94	0.90
a_td_2	88.06	93.31	98.87	8.01GY	9.64	1.00	97.35	-0.76	0.82	0.93	0.94	0.90
a_td_3	87.51	93.08	97.52	8.00GY	9.63	1.10	97.26	-1.37	1.55	0.92	0.94	0.89
a_td_4	88.29	93.86	97.88	7.65GY	9.66	1.11	97.58	-1.29	1.86	0.93	0.95	0.89
a_ll$_t$_w	61.19	66.32	85.67	2.92B	8.39	2.29	85.16	-3.95	-11.13	0.54	0.69	0.80
a_ll$_t$_0	58.89	63.91	83.25	3.33B	8.26	2.39	83.92	-4.07	-11.50	0.51	0.66	0.78
a_ll$_t$_1	59.63	64.67	84.34	3.47B	8.31	2.40	84.31	-4.00	-11.61	0.52	0.67	0.79
a_ll$_t$_2	58.47	63.58	82.88	3.20B	8.25	2.43	83.75	-4.33	-11.53	0.50	0.66	0.78
a_ll$_t$_3	58.29	63.27	82.96	3.68B	8.23	2.47	83.59	-4.11	-11.86	0.50	0.66	0.78
a_ll$_t$_4	58.50	63.74	81.94	2.07B	8.26	2.31	83.83	-4.64	-10.68	0.51	0.66	0.77
a_cg$_t$_w	59.32	64.74	60.93	7.11GY	8.31	1.95	84.35	-4.89	7.40	0.62	0.66	0.55
a_cg$_t$_0	55.08	60.29	56.59	7.26GY	8.07	2.00	82.00	-5.20	7.38	0.58	0.62	0.51
a_cg$_t$_1	55.04	60.29	56.93	7.46GY	8.07	1.98	81.99	-5.29	7.05	0.57	0.62	0.51
a_cg$_t$_2	54.96	60.26	56.67	7.43GY	8.07	2.02	81.98	-5.42	7.27	0.57	0.62	0.51
a_cg$_t$_3	54.73	60.00	56.60	7.49GY	8.05	2.00	81.84	-5.38	7.08	0.57	0.62	0.51
a_cg$_t$_4	54.75	60.00	56.32	7.35GY	8.05	2.02	81.84	-5.34	7.35	0.57	0.62	0.50
a_cy$_t$_w	74.39	81.10	29.71	7.30Y	9.11	8.02	92.18	-5.12	56.16	1.02	0.81	0.19
a_cy$_t$_0	74.47	80.36	26.65	6.37Y	9.08	8.68	91.85	-3.53	60.23	1.05	0.80	0.16
a_cy$_t$_1	74.04	79.99	26.17	6.46Y	9.06	8.74	91.68	-3.71	60.69	1.04	0.79	0.15
a_cy$_t$_2	73.40	79.48	26.79	6.66Y	9.04	8.53	91.45	-4.04	59.32	1.02	0.79	0.16
a_cy$_t$_3	71.42	77.19	25.28	6.53Y	8.93	8.64	90.41	-3.73	59.94	1.00	0.77	0.15
a_cy$_t$_4	69.55	74.70	26.16	6.16Y	8.81	8.18	89.25	-2.74	56.52	0.98	0.74	0.16
a_go$_t$_w	67.22	67.89	48.93	1.40Y	8.47	3.81	85.95	6.40	21.84	0.89	0.64	0.42

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Table 2: Paint sample color conversions.

	X	**Y**	**Z**	**H**	**V**	**C**	**L***	**a***	**b***	**R**	**G**	**B**
a_go$_t$_0	66.98	67.13	47.00	0.80Y	8.43	4.10	85.57	7.52	23.23	0.90	0.63	0.40
a_go$_t$_1	67.12	67.29	47.24	0.80Y	8.44	4.08	85.65	7.49	23.11	0.91	0.63	0.40
a_go$_t$_2	67.08	67.28	46.89	0.89Y	8.44	4.13	85.65	7.41	23.49	0.91	0.63	0.40
a_go$_t$_3	67.36	67.63	47.24	0.97Y	8.46	4.10	85.82	7.27	23.42	0.91	0.64	0.40
a_go$_t$_4	67.28	67.38	47.18	0.72Y	8.45	4.11	85.69	7.64	23.26	0.91	0.63	0.40
a_ru$_t$_w	41.92	42.06	34.88	0.69Y	6.93	2.50	70.91	6.30	12.33	0.54	0.40	0.31
a_ru$_t$_0	37.97	37.73	30.64	9.88YR	6.62	2.64	67.82	7.28	12.82	0.50	0.35	0.27
a_ru$_t$_1	37.54	37.39	30.45	9.97YR	6.55	2.55	67.14	7.07	12.35	0.49	0.35	0.27
a_ru$_t$_2	37.54	37.39	30.45	0.14Y	6.59	2.58	67.57	6.94	12.67	0.49	0.35	0.27
a_ru$_t$_3	37.58	37.45	30.73	0.11Y	6.59	2.53	67.61	6.91	12.33	0.49	0.35	0.27
a_ru$_t$_4	37.69	37.53	30.53	0.12Y	6.60	2.59	67.67	6.97	12.72	0.49	0.35	0.27
a_bs$_t$_w	49.71	48.75	45.35	6.05YR	7.38	2.29	75.29	9.67	7.31	0.64	0.45	0.41
a_bs$_t$_0	46.09	44.36	40.28	4.26YR	7.09	2.72	72.47	11.82	8.25	0.61	0.40	0.36
a_bs$_t$_1	46.31	44.60	40.68	4.22YR	7.11	2.69	72.63	11.75	8.05	0.61	0.40	0.36
a_bs$_t$_2	46.89	45.16	40.97	4.33YR	7.14	2.73	73.00	11.81	8.35	0.62	0.41	0.37
a_bs$_t$_3	46.09	44.42	40.60	4.27YR	7.09	2.66	72.51	11.63	7.95	0.61	0.40	0.36
a_bs$_t$_4	46.29	44.62	40.61	4.39YR	7.11	2.68	72.64	11.63	8.17	0.61	0.41	0.36
a_ro$_t$_w	49.11	46.49	40.15	3.53YR	7.23	3.39	73.86	14.21	10.82	0.68	0.41	0.36
a_ro$_t$_0	49.38	46.11	38.93	2.75YR	7.21	3.78	73.61	16.01	11.86	0.70	0.40	0.34
a_ro$_t$_1	49.96	46.62	39.35	2.68YR	7.24	3.81	73.94	16.16	11.92	0.71	0.41	0.35
a_ro$_t$_2	50.09	46.66	39.41	2.54YR	7.24	3.85	73.97	16.39	11.90	0.71	0.41	0.35
a_ro$_t$_3	49.34	46.17	38.84	2.99YR	7.21	3.76	73.65	15.74	12.04	0.70	0.40	0.34
a_ro$_t$_4	49.31	46.10	38.46	3.08YR	7.21	3.82	73.61	15.83	12.44	0.70	0.40	0.34
a_h$_t$_w	22.59	20.70	22.26	2.56R	5.10	2.62	52.61	14.23	-0.10	0.30	0.18	0.21
a_h$_t$_0	20.60	18.51	19.86	1.72R	4.86	2.89	50.11	15.65	0.01	0.28	0.16	0.18
a_h$_t$_1	20.54	18.43	19.91	1.72R	4.86	2.89	50.11	15.65	0.01	0.28	0.15	0.18
a_h$_t$_2	20.75	18.68	20.10	1.61R	4.88	2.86	50.31	15.52	-0.11	0.29	0.16	0.19
a_h$_t$_3	20.60	18.59	20.09	1.46R	4.87	2.80	50.20	15.26	-0.27	0.28	0.16	0.19
a_h$_t$_4	20.49	18.53	19.84	2.20R	4.86	2.75	50.13	15.01	0.09	0.28	0.16	0.18
a_ch$_t$_w	28.82	28.75	32.48	9.13R	5.89	0.65	60.56	6.20	-2.28	0.33	0.27	0.30
a_ch$_t$_0	26.23	25.91	29.33	5.83R	5.63	0.88	57.95	7.03	-2.29	0.31	0.24	0.27
a_ch$_t$_1	26.78	26.50	30.11	5.55R	5.68	0.84	58.51	6.91	-2.47	0.31	0.25	0.28
a_ch$_t$_2	26.44	26.16	29.64	6.00R	5.65	0.84	58.19	6.89	-2.34	0.31	0.25	0.27
a_ch$_t$_3	26.59	26.32	29.94	5.43R	5.67	0.82	58.34	6.84	-2.52	0.31	0.25	0.28
a_ch$_t$_4	25.97	25.70	29.11	6.24R	5.61	0.82	57.75	6.80	-2.31	0.30	0.24	0.27
a_lb$_t$_w	19.60	20.96	26.73	1.76B	5.13	1.25	52.91	-1.38	-7.03	0.18	0.21	0.25
a_lb$_t$_0	16.49	17.58	22.54	2.46B	4.75	1.16	48.99	-1.00	-6.84	0.15	0.18	0.21
a_lb$_t$_1	16.55	17.63	22.72	3.07B	4.75	1.20	49.04	-0.94	-7.07	0.15	0.18	0.21
a_lb$_t$_2	16.39	17.45	22.41	2.89B	4.73	1.15	48.82	-0.85	-6.90	0.15	0.18	0.21
a_lb$_t$_3	16.48	17.59	22.68	2.83B	4.75	1.22	48.99	-1.10	-7.08	0.15	0.18	0.21
a_lb$_t$_4	16.36	17.56	22.30	0.64B	4.75	1.20	48.95	-1.60	-6.48	0.15	0.18	0.21
c_ll_w	11.10	11.75	28.87	2.16PB	3.96	6.58	40.81	-0.27	-31.16	0.04	0.12	0.29
c_ll_0	21.35	24.01	45.42	8.86B	5.44	5.78	56.10	-6.60	-25.85	0.10	0.26	0.44

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
c_ll_1	21.31	23.90	45.34	9.03B	5.43	5.79	55.99	-6.31	-25.96	0.10	0.26	0.44
c_ll_2	21.20	23.84	44.31	8.70B	5.43	5.56	55.92	-6.55	-24.93	0.10	0.26	0.43
c_ll_3	20.91	23.56	43.88	8.61B	5.40	5.57	55.64	-6.70	-24.92	0.10	0.26	0.43
c_ll_4	19.62	22.22	41.04	8.16B	5.26	5.40	54.26	-7.11	-24.04	0.09	0.24	0.40
c_cg_w	13.05	15.08	12.51	7.48GY	4.44	2.52	45.74	-7.96	8.76	0.13	0.16	0.11
c_cg_0	12.68	14.60	11.21	6.26GY	4.37	2.67	45.08	-7.59	11.11	0.13	0.16	0.10
c_cg_1	13.00	14.91	11.85	6.52GY	4.41	2.55	45.51	-7.31	10.09	0.13	0.16	0.10
c_cg_2	13.01	15.04	11.38	6.29GY	4.43	2.77	45.68	-8.01	11.69	0.13	0.16	0.10
c_cg_3	13.20	15.25	11.73	6.47GY	4.46	2.73	45.97	-7.98	11.20	0.13	0.16	0.10
c_cg_4	13.53	15.67	12.09	6.63GY	4.51	2.78	46.54	-8.29	11.23	0.14	0.17	0.10
c_cy_w	70.80	74.04	10.13	4.64Y	8.78	12.98	88.94	1.29	89.86	1.11	0.71	0.00
c_cy_0	71.57	73.60	10.31	4.05Y	8.76	13.03	88.73	3.83	88.96	1.14	0.69	0.00
c_cy_1	71.27	73.07	10.45	3.94Y	8.73	12.94	88.48	4.27	88.11	1.13	0.68	0.00
c_cy_2	69.79	71.52	10.53	3.94Y	8.66	12.74	87.74	4.31	86.61	1.11	0.67	0.00
c_cy_3	66.86	68.27	10.56	3.83Y	8.49	12.37	86.14	4.79	83.78	1.06	0.64	0.01
c_cy_4	63.13	64.00	10.43	3.61Y	8.27	11.97	83.96	5.74	80.39	1.01	0.59	0.01
c_go_w	35.02	31.58	11.52	7.97YR	6.13	7.52	62.99	18.25	41.13	0.59	0.26	0.08
c_go_0	37.27	33.16	12.73	7.13YR	6.26	7.65	64.29	20.17	40.17	0.63	0.27	0.09
c_go_1	37.47	33.41	13.00	7.17YR	6.28	7.58	64.49	19.97	39.83	0.64	0.27	0.09
c_go_2	37.10	33.07	12.77	7.18YR	6.25	7.59	64.22	19.97	39.92	0.63	0.27	0.09
c_go_3	37.50	33.51	13.15	7.22YR	6.29	7.53	64.57	19.76	39.57	0.63	0.27	0.09
c_go_4	37.38	33.42	13.17	7.25YR	6.28	7.49	64.50	19.63	39.41	0.63	0.27	0.09
c_ru_w	10.19	9.52	6.98	6.94YR	3.59	2.41	36.96	9.41	10.87	0.15	0.08	0.06
c_ru_0	14.57	13.06	7.92	5.68YR	4.16	3.79	42.85	14.12	17.58	0.23	0.11	0.07
c_ru_1	14.68	13.20	8.01	5.81YR	4.18	3.78	43.06	13.94	17.61	0.23	0.11	0.07
c_ru_2	14.62	13.11	7.98	5.63YR	4.16	3.79	42.92	14.15	17.49	0.23	0.11	0.07
c_ru_3	14.70	13.26	8.08	5.99YR	4.19	3.73	43.15	13.65	17.52	0.23	0.11	0.07
c_ru_4	14.88	13.47	8.10	6.33YR	4.22	3.76	43.46	13.39	18.00	0.23	0.11	0.07
c_bs_w	9.31	7.88	5.96	0.69YR	3.28	3.19	33.73	16.35	9.42	0.15	0.06	0.05
c_bs_0	10.26	8.03	4.71	0.69YR	3.31	4.84	34.04	22.55	15.70	0.19	0.05	0.04
c_bs_1	10.64	8.31	4.85	0.61YR	3.37	4.96	34.61	23.05	16.04	0.19	0.05	0.04
c_bs_2	10.44	8.20	4.91	0.62YR	3.35	4.78	34.40	22.39	15.37	0.19	0.05	0.04
c_bs_3	10.38	8.14	4.69	0.94YR	3.34	4.88	34.28	22.44	16.25	0.19	0.05	0.04
c_bs_4	10.13	7.98	4.70	0.89YR	3.30	4.74	33.94	21.98	15.62	0.18	0.05	0.04
c_ro_w	15.14	11.57	6.05	0.36YR	3.93	6.25	40.52	27.65	20.77	0.28	0.07	0.05
c_ro_0	21.71	16.93	9.12	0.24YR	4.67	6.78	48.17	29.27	22.73	0.40	0.11	0.07
c_ro_1	21.65	16.82	9.02	0.16YR	4.66	6.84	48.04	29.59	22.80	0.40	0.11	0.07
c_ro_2	21.64	16.83	8.92	0.28YR	4.66	6.86	48.05	29.51	23.13	0.40	0.11	0.07
c_ro_3	21.71	16.95	9.19	0.22YR	4.67	6.74	48.20	29.16	22.52	0.40	0.11	0.07
c_ro_4	21.59	16.86	9.15	0.23YR	4.66	6.73	48.09	29.09	22.47	0.39	0.11	0.07
c_h_w	13.24	9.77	5.89	8.29R	3.64	6.11	37.42	29.14	16.10	0.25	0.06	0.05
c_h_0	12.87	10.00	7.04	7.94R	3.68	5.01	37.84	24.92	12.15	0.23	0.07	0.06
c_h_1	12.85	10.00	7.07	7.94R	3.68	4.97	37.84	24.76	12.04	0.23	0.07	0.06

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Table 2: Paint sample color conversions.

	X	**Y**	**Z**	**H**	**V**	**C**	**L***	**a***	**b***	**R**	**G**	**B**
c_h_2	12.78	9.98	7.09	7.99R	3.67	4.91	37.81	24.46	11.91	0.23	0.07	0.06
c_h_3	12.85	10.06	7.24	7.91R	3.69	4.85	37.96	24.26	11.61	0.23	0.07	0.06
c_h_4	13.09	10.29	7.46	7.91R	3.73	4.82	38.37	24.11	11.49	0.23	0.07	0.07
c_ch_w	7.91	6.81	5.87	8.98R	3.06	2.50	31.36	14.33	5.73	0.12	0.05	0.05
c_ch_0	9.33	8.26	7.54	8.77R	3.36	2.24	34.52	13.10	4.57	0.14	0.07	0.07
c_ch_1	9.45	8.36	7.63	8.74R	3.38	2.27	34.72	13.21	4.60	0.14	0.07	0.07
c_ch_2	9.34	8.28	7.54	8.96R	3.36	2.23	34.56	13.00	4.65	0.14	0.07	0.07
c_ch_3	9.52	8.42	7.68	8.80R	3.39	2.27	34.85	13.18	4.62	0.14	0.07	0.07
c_ch_4	9.39	8.34	7.57	9.23R	3.38	2.21	34.69	12.84	4.74	0.14	0.07	0.07
c_lb_w	4.37	4.59	5.23	2.28G	2.49	0.41	25.52	0.25	-1.45	0.04	0.05	0.05
c_lb_0	5.08	5.34	6.07	2.05G	2.70	0.43	27.69	0.22	-1.46	0.05	0.05	0.06
c_lb_1	5.38	5.65	6.52	5.03G	2.78	0.41	28.52	0.29	-1.87	0.06	0.06	0.06
c_lb_2	5.68	5.97	6.83	3.47G	2.86	0.42	29.32	0.28	-1.72	0.06	0.06	0.06
c_lb_3	5.54	5.83	6.71	4.94G	2.83	0.43	28.97	0.19	-1.85	0.06	0.06	0.06
c_lb_4	5.68	5.97	6.84	3.77G	2.86	0.44	29.35	0.17	-1.71	0.06	0.06	0.06
c_td_w	90.09	95.64	99.20	7.15GY	9.73	1.11	98.29	-1.06	2.22	0.95	0.96	0.90
c_td_0	88.40	93.75	96.82	6.80GY	9.65	1.12	97.53	-0.88	2.48	0.94	0.94	0.88
c_td_1	88.36	93.72	96.40	6.65GY	9.65	1.14	97.52	-0.91	2.74	0.94	0.94	0.88
c_td_2	87.72	93.03	94.74	6.24GY	9.62	1.19	97.24	-0.88	3.37	0.94	0.93	0.86
c_td_3	87.74	93.15	95.25	6.56GY	9.63	1.18	97.29	-1.06	3.11	0.94	0.94	0.87
c_td_4	87.25	92.77	93.19	6.12GY	9.61	1.29	97.13	-1.30	4.24	0.94	0.93	0.84
c_ll$_t$_w	79.08	84.55	94.25	3.80G	9.27	1.06	93.69	-2.13	-2.42	0.79	0.86	0.87
c_ll$_t$_0	75.74	81.23	91.87	6.30G	9.12	1.14	92.24	-2.60	-3.30	0.75	0.83	0.85
c_ll$_t$_1	75.18	80.61	91.77	7.32G	9.09	1.14	91.96	-2.54	-3.71	0.74	0.82	0.85
c_ll$_t$_2	75.13	80.68	90.55	5.28G	9.09	1.17	91.99	-2.77	-2.81	0.74	0.82	0.83
c_ll$_t$_3	75.12	80.66	90.92	5.94G	9.09	1.17	91.98	-2.77	-3.08	0.74	0.82	0.84
c_ll$_t$_4	75.77	81.43	90.06	3.63G	9.13	1.19	92.32	-2.93	-1.89	0.75	0.83	0.83
c_cg$_t$_w	55.61	61.23	55.90	7.09GY	8.12	2.24	82.50	-6.05	8.90	0.58	0.63	0.50
c_cg$_t$_0	55.32	60.81	57.34	7.75GY	8.10	2.05	82.28	-5.81	7.15	0.57	0.63	0.51
c_cg$_t$_1	55.64	61.10	57.73	7.71GY	8.11	2.03	82.43	-5.66	7.04	0.58	0.63	0.52
c_cg$_t$_2	55.57	61.06	57.11	7.48GY	8.11	2.08	82.41	-5.76	7.60	0.58	0.63	0.51
c_cg$_t$_3	54.90	60.34	57.16	7.87GY	8.07	2.03	82.02	-5.77	6.88	0.57	0.62	0.51
c_cg$_t$_4	55.61	61.08	57.43	7.57GY	8.11	2.05	82.42	-5.67	7.3	0.58	0.63	0.51
c_cy$_t$_w	77.76	84.90	35.29	7.69Y	9.28	7.35	93.84	-5.41	51.32	1.04	0.85	0.24
c_cy$_t$_0	75.56	80.84	25.76	5.69Y	9.10	8.98	92.06	-2.21	62.01	1.08	0.79	0.15
c_cy$_t$_1	75.34	80.54	25.70	5.64Y	9.09	8.97	91.93	-2.09	61.88	1.08	0.79	0.15
c_cy$_t$_2	74.25	79.15	25.46	5.47Y	9.02	8.88	91.30	-1.63	61.19	1.06	0.78	0.15
c_cy$_t$_3	72.55	77.37	25.36	5.54Y	8.94	8.71	90.49	-1.69	59.96	1.04	0.76	0.15
c_cy$_t$_4	70.05	74.32	25.41	5.22Y	8.79	8.38	89.07	-0.88	57.42	1.00	0.73	0.16
c_go$_t$_w	63.94	63.60	40.35	0.68Y	8.25	4.84	83.76	8.48	27.63	0.89	0.59	0.33
c_go$_t$_0	60.51	59.58	36.76	0.11Y	8.03	5.09	81.61	9.76	28.35	0.86	0.55	0.30
c_go$_t$_1	60.99	60.13	37.38	0.16Y	8.06	5.03	81.91	9.61	28.08	0.87	0.55	0.31
c_go$_t$_2	60.29	59.35	36.62	0.10Y	8.01	5.08	81.48	9.78	28.31	0.86	0.54	0.30

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
c_go$_t$_3	60.41	59.52	37.01	0.13Y	8.02	5.03	81.58	9.66	27.97	0.86	0.55	0.30
c_go$_t$_4	60.69	59.72	37.58	9.97YR	8.03	4.97	81.68	9.86	27.44	0.86	0.55	0.31
c_ru$_t$_w	39.77	38.92	30.48	8.67YR	6.70	3.10	68.69	9.23	14.55	0.54	0.36	0.26
c_ru$_t$_0	39.53	38.62	29.95	8.62YR	6.68	3.17	68.48	9.41	14.94	0.54	0.35	0.26
c_ru$_t$_1	39.43	38.54	29.96	8.63YR	6.68	3.15	68.42	9.37	14.82	0.54	0.35	0.26
c_ru$_t$_2	39.61	38.71	29.89	8.67YR	6.69	3.20	68.54	9.39	15.14	0.54	0.35	0.26
c_ru$_t$_3	39.61	38.76	30.48	8.64YR	6.69	3.07	68.58	9.23	14.35	0.54	0.36	0.27
c_ru$_t$_4	39.34	38.50	29.72	8.81YR	6.67	3.17	68.39	9.19	15.12	0.53	0.35	0.26
c_bs$_t$_w	40.87	39.53	37.96	3.41YR	6.75	2.22	69.13	10.76	5.33	0.53	0.36	0.34
c_bs$_t$_0	38.82	36.02	31.27	1.84YR	6.49	3.46	66.54	15.51	9.71	0.55	0.31	0.28
c_bs$_t$_1	39.87	37.06	32.24	1.89YR	6.57	3.46	67.32	15.46	9.70	0.56	0.32	0.29
c_bs$_t$_2	39.04	36.24	31.22	2.04YR	6.50	3.50	66.70	15.50	10.07	0.55	0.31	0.28
c_bs$_t$_3	38.75	36.03	31.23	2.04YR	6.49	3.43	66.54	15.28	9.77	0.55	0.31	0.28
c_bs$_t$_4	39.51	36.68	32.00	1.74YR	6.54	3.46	67.04	15.54	9.55	0.56	0.32	0.29
c_ro$_t$_w	52.41	49.22	39.34	4.09YR	7.41	4.03	75.58	15.59	14.76	0.75	0.43	0.34
c_ro$_t$_0	43.16	39.49	32.54	1.72YR	6.75	4.14	69.11	17.79	12.37	0.63	0.34	0.29
c_ro$_t$_1	43.28	39.58	32.65	1.63YR	6.75	4.15	69.17	17.90	12.32	0.63	0.34	0.29
c_ro$_t$_2	42.95	39.30	32.13	1.89YR	6.73	4.16	68.97	17.76	12.70	0.63	0.33	0.28
c_ro$_t$_3	43.16	39.72	33.08	1.94YR	6.76	3.98	69.27	17.09	11.90	0.62	0.34	0.29
c_ro$_t$_4	42.74	39.07	32.27	1.61YR	6.72	4.13	68.8	17.83	12.21	0.62	0.33	0.29
c_h$_t$_w	52.72	51.81	54.96	1.15YR	7.57	1.73	77.17	9.58	0.61	0.64	0.48	0.50
c_h$_t$_0	47.84	45.91	49.65	5.61R	7.19	2.26	73.49	12.33	-0.40	0.60	0.42	0.46
c_h$_t$_1	49.14	47.27	51.06	5.97R	7.28	2.23	74.36	12.15	-0.34	0.61	0.43	0.47
c_h$_t$_2	49.21	47.36	50.78	6.68R	7.29	2.22	74.42	12.09	0.05	0.61	0.43	0.47
c_h$_t$_3	49.52	47.67	51.36	6.28R	7.31	2.22	74.61	12.07	-0.22	0.62	0.44	0.47
c_h$_t$_4	49.55	47.68	51.10	6.71R	7.31	2.23	74.63	12.11	0.07	0.62	0.44	0.47
c_ch$_t$_w	42.16	42.07	45.44	4.11YR	6.93	0.96	70.92	6.99	-0.34	0.49	0.40	0.42
c_ch$_t$_0	36.16	34.79	37.27	6.97R	6.39	1.90	65.58	10.96	0.08	0.45	0.32	0.34
c_ch$_t$_1	35.39	34.05	36.58	6.81R	6.33	1.87	65.00	10.85	-0.05	0.44	0.31	0.34
c_ch$_t$_2	35.45	34.12	36.35	7.53R	6.34	1.86	65.06	10.82	0.33	0.44	0.31	0.33
c_ch$_t$_3	36.09	34.82	37.19	7.70R	6.39	1.81	65.61	10.60	0.23	0.45	0.32	0.34
c_ch$_t$_4	36.07	34.78	36.83	8.27R	6.39	1.84	65.58	10.66	0.62	0.45	0.32	0.34
c_lb$_t$_w	11.13	11.86	15.70	4.62B	3.98	1.18	41.00	-0.83	-7.12	0.10	0.12	0.15
c_lb$_t$_0	9.18	9.66	13.18	7.98B	3.62	1.16	37.22	0.22	-7.66	0.08	0.10	0.12
c_lb$_t$_1	9.30	9.78	13.33	8.02B	3.64	1.16	37.44	0.24	-7.66	0.08	0.10	0.13
c_lb$_t$_2	9.25	9.73	13.16	7.69B	3.63	1.11	37.34	0.24	-7.40	0.08	0.10	0.12
c_lb$_t$_3	9.38	9.88	13.40	7.60B	3.66	1.15	37.62	0.14	-7.53	0.09	0.10	0.13
c_lb$_t$_4	9.28	9.76	13.26	7.87B	3.64	1.14	37.41	0.24	-7.54	0.08	0.10	0.13
d_ll_w	9.34	10.04	26.40	1.61PB	3.68	6.81	37.91	-1.41	-32.38	0.02	0.11	0.26
d_ll_0	13.28	14.43	35.06	1.29PB	4.35	7.12	44.85	-2.62	-32.83	0.03	0.16	0.35
d_ll_1	13.30	14.37	34.87	1.48PB	4.34	7.08	44.76	-2.15	-32.74	0.04	0.16	0.35
d_ll_2	13.09	14.37	33.94	0.87PB	4.34	6.85	44.76	-3.46	-31.52	0.03	0.16	0.34
d_ll_3	13.37	14.54	35.05	1.26PB	4.36	7.06	45.00	-2.67	-32.58	0.03	0.16	0.35

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
d_ll_4	13.92	15.44	36.01	0.50PB	4.48	6.95	46.23	-4.45	-31.68	0.03	0.17	0.36
d_cg_w	12.65	14.88	11.31	7.08GY	4.41	2.94	45.47	-9.43	11.51	0.12	0.16	0.10
d_cg_0	13.12	15.33	12.24	7.43GY	4.47	2.75	46.08	-8.93	10.03	0.13	0.17	0.11
d_cg_1	13.11	15.30	12.21	7.38GY	4.46	2.74	46.04	-8.85	10.04	0.13	0.16	0.11
d_cg_2	12.82	14.92	11.80	7.11GY	4.41	2.71	45.52	-8.51	10.25	0.13	0.16	0.10
d_cg_3	13.33	15.53	12.39	7.29GY	4.49	2.73	46.35	-8.72	10.11	0.13	0.17	0.11
d_cg_4	12.76	14.95	11.99	7.62GY	4.42	2.75	45.56	-9.11	9.82	0.12	0.16	0.10
d_cy_w	70.94	74.41	9.50	4.75Y	8.80	13.26	89.12	0.83	92.11	1.11	0.71	-0.01
d_cy_0	68.26	68.93	9.30	3.49Y	8.53	13.09	86.47	6.46	88.15	1.11	0.64	0.00
d_cy_1	67.24	67.90	9.25	3.50Y	8.47	12.99	85.96	6.42	87.44	1.09	0.63	0.00
d_cy_2	65.22	65.93	8.40	3.58Y	8.37	13.12	84.96	6.22	88.50	1.06	0.61	-0.01
d_cy_3	62.10	62.78	8.61	3.60Y	8.20	12.61	83.33	6.10	85.00	1.00	0.58	0.00
d_cy_4	59.52	60.18	8.74	3.61Y	8.06	12.19	81.94	5.99	82.17	0.96	0.56	0.00
d_go_w	30.82	27.27	9.70	7.37YR	5.75	7.44	59.22	19.56	39.94	0.53	0.22	0.06
d_go_0	25.74	22.51	9.34	6.31YR	5.29	6.52	54.56	19.61	33.03	0.44	0.18	0.07
d_go_1	25.53	22.43	9.40	6.51YR	5.28	6.40	54.48	19.05	32.69	0.44	0.18	0.07
d_go_2	25.63	22.44	9.28	6.39YR	5.29	6.51	54.49	19.45	33.08	0.44	0.18	0.07
d_go_3	25.59	22.46	9.35	6.48YR	5.29	6.45	54.51	19.20	32.91	0.44	0.18	0.07
d_go_4	25.47	22.34	9.40	6.37YR	5.28	6.41	54.38	19.27	32.52	0.44	0.18	0.07
d_ru_w	7.77	6.98	4.86	5.16YR	3.10	2.68	31.76	11.28	11.06	0.12	0.06	0.04
d_ru_0	6.09	5.90	5.49	7.08YR	2.84	1.11	29.15	5.59	3.59	0.08	0.05	0.05
d_ru_1	6.16	5.98	5.61	7.18YR	2.86	1.08	29.35	5.48	3.43	0.08	0.05	0.05
d_ru_2	6.21	6.06	5.61	8.06YR	2.88	1.10	29.56	5.20	3.77	0.08	0.06	0.05
d_ru_3	6.13	5.96	5.52	7.72YR	2.86	1.11	29.32	5.36	3.73	0.08	0.05	0.05
d_ru_4	6.13	5.95	5.53	7.40YR	2.86	1.11	29.29	5.49	3.66	0.08	0.05	0.05
d_bs_w	10.34	8.31	5.72	9.83R	3.37	4.16	34.62	20.68	12.00	0.18	0.06	0.05
d_bs_0	9.33	8.06	6.79	9.65R	3.32	2.70	34.11	14.85	6.69	0.14	0.06	0.06
d_bs_1	9.35	8.11	6.84	9.83R	3.33	2.66	34.21	14.59	6.68	0.14	0.06	0.06
d_bs_2	9.33	8.07	6.73	9.93R	3.32	2.71	34.13	14.80	6.97	0.14	0.06	0.06
d_bs_3	9.38	8.12	6.87	9.68R	3.33	2.67	34.24	14.73	6.62	0.14	0.06	0.06
d_bs_4	9.37	8.11	6.83	9.79R	3.33	2.68	34.22	14.71	6.73	0.14	0.06	0.06
d_ro_w	12.95	9.79	5.45	9.79R	3.64	5.89	37.46	27.08	18.12	0.24	0.06	0.04
d_ro_0	12.15	9.99	7.50	9.14R	3.67	3.96	37.82	20.11	10.39	0.20	0.07	0.07
d_ro_1	12.32	10.18	7.63	9.39R	3.71	3.91	38.17	19.79	10.53	0.20	0.07	0.07
d_ro_2	12.10	9.98	7.51	9.26R	3.67	3.91	37.80	19.84	10.35	0.20	0.07	0.07
d_ro_3	12.38	10.21	7.62	9.37R	3.71	3.96	38.21	19.99	10.66	0.21	0.07	0.07
d_ro_4	12.05	9.92	7.37	9.44R	3.66	3.94	37.71	19.89	10.68	0.20	0.07	0.06
d_h_w	8.06	6.35	5.19	6.31R	2.95	3.66	30.28	20.37	6.91	0.14	0.04	0.05
d_h_0	9.16	7.46	6.53	5.73R	3.20	3.35	32.84	18.94	5.52	0.15	0.05	0.06
d_h_1	9.12	7.43	6.51	5.76R	3.19	3.33	32.77	18.87	5.52	0.15	0.05	0.06
d_h_2	9.14	7.47	6.54	5.83R	3.20	3.31	32.85	18.75	5.52	0.15	0.05	0.06
d_h_3	9.10	7.41	6.50	5.71R	3.19	3.33	32.73	18.86	5.45	0.15	0.05	0.06
d_h_4	9.05	7.38	6.45	5.82R	3.18	3.31	32.66	18.78	5.53	0.15	0.05	0.06

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Table 2: Paint sample color conversions.

	X	**Y**	**Z**	**H**	**V**	**C**	**L***	**a***	**b***	**R**	**G**	**B**
d_ch_w	6.39	5.92	5.90	9.53R	2.85	1.30	29.20	8.65	1.89	0.09	0.05	0.05
d_ch_0	7.60	7.13	7.38	8.31R	3.13	1.17	32.09	8.28	0.97	0.10	0.06	0.07
d_ch_1	7.66	7.18	7.43	8.39R	3.14	1.18	32.22	8.33	1.03	0.10	0.06	0.07
d_ch_2	7.57	7.11	7.33	8.76R	3.12	1.17	32.05	8.20	1.11	0.10	0.06	0.07
d_ch_3	7.59	7.13	7.41	8.32R	3.13	1.14	32.11	8.16	0.89	0.10	0.06	0.07
d_ch_4	7.56	7.12	7.42	8.36R	3.12	1.11	32.07	8.01	0.81	0.10	0.06	0.07
d_lb_w	4.03	4.24	4.86	3.53G	2.39	0.42	24.45	0.20	-1.54	0.04	0.04	0.04
d_lb_0	5.36	5.64	6.58	8.68G	2.78	0.43	28.48	0.20	-2.18	0.05	0.06	0.06
d_lb_1	5.34	5.63	6.58	9.36G	2.78	0.48	28.46	-0.01	-2.22	0.05	0.06	0.06
d_lb_2	5.34	5.63	6.53	7.24G	2.78	0.46	28.46	0.06	-2.01	0.05	0.06	0.06
d_lb_3	5.36	5.63	6.61	10.00G	2.78	0.43	28.46	0.22	-2.31	0.05	0.06	0.06
d_lb_4	5.32	5.60	6.52	7.96G	2.77	0.46	28.39	0.05	-2.08	0.05	0.06	0.06
d_td_w	90.97	96.43	99.35	6.63GY	9.76	1.13	98.60	-0.84	2.66	0.97	0.97	0.90
d_td_0	88.26	93.53	96.01	6.43GY	9.65	1.14	97.44	-0.76	2.87	0.94	0.94	0.87
d_td_1	88.39	93.58	95.74	6.14GY	9.65	1.15	97.46	-0.61	3.08	0.95	0.94	0.87
d_td_2	87.87	93.46	94.63	6.45GY	9.64	1.25	97.41	-1.36	3.74	0.94	0.94	0.86
d_td_3	85.92	91.22	93.52	6.67GY	9.55	1.17	96.50	-1.05	2.92	0.92	0.92	0.85
d_td_4	88.14	93.66	95.18	6.46GY	9.65	1.23	97.49	-1.21	3.51	0.94	0.94	0.86
d_ll$_t$_w	63.20	68.34	86.15	1.30B	8.50	1.99	86.18	-3.65	-9.72	0.57	0.71	0.81
d_ll$_t$_0	53.36	58.15	78.18	4.51B	7.95	2.77	80.82	-4.52	-13.03	0.45	0.61	0.74
d_ll$_t$_1	53.52	58.33	78.36	4.48B	7.96	2.77	80.92	-4.54	-13.00	0.45	0.61	0.74
d_ll$_t$_2	52.94	57.83	76.94	3.82B	7.93	2.69	80.64	-4.83	-12.38	0.44	0.60	0.72
d_ll$_t$_3	53.53	58.43	78.42	4.31B	7.96	2.78	80.98	-4.75	-12.95	0.45	0.61	0.74
d_ll$_t$_4	53.60	58.58	78.24	3.98B	7.97	2.75	81.06	-4.93	-12.66	0.45	0.61	0.74
d_cg$_t$_w	52.20	57.27	52.29	6.79GY	7.90	2.16	80.33	-5.42	8.70	0.55	0.59	0.46
d_cg$_t$_0	44.70	49.33	45.60	7.37GY	7.42	2.13	75.66	-5.92	7.67	0.46	0.51	0.41
d_cg$_t$_1	45.21	49.82	45.88	7.19GY	7.45	2.13	75.96	-5.74	7.87	0.47	0.52	0.41
d_cg$_t$_2	44.79	49.57	45.31	7.33GY	7.43	2.23	75.80	-6.30	8.24	0.46	0.51	0.40
d_cg$_t$_3	44.76	49.52	45.59	7.47GY	7.43	2.19	75.77	-6.24	7.88	0.46	0.51	0.41
d_cg$_t$_4	44.62	49.33	45.07	7.25GY	7.42	2.21	75.66	-6.15	8.25	0.46	0.51	0.40
d_cy$_t$_w	75.41	80.87	21.36	5.75Y	9.10	10.03	92.07	-2.56	69.56	1.09	0.79	0.10
d_cy$_t$_0	71.48	75.26	18.35	4.79Y	8.84	10.35	89.51	0.27	70.91	1.07	0.73	0.08
d_cy$_t$_1	71.41	74.91	18.54	4.64Y	8.82	10.29	89.35	0.83	70.24	1.07	0.72	0.08
d_cy$_t$_2	69.49	72.95	17.78	4.71Y	8.73	10.28	88.42	0.69	70.20	1.04	0.70	0.08
d_cy$_t$_3	67.54	70.98	18.10	4.77Y	8.63	9.95	87.48	0.53	67.90	1.01	0.68	0.08
d_cy$_t$_4	65.57	68.89	18.16	4.79Y	8.53	9.69	86.45	0.56	66.00	0.98	0.66	0.09
d_go$_t$_w	67.28	68.09	50.71	1.53Y	8.48	3.56	86.05	6.09	20.17	0.88	0.65	0.43
d_go$_t$_0	57.96	57.38	42.03	9.66YR	7.90	3.84	80.39	8.86	19.86	0.79	0.53	0.36
d_go$_t$_1	57.34	56.72	41.48	9.61YR	7.86	3.84	80.02	8.93	19.86	0.78	0.53	0.35
d_go$_t$_2	57.51	56.86	41.62	9.56YR	7.87	3.85	80.10	9.01	19.84	0.78	0.53	0.36
d_go$_t$_3	57.49	56.95	41.62	9.75YR	7.88	3.83	80.15	8.74	19.92	0.78	0.53	0.36
d_go$_t$_4	57.55	57.01	41.80	9.71YR	7.88	3.81	80.19	8.76	19.77	0.78	0.53	0.36
d_ru$_t$_w	41.08	40.84	33.02	9.91YR	6.84	2.73	70.06	7.38	13.36	0.54	0.38	0.29

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
d_ru$_t$_0	31.29	30.83	27.04	8.40YR	6.07	2.13	62.36	7.75	8.79	0.41	0.29	0.24
d_ru$_t$_1	31.02	30.80	27.03	9.26YR	6.06	2.03	62.34	6.88	8.76	0.40	0.29	0.24
d_ru$_t$_2	31.09	30.72	26.71	8.81YR	6.06	2.14	62.27	7.43	9.14	0.40	0.29	0.24
d_ru$_t$_3	31.26	30.88	27.13	8.65YR	6.07	2.09	62.41	7.47	8.71	0.40	0.29	0.24
d_ru$_t$_4	31.10	30.71	26.87	8.69YR	6.06	2.11	62.26	7.48	8.87	0.40	0.29	0.24
d_bs$_t$_w	47.89	46.63	42.89	5.40YR	7.24	2.45	73.95	10.46	7.77	0.62	0.43	0.38
d_bs$_t$_0	39.54	37.33	35.20	1.15YR	6.59	2.79	67.52	13.56	6.06	0.53	0.33	0.32
d_bs$_t$_1	39.47	37.14	34.94	0.90YR	6.57	2.87	67.38	13.94	6.17	0.53	0.33	0.32
d_bs$_t$_2	39.01	36.94	34.27	2.02YR	6.56	2.77	67.23	13.14	6.79	0.53	0.33	0.31
d_bs$_t$_3	39.12	36.98	34.80	1.39YR	6.56	2.76	67.26	13.34	6.15	0.53	0.33	0.31
d_bs$_t$_4	39.13	37.00	34.91	1.30YR	6.56	2.74	67.27	13.34	6.02	0.53	0.33	0.32
d_ro$_t$_w	53.79	51.85	46.22	4.64YR	7.57	2.95	77.19	12.25	9.63	0.72	0.47	0.41
d_ro$_t$_0	43.25	40.84	38.65	0.99YR	6.84	2.89	70.07	13.92	6.08	0.58	0.36	0.35
d_ro$_t$_1	42.82	40.34	38.34	0.62YR	6.81	2.91	69.71	14.16	5.85	0.58	0.36	0.35
d_ro$_t$_2	43.06	40.79	38.08	1.78YR	6.84	2.86	70.03	13.52	6.72	0.58	0.36	0.34
d_ro$_t$_3	43.17	40.84	38.62	1.21YR	6.84	2.85	70.06	13.69	6.12	0.58	0.36	0.35
d_ro$_t$_4	43.00	40.65	38.18	1.34YR	6.83	2.89	69.93	13.79	6.43	0.58	0.36	0.34
d_h$_t$_w	22.79	21.10	22.25	4.54R	5.15	2.42	53.06	13.22	0.70	0.30	0.18	0.20
d_h$_t$_0	18.86	17.32	19.64	9.08RP	4.72	2.32	48.66	13.19	-2.07	0.25	0.15	0.18
d_h$_t$_1	18.86	17.32	19.61	9.16RP	4.72	2.32	48.66	13.19	-2.02	0.25	0.15	0.18
d_h$_t$_2	18.45	16.98	19.08	9.80RP	4.68	2.23	48.23	12.86	-1.71	0.24	0.15	0.18
d_h$_t$_3	18.76	17.23	19.53	9.14RP	4.71	2.30	48.55	13.14	-2.04	0.25	0.15	0.18
d_h$_t$_4	18.77	17.31	19.56	9.44RP	4.72	2.22	48.65	12.76	-1.94	0.24	0.15	0.18
d_ch$_t$_w	29.14	29.37	32.64	6.38YR	5.94	0.50	61.11	5.05	-1.56	0.33	0.28	0.30
d_ch$_t$_0	24.73	24.83	30.27	6.77P	5.52	0.54	56.91	5.19	-5.46	0.27	0.24	0.28
d_ch$_t$_1	24.63	24.72	30.16	6.82P	5.51	0.56	56.81	5.23	-5.48	0.27	0.24	0.28
d_ch$_t$_2	24.60	24.76	29.94	7.65P	5.52	0.44	56.84	4.94	-5.09	0.27	0.24	0.28
d_ch$_t$_3	24.49	24.62	29.92	6.89P	5.50	0.49	56.71	5.03	-5.30	0.27	0.24	0.28
d_ch$_t$_4	24.62	24.75	30.19	6.25P	5.52	0.52	56.83	5.06	-5.47	0.27	0.24	0.28
d_lb$_t$_w	13.52	14.44	17.53	5.91BG	4.35	0.87	44.85	-1.11	-4.42	0.13	0.15	0.16
d_lb$_t$_0	11.76	12.48	16.43	5.10B	4.07	1.13	41.96	-0.48	-7.07	0.11	0.13	0.15
d_lb$_t$_1	11.61	12.28	16.30	6.03B	4.04	1.14	41.66	-0.23	-7.29	0.11	0.12	0.15
d_lb$_t$_2	11.58	12.31	16.15	4.43B	4.05	1.12	41.71	-0.65	-6.90	0.11	0.13	0.15
d_lb$_t$_3	11.57	12.28	16.22	5.11B	4.04	1.14	41.66	-0.55	-7.12	0.11	0.13	0.15
d_lb$_t$_4	11.69	12.46	16.41	4.28B	4.07	1.18	41.94	-0.86	-7.06	0.11	0.13	0.15
e_ll_w	7.38	7.66	16.20	2.68PB	3.24	4.05	33.26	1.19	-21.55	0.04	0.08	0.16
e_ll_0	7.75	8.06	17.09	2.54PB	3.32	4.18	34.12	0.96	-22.00	0.04	0.08	0.17
e_ll_1	7.74	8.11	16.00	2.15PB	3.33	3.64	34.20	0.54	-19.50	0.05	0.08	0.16
e_ll_2	7.20	7.50	15.33	2.48PB	3.21	3.76	32.91	0.95	-20.23	0.04	0.08	0.15
e_ll_3	7.26	7.51	15.93	2.78PB	3.21	4.03	32.95	1.33	-21.51	0.04	0.08	0.16
e_ll_4	7.22	7.53	15.58	2.41PB	3.21	3.86	32.98	0.85	-20.67	0.04	0.08	0.15
e_cg_w	6.09	6.62	6.82	8.76GY	3.02	1.01	30.93	-2.03	1.08	0.06	0.07	0.06
e_cg_0	5.96	6.48	6.70	8.95GY	2.98	1.01	30.60	-2.04	1.00	0.06	0.07	0.06

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
e_cg_1	6.13	6.66	6.88	8.94GY	3.02	1.01	31.02	-2.06	1.02	0.06	0.07	0.06
e_cg_2	6.01	6.55	6.74	8.93GY	3.00	1.04	30.75	-2.17	1.12	0.06	0.07	0.06
e_cg_3	6.02	6.55	6.65	7.97GY	3.00	1.04	30.75	-2.03	1.45	0.06	0.07	0.06
e_cg_4	5.99	6.51	6.66	8.37GY	2.99	1.03	30.67	-2.05	1.28	0.06	0.07	0.06
e_cy_w	63.60	65.39	9.60	4.14Y	8.34	12.33	84.68	3.71	84.15	1.01	0.61	0.00
e_cy_0	63.72	65.58	9.01	4.19Y	8.35	12.60	84.78	3.58	86.18	1.01	0.62	0.00
e_cy_1	60.61	62.30	9.30	4.17Y	8.18	12.07	83.07	3.67	82.32	0.96	0.59	0.00
e_cy_2	60.25	61.96	9.03	4.20Y	8.16	12.13	82.89	3.60	82.87	0.95	0.58	0.00
e_cy_3	58.96	60.35	8.79	4.05Y	8.07	12.06	82.03	4.23	82.15	0.94	0.56	0.00
e_cy_4	58.47	59.89	9.21	4.07Y	8.04	11.83	81.78	4.12	80.36	0.93	0.56	0.01
e_go_w	20.58	18.18	8.07	6.69YR	4.82	5.65	49.71	17.25	28.87	0.35	0.14	0.06
e_go_0	19.84	17.48	7.81	6.58YR	4.74	5.58	48.86	17.26	28.32	0.34	0.14	0.06
e_go_1	19.25	16.85	7.69	6.13YR	4.66	5.52	48.07	17.73	27.38	0.33	0.13	0.06
e_go_2	19.26	16.91	7.66	6.36YR	4.67	5.51	48.15	17.39	27.63	0.33	0.13	0.06
e_go_3	19.30	16.87	7.68	6.10YR	4.66	5.55	48.10	17.83	27.48	0.33	0.13	0.06
e_go_4	19.32	16.86	7.59	6.05YR	4.66	5.60	48.08	18.02	27.75	0.33	0.13	0.06
e_ru_w	7.12	6.88	6.36	6.70YR	3.07	1.20	31.53	6.08	3.95	0.09	0.06	0.06
e_ru_0	6.38	6.25	5.99	7.81YR	2.93	0.97	30.03	4.98	2.93	0.08	0.06	0.05
e_ru_1	6.35	6.29	6.18	8.73YR	2.94	0.83	30.13	4.28	2.28	0.08	0.06	0.06
e_ru_2	6.19	6.12	6.06	8.34YR	2.90	0.81	29.71	4.35	2.10	0.08	0.06	0.05
e_ru_3	6.25	6.15	6.09	7.58YR	2.90	0.82	29.78	4.66	2.07	0.08	0.06	0.06
e_ru_4	6.35	6.26	6.19	8.14YR	2.93	0.82	30.07	4.48	2.16	0.08	0.06	0.06
e_bs_w	9.41	8.16	6.83	9.93R	3.34	2.69	34.31	14.68	6.86	0.15	0.06	0.06
e_bs_0	8.98	7.82	6.63	10.00R	3.27	2.54	33.61	14.07	6.46	0.14	0.06	0.06
e_bs_1	8.75	7.73	6.68	0.36YR	3.25	2.31	33.42	12.94	5.93	0.13	0.06	0.06
e_bs_2	8.69	7.65	6.63	0.06YR	3.24	2.34	33.24	13.18	5.83	0.13	0.06	0.06
e_bs_3	8.61	7.58	6.62	9.91R	3.22	2.31	33.10	13.14	5.64	0.13	0.06	0.06
e_bs_4	8.66	7.63	6.66	9.91R	3.23	2.31	33.19	13.14	5.64	0.13	0.06	0.06
e_ro_w	10.50	8.78	6.86	9.46R	3.46	3.41	35.56	17.84	8.91	0.17	0.07	0.06
e_ro_0	10.19	8.48	6.54	9.48R	3.40	3.47	34.96	18.09	9.16	0.17	0.06	0.06
e_ro_1	10.24	8.53	6.56	9.65R	3.41	3.45	35.07	17.95	9.27	0.17	0.06	0.06
e_ro_2	10.25	8.55	6.65	9.46R	3.42	3.42	35.11	17.90	8.98	0.17	0.06	0.06
e_ro_3	10.15	8.45	6.56	9.42R	3.40	3.43	34.90	17.98	8.99	0.17	0.06	0.06
e_ro_4	10.16	8.46	6.56	9.43R	3.40	3.44	34.93	17.99	9.01	0.17	0.06	0.06
e_h_w	8.30	6.97	6.35	6.01R	3.09	2.76	31.73	16.28	4.37	0.13	0.05	0.06
e_h_0	8.31	6.87	6.04	6.42R	3.07	2.99	31.51	17.26	5.28	0.13	0.05	0.05
e_h_1	8.55	7.13	6.36	6.32R	3.13	2.91	32.10	16.90	4.97	0.14	0.05	0.06
e_h_2	8.51	7.09	6.35	6.11R	3.12	2.92	32.00	16.96	4.83	0.14	0.05	0.06
e_h_3	8.56	7.11	6.40	5.89R	3.12	2.95	32.07	17.15	4.72	0.14	0.05	0.06
e_h_4	8.52	7.08	6.36	6.00R	3.12	2.93	32.00	17.06	4.78	0.14	0.05	0.06
e_ch_w	6.86	6.44	6.65	8.71R	2.97	1.11	30.49	7.96	1.02	0.09	0.06	0.06
e_ch_0	6.77	6.34	6.42	9.84R	2.95	1.16	30.26	8.02	1.53	0.09	0.06	0.06
e_ch_1	6.94	6.51	6.64	9.47R	2.99	1.15	30.67	8.03	1.37	0.09	0.06	0.06

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Table 2: Paint sample color conversions.

	X	**Y**	**Z**	**H**	**V**	**C**	**L***	**a***	**b***	**R**	**G**	**B**
e_ch_2	6.95	6.52	6.69	9.03R	2.99	1.13	30.69	8.01	1.18	0.09	0.06	0.06
e_ch_3	6.91	6.46	6.65	8.35R	2.98	1.16	30.54	8.28	1.08	0.09	0.06	0.06
e_ch_4	7.18	6.76	6.99	8.86R	3.05	1.10	31.25	7.90	1.00	0.09	0.06	0.06
e_lb_w	5.62	5.90	7.02	3.16BG	2.84	0.42	29.15	0.36	-2.73	0.06	0.06	0.07
e_lb_0	5.16	5.44	6.26	5.08G	2.73	0.45	27.94	0.11	-1.80	0.05	0.05	0.06
e_lb_1	5.17	5.43	6.20	2.61G	2.73	0.43	27.94	0.22	-1.55	0.05	0.05	0.06
e_lb_2	5.16	5.43	6.27	5.67G	2.73	0.43	27.93	0.17	-1.87	0.05	0.05	0.06
e_lb_3	5.15	5.40	6.26	6.17G	2.72	0.38	27.83	0.38	-1.97	0.05	0.05	0.06
e_lb_4	5.16	5.41	6.27	5.99G	2.72	0.40	27.88	0.30	-1.93	0.05	0.05	0.06
e_td_w	77.00	82.40	82.60	6.97GY	9.17	1.40	92.75	-2.28	4.21	0.82	0.83	0.75
e_td_0	75.27	80.74	80.56	7.10GY	9.10	1.46	92.02	-2.61	4.46	0.80	0.82	0.73
e_td_1	73.96	79.04	80.38	7.32GY	9.02	1.32	91.25	-2.02	3.28	0.78	0.80	0.73
e_td_2	74.95	79.95	84.56	9.05GY	9.06	1.14	91.66	-1.75	0.90	0.78	0.81	0.77
e_td_3	75.37	80.15	85.50	9.09GY	9.07	1.05	91.75	-1.26	0.37	0.78	0.81	0.78
e_td_4	75.49	80.38	85.72	9.27GY	9.08	1.08	91.85	-1.45	0.38	0.78	0.81	0.78
e_ll$_t$_w	59.63	64.79	78.92	7.19BG	8.31	1.73	84.38	-4.27	-7.47	0.54	0.67	0.74
e_ll$_t$_0	58.09	63.31	76.89	6.80BG	8.23	1.78	83.61	-4.68	-7.23	0.53	0.66	0.72
e_ll$_t$_1	56.51	61.53	76.59	9.33BG	8.14	1.94	82.66	-4.49	-8.63	0.50	0.64	0.72
e_ll$_t$_2	57.07	62.06	78.58	1.06B	8.16	2.10	82.95	-4.31	-9.67	0.50	0.64	0.74
e_ll$_t$_3	57.56	62.25	79.04	1.90B	8.17	2.03	83.05	-3.55	-9.86	0.51	0.64	0.74
e_ll$_t$_4	56.79	61.61	78.89	2.21B	8.14	2.17	82.71	-3.98	-10.32	0.50	0.64	0.74
e_cg$_t$_w	58.51	63.42	63.03	8.08GY	8.24	1.62	83.66	-3.90	4.34	0.61	0.65	0.57
e_cg$_t$_0	58.10	63.16	62.41	8.19GY	8.22	1.69	83.53	-4.30	4.65	0.60	0.65	0.56
e_cg$_t$_1	56.97	61.79	61.14	7.96GY	8.15	1.64	82.80	-3.94	4.54	0.59	0.63	0.55
e_cg$_t$_2	56.38	61.27	60.94	8.37GY	8.12	1.65	82.52	-4.19	4.24	0.58	0.63	0.55
e_cg$_t$_3	56.62	61.22	61.00	7.85GY	8.12	1.56	82.50	-3.50	4.15	0.59	0.63	0.55
e_cg$_t$_4	56.63	61.42	61.14	8.19GY	8.13	1.62	82.60	-3.92	4.20	0.59	0.63	0.55
e_cy$_t$_w	67.98	74.48	27.09	7.79Y	8.80	7.86	89.15	-5.72	54.89	0.92	0.75	0.17
e_cy$_t$_0	66.41	72.86	26.35	7.90Y	8.72	7.85	88.38	-5.86	54.72	0.90	0.73	0.17
e_cy$_t$_1	64.69	71.27	25.79	8.29Y	8.64	7.80	87.62	-6.44	54.29	0.87	0.72	0.16
e_cy$_t$_2	64.61	71.30	26.18	8.48Y	8.65	7.72	87.63	-6.69	53.70	0.87	0.72	0.17
e_cy$_t$_3	64.26	70.57	26.08	8.08Y	8.61	7.67	87.28	-5.96	53.24	0.87	0.71	0.17
e_cy$_t$_4	64.14	70.46	25.81	8.08Y	8.60	7.71	87.22	-5.99	53.60	0.87	0.71	0.16
e_go$_t$_w	61.93	63.05	52.46	1.99Y	8.22	2.63	83.47	5.07	13.94	0.78	0.60	0.46
e_go$_t$_0	59.83	60.89	50.31	1.99Y	8.10	2.67	82.32	5.07	14.15	0.75	0.58	0.44
e_go$_t$_1	58.51	59.60	48.47	2.18Y	8.03	2.76	81.62	4.91	14.86	0.74	0.57	0.42
e_go$_t$_2	58.40	59.48	48.97	2.13Y	8.02	2.67	81.55	4.93	14.21	0.73	0.57	0.43
e_go$_t$_3	58.59	59.46	49.22	1.65Y	8.02	2.68	81.54	5.44	13.93	0.74	0.57	0.43
e_go$_t$_4	58.16	59.01	48.50	1.65Y	8.00	2.73	81.30	5.46	14.27	0.74	0.56	0.42
e_ru$_t$_w	38.16	38.10	33.44	9.73YR	6.64	2.12	68.09	6.71	9.39	0.48	0.36	0.30
e_ru$_t$_0	37.83	37.86	33.70	9.92YR	6.63	2.00	67.92	6.39	8.73	0.48	0.36	0.30
e_ru$_t$_1	36.34	36.20	31.14	9.73YR	6.50	2.23	66.67	6.84	10.13	0.47	0.34	0.28
e_ru$_t$_2	36.50	36.41	31.60	9.79YR	6.52	2.16	66.83	6.70	9.75	0.47	0.34	0.28

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L*	a*	b*	R	G	B
e_ru$_t$_3	36.66	36.46	31.83	9.34YR	6.52	2.17	66.87	7.08	9.49	0.47	0.34	0.28
e_ru$_t$_4	36.97	36.83	32.28	9.52YR	6.55	2.13	67.15	6.88	9.36	0.47	0.35	0.29
e_bs$_t$_w	42.90	41.49	39.77	3.45YR	6.89	2.28	70.52	10.92	5.51	0.55	0.38	0.36
e_bs$_t$_0	41.92	40.60	39.02	3.54YR	6.83	2.22	69.89	10.69	5.34	0.54	0.37	0.35
e_bs$_t$_1	42.38	40.87	39.18	3.08YR	6.85	2.33	70.08	11.25	5.48	0.55	0.37	0.35
e_bs$_t$_2	42.90	41.46	40.13	3.02YR	6.89	2.26	70.49	11.04	5.04	0.55	0.38	0.36
e_bs$_t$_3	42.40	40.81	39.66	2.37YR	6.84	2.32	70.04	11.50	4.82	0.55	0.37	0.36
e_bs$_t$_4	42.10	40.54	39.29	2.56YR	6.82	2.31	69.85	11.41	4.94	0.55	0.37	0.36
e_ro$_t$_w	46.39	44.81	42.60	3.47YR	7.12	2.43	72.77	11.36	6.06	0.60	0.41	0.38
e_ro$_t$_0	46.52	44.98	42.77	3.55YR	7.13	2.42	72.88	11.28	6.05	0.60	0.41	0.39
e_ro$_t$_1	45.27	43.32	39.48	3.53YR	7.02	2.81	71.77	12.48	8.02	0.60	0.39	0.35
e_ro$_t$_2	45.54	43.64	40.18	3.42YR	7.04	2.74	71.98	12.33	7.55	0.60	0.39	0.36
e_ro$_t$_3	45.47	43.36	40.15	3.42YR	7.04	2.74	71.98	12.33	7.55	0.61	0.39	0.36
e_ro$_t$_4	45.55	43.51	40.21	2.97YR	7.03	2.79	71.90	12.74	7.36	0.61	0.39	0.36
e_h$_t$_w	18.62	16.75	18.42	0.37R	4.65	2.70	47.94	15.01	-0.91	0.25	0.14	0.17
e_h$_t$_0	18.61	16.71	18.42	0.17R	4.64	2.74	47.89	15.21	-0.99	0.25	0.14	0.17
e_h$_t$_1	18.28	16.25	17.77	0.35R	4.59	2.89	47.30	15.98	-0.68	0.25	0.14	0.16
e_h$_t$_2	18.23	16.23	17.59	0.90R	4.58	2.87	47.28	15.85	-0.35	0.25	0.14	0.16
e_h$_t$_3	18.57	16.63	18.19	0.53R	4.63	2.79	47.79	15.44	-0.71	0.26	0.14	0.17
e_h$_t$_4	18.82	16.91	18.52	0.59R	4.67	2.73	48.15	15.16	-0.75	0.26	0.14	0.17
e_ch$_t$_w	21.85	21.46	25.22	7.12RP	5.18	0.96	53.45	7.20	-3.70	0.25	0.20	0.24
e_ch$_t$_0	20.91	20.52	24.02	7.84RP	5.08	0.96	52.42	7.19	-3.48	0.24	0.19	0.22
e_ch$_t$_1	20.22	19.66	23.01	7.59RP	4.99	1.16	51.44	8.00	-3.42	0.24	0.18	0.21
e_ch$_t$_2	20.88	20.32	24.02	6.21RP	5.06	1.16	52.20	7.96	-3.85	0.24	0.19	0.22
e_ch$_t$_3	20.46	19.88	23.57	5.81RP	5.01	1.20	51.70	8.09	-3.94	0.24	0.18	0.22
e_ch$_t$_4	21.05	20.51	24.32	5.73RP	5.08	1.15	52.41	7.89	-3.99	0.25	0.19	0.23
e_lb$_t$_w	18.91	20.16	26.20	3.86B	5.04	1.33	52.02	-1.03	-7.73	0.17	0.21	0.25
e_lb$_t$_0	17.11	18.28	23.74	3.33B	4.83	1.31	49.83	-1.22	-7.47	0.16	0.19	0.22
e_lb$_t$_1	15.54	16.58	21.78	4.15B	4.63	1.32	47.73	-1.09	-7.65	0.14	0.17	0.20
e_lb$_t$_2	15.87	16.94	22.50	5.03B	4.67	1.42	48.18	-1.07	-8.17	0.14	0.17	0.21
e_lb$_t$_3	15.60	16.65	22.18	5.18B	4.63	1.43	47.81	-1.08	-8.24	0.14	0.17	0.21
e_lb$_t$_4	15.58	16.67	22.15	4.62B	4.64	1.44	47.84	-1.3	-8.13	0.14	0.17	0.21
g_ll_w	8.42	8.63	23.53	3.13PB	3.43	6.56	35.27	2.10	-32.21	0.02	0.09	0.24
g_ll_0	9.03	9.46	26.48	2.43PB	3.58	7.13	36.85	0.53	-34.33	0.02	0.10	0.27
g_ll_1	13.23	14.28	36.18	1.62PB	4.33	7.52	44.63	-1.96	-34.67	0.03	0.15	0.36
g_ll_2	14.78	16.00	38.51	1.48PB	4.55	7.30	46.97	-2.34	-33.55	0.04	0.17	0.38
g_ll_3	14.86	16.11	39.23	1.46PB	4.57	7.46	47.11	-2.48	-34.20	0.04	0.17	0.39
g_ll_4	14.67	16.03	38.84	1.16PB	4.56	7.41	47.01	-3.20	-33.88	0.04	0.17	0.39
g_cg_w	11.52	13.22	10.57	6.57GY	4.18	2.45	43.09	-7.06	9.51	0.12	0.14	0.09
g_cg_0	7.32	8.14	7.25	6.23GY	3.33	1.65	34.26	-3.72	5.19	0.08	0.08	0.06
g_cg_1	6.85	7.60	6.91	6.51GY	3.23	1.57	33.13	-3.57	4.55	0.07	0.08	0.06
g_cg_2	7.30	8.09	7.44	6.63GY	3.33	1.53	34.17	-3.49	4.34	0.08	0.08	0.07
g_cg_3	7.32	8.16	7.28	6.46GY	3.34	1.69	34.31	-3.96	5.17	0.08	0.09	0.06

Continued on Next Page...

Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
g_cg_4	7.60	8.49	7.36	6.16GY	3.40	1.81	34.99	-4.24	6.05	0.08	0.09	0.06
g_cy_w	71.15	73.54	9.52	4.25Y	8.76	13.30	88.70	3.06	91.31	1.13	0.69	-0.01
g_cy_0	69.94	71.39	11.10	3.78Y	8.65	12.54	87.67	4.91	84.86	1.11	0.67	0.01
g_cy_1	67.76	69.38	11.58	3.90Y	8.55	12.09	86.69	4.39	81.85	1.07	0.65	0.02
g_cy_2	66.74	68.25	11.17	3.87Y	8.49	12.13	86.13	4.56	82.02	1.06	0.64	0.02
g_cy_3	62.30	63.92	11.07	4.03Y	8.27	11.61	83.92	3.99	78.49	0.98	0.60	0.02
g_cy_4	57.91	59.28	10.69	4.00Y	8.01	11.19	81.45	4.20	75.30	0.91	0.56	0.02
g_go_w	31.03	27.40	9.62	7.30YR	5.76	7.53	59.34	19.85	40.37	0.54	0.22	0.06
g_go_0	26.73	24.03	12.58	6.32YR	5.45	5.44	56.12	17.00	26.45	0.43	0.20	0.10
g_go_1	26.24	23.51	12.21	6.19YR	5.39	5.47	55.59	17.24	26.51	0.43	0.19	0.10
g_go_2	26.69	23.87	12.17	6.20YR	5.43	5.60	55.96	17.54	27.25	0.44	0.19	0.09
g_go_3	29.02	26.59	15.54	6.58YR	5.69	4.94	58.59	15.44	23.58	0.45	0.22	0.13
g_go_4	29.81	27.31	16.01	6.50YR	5.76	4.98	59.26	15.61	23.68	0.47	0.23	0.13
g_ru_w	9.06	8.25	5.70	5.90YR	3.36	2.73	34.49	10.94	11.88	0.14	0.07	0.05
g_ru_0	6.98	6.86	6.46	8.46YR	3.07	1.04	31.47	4.94	3.47	0.09	0.06	0.06
g_ru_1	6.70	6.61	6.30	8.91YR	3.01	0.96	30.91	4.55	3.14	0.08	0.06	0.06
g_ru_2	6.70	6.88	6.58	5.62Y	3.07	0.85	31.53	1.86	3.08	0.08	0.07	0.06
g_ru_3	7.22	7.14	6.77	9.41YR	3.13	0.99	32.13	4.44	3.38	0.09	0.07	0.06
g_ru_4	7.14	7.05	6.64	9.28YR	3.11	1.02	31.92	4.55	3.53	0.09	0.07	0.06
g_bs_w	9.06	7.24	4.91	9.99R	3.15	4.03	32.34	20.20	11.80	0.16	0.05	0.04
g_bs_0	8.19	6.57	4.42	0.33YR	3.00	3.85	30.80	19.31	11.61	0.14	0.05	0.04
g_bs_1	8.70	6.90	4.35	0.61YR	3.08	4.23	31.57	20.47	13.33	0.15	0.05	0.04
g_bs_2	8.83	6.99	4.41	0.55YR	3.10	4.26	31.79	20.63	13.37	0.16	0.05	0.04
g_bs_3	8.60	6.84	4.41	0.48YR	3.06	4.11	31.44	20.14	12.76	0.15	0.05	0.04
g_bs_4	8.38	6.73	4.53	0.40YR	3.04	3.87	31.19	19.31	11.75	0.15	0.05	0.04
g_ro_w	14.09	10.70	6.06	9.61R	3.79	5.99	39.07	27.49	18.21	0.26	0.07	0.05
g_ro_0	12.28	9.73	6.93	8.51R	3.63	4.61	37.35	23.04	11.75	0.21	0.07	0.06
g_ro_1	12.10	9.61	6.83	8.69R	3.61	4.55	37.14	22.69	11.78	0.21	0.07	0.06
g_ro_2	12.19	9.67	6.93	8.51R	3.62	4.56	37.25	22.82	11.57	0.21	0.07	0.06
g_ro_3	12.19	9.69	6.98	8.46R	3.62	4.53	37.27	22.73	11.41	0.21	0.07	0.06
g_ro_4	12.22	9.73	6.83	8.94R	3.63	4.56	37.35	22.58	12.13	0.21	0.07	0.06
g_h_w	8.63	7.09	6.03	6.94R	3.12	3.17	32.02	17.92	6.17	0.14	0.05	0.05
g_h_0	8.71	7.17	6.22	6.45R	3.14	3.15	32.19	17.91	5.68	0.14	0.05	0.06
g_h_1	8.65	7.13	6.20	6.43R	3.13	3.12	32.09	17.82	5.61	0.14	0.05	0.06
g_h_2	8.75	7.15	6.16	6.34R	3.13	3.26	32.14	18.45	5.87	0.14	0.05	0.06
g_h_3	8.80	7.22	6.28	6.24R	3.15	3.20	32.29	18.20	5.63	0.14	0.05	0.06
g_h_4	8.81	7.22	6.25	6.32R	3.15	3.22	32.29	18.26	5.75	0.14	0.05	0.06
g_ch_w	7.78	6.68	5.97	7.81R	3.03	2.43	31.06	14.41	4.78	0.12	0.05	0.05
g_ch_0	8.08	7.32	7.08	8.50R	3.17	1.73	32.52	10.91	2.86	0.11	0.06	0.06
g_ch_1	8.08	7.32	7.09	8.41R	3.17	1.73	32.52	10.91	2.80	0.11	0.06	0.06
g_ch_2	8.24	7.44	7.17	8.43R	3.19	1.79	32.79	11.17	2.98	0.12	0.06	0.07
g_ch_3	8.37	7.57	7.30	8.53R	3.22	1.77	33.08	11.07	2.96	0.12	0.06	0.07
g_ch_4	8.31	7.53	7.21	8.99R	3.21	1.76	32.99	10.91	3.15	0.12	0.06	0.07

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
g_lb_w	4.43	4.66	5.31	2.52G	2.51	0.42	25.74	0.21	-1.47	0.05	0.05	0.05
g_lb_0	5.41	5.68	6.47	2.52G	2.79	0.41	28.58	0.29	-1.58	0.06	0.06	0.06
g_lb_1	5.47	5.75	6.60	4.22G	2.81	0.43	28.77	0.18	-1.75	0.06	0.06	0.06
g_lb_2	5.56	5.84	6.70	3.77G	2.83	0.41	28.99	0.30	-1.75	0.06	0.06	0.06
g_lb_3	5.40	5.68	6.54	4.60G	2.79	0.43	28.60	0.18	-1.79	0.06	0.06	0.06
g_lb_4	5.55	5.83	6.66	2.99G	2.83	0.44	28.99	0.19	-1.61	0.06	0.06	0.06
g_td_w	90.56	96.03	99.99	7.15GY	9.75	1.08	98.44	-0.88	1.97	0.96	0.97	0.91
g_td_0	88.91	94.32	97.70	6.99GY	9.68	1.11	97.76	-0.94	2.29	0.94	0.95	0.89
g_td_1	87.86	93.47	97.01	7.51GY	9.64	1.14	97.42	-1.39	2.16	0.93	0.94	0.88
g_td_2	88.21	93.74	96.68	7.06GY	9.65	1.15	97.53	-1.21	2.56	0.94	0.94	0.88
g_td_3	88.19	93.81	97.46	7.54GY	9.66	1.13	97.56	-1.38	2.10	0.93	0.95	0.89
g_td_4	88.31	94.05	95.78	6.87GY	9.67	1.24	97.65	-1.58	3.38	0.94	0.95	0.87
g_ll_t_w	55.03	60.02	80.14	4.16B	8.05	2.73	81.85	-4.69	-12.75	0.46	0.63	0.76
g_ll_t_0	52.68	57.56	79.00	5.18B	7.91	3.03	80.49	-4.85	-14.22	0.43	0.60	0.75
g_ll_t_1	51.50	56.39	78.05	5.32B	7.84	3.14	79.84	-5.13	-14.63	0.41	0.59	0.74
g_ll_t_2	52.76	57.69	79.09	5.03B	7.92	3.03	80.57	-4.97	-14.17	0.43	0.60	0.75
g_ll_t_3	52.85	57.82	79.47	5.09B	7.93	3.07	80.64	-5.06	-14.33	0.43	0.61	0.75
g_ll_t_4	52.75	57.85	78.25	4.25B	7.93	2.93	80.65	-5.38	-13.38	0.43	0.61	0.74
g_cg_t_w	44.15	48.82	42.58	6.37GY	7.38	2.43	75.34	-6.17	10.51	0.47	0.51	0.38
g_cg_t_0	41.24	45.61	40.84	6.82GY	7.17	2.28	73.29	-6.05	9.02	0.43	0.47	0.36
g_cg_t_1	39.95	44.52	40.28	7.51GY	7.10	2.33	72.57	-6.93	8.44	0.41	0.46	0.36
g_cg_t_2	43.25	47.81	43.40	7.08GY	7.32	2.23	74.70	-6.06	8.47	0.45	0.50	0.39
g_cg_t_3	41.15	45.70	41.42	7.35GY	7.18	2.28	73.35	-6.58	8.43	0.42	0.48	0.37
g_cg_t_4	44.40	49.06	44.87	7.23GY	7.40	2.20	75.49	-6.07	8.19	0.46	0.51	0.40
g_cy_t_w	75.20	80.11	23.66	5.37Y	9.07	9.42	91.73	-1.53	64.92	1.09	0.78	0.13
g_cy_t_0	74.10	77.57	24.51	4.47Y	8.95	9.07	90.58	1.16	61.52	1.09	0.75	0.14
g_cy_t_1	72.27	75.62	24.17	4.48Y	8.86	8.93	89.68	1.22	60.52	1.06	0.73	0.14
g_cy_t_2	71.37	74.72	24.82	4.51Y	8.81	8.67	89.26	1.11	58.72	1.04	0.72	0.15
g_cy_t_3	67.63	70.79	24.84	4.54Y	8.62	8.21	87.38	1.13	55.44	0.98	0.68	0.16
g_cy_t_4	66.05	68.81	24.70	4.33Y	8.52	8.06	86.41	1.82	54.00	0.96	0.66	0.16
g_go_t_w	61.12	60.83	41.99	0.40Y	8.10	4.22	82.29	8.26	23.18	0.84	0.57	0.35
g_go_t_0	58.10	57.20	41.91	9.14YR	7.89	3.92	80.29	9.64	19.83	0.79	0.53	0.36
g_go_t_1	57.17	56.73	42.19	9.81YR	7.86	3.68	80.03	8.51	19.05	0.77	0.53	0.36
g_go_t_2	57.92	57.31	42.47	9.54YR	7.90	3.77	80.35	8.93	19.29	0.78	0.53	0.36
g_go_t_3	57.94	57.43	42.89	9.66YR	7.91	3.69	80.42	8.69	18.92	0.78	0.53	0.37
g_go_t_4	57.85	57.30	42.42	9.65YR	7.90	3.76	80.35	8.78	19.33	0.78	0.53	0.36
g_ru_t_w	32.37	31.30	22.17	8.69YR	6.11	3.57	62.76	9.97	17.56	0.46	0.28	0.19
g_ru_t_0	25.98	24.93	18.30	8.11YR	5.53	3.20	57.01	10.04	14.97	0.37	0.22	0.16
g_ru_t_1	25.17	24.26	17.98	8.38YR	5.47	3.07	56.35	9.49	14.48	0.35	0.22	0.15
g_ru_t_2	25.62	24.70	18.43	8.32YR	5.51	3.05	56.78	9.53	14.31	0.36	0.22	0.16
g_ru_t_3	26.69	25.88	19.80	8.52YR	5.62	2.91	57.92	9.05	13.60	0.37	0.24	0.17
g_ru_t_4	25.73	24.83	18.22	8.51YR	5.52	3.13	56.91	9.46	14.94	0.36	0.22	0.16
g_bs_t_w	36.51	33.36	26.86	2.23YR	6.28	4.00	64.45	16.99	12.67	0.54	0.28	0.24

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L*	a*	b*	R	G	B
g_bs$_t$_0	32.96	29.90	25.11	0.88YR	5.99	3.80	61.56	17.23	10.49	0.48	0.25	0.22
g_bs$_t$_1	32.01	29.17	24.82	0.98YR	5.92	3.62	60.93	16.56	9.87	0.47	0.25	0.22
g_bs$_t$_2	32.64	29.55	24.69	0.86YR	5.96	3.84	61.27	17.39	10.67	0.48	0.25	0.22
g_bs$_t$_3	32.89	29.90	25.20	0.96YR	5.99	3.74	61.57	17.00	10.35	0.48	0.25	0.22
g_bs$_t$_4	32.49	29.58	24.90	1.13YR	5.96	3.70	61.29	16.73	10.35	0.47	0.25	0.22
g_ro$_t$_w	43.68	40.38	32.89	2.74YR	6.81	4.00	69.74	16.62	12.97	0.63	0.35	0.29
g_ro$_t$_0	36.89	33.83	30.33	0.06YR	6.31	3.50	64.83	16.62	8.10	0.52	0.29	0.27
g_ro$_t$_1	37.40	34.52	31.17	0.38YR	6.37	3.36	65.37	15.94	7.84	0.53	0.30	0.28
g_ro$_t$_2	38.19	35.32	31.91	0.50YR	6.43	3.35	65.99	15.85	7.88	0.54	0.31	0.29
g_ro$_t$_3	38.02	35.17	31.87	0.45YR	6.42	3.33	65.88	15.79	7.73	0.53	0.30	0.29
g_ro$_t$_4	38.06	35.16	31.63	0.55YR	6.42	3.38	65.88	15.94	8.07	0.54	0.30	0.28
g_h$_t$_w	16.46	14.57	14.58	4.48R	4.37	2.84	45.05	15.80	2.43	0.24	0.12	0.13
g_h$_t$_0	16.81	15.16	17.41	8.12RP	4.45	2.48	45.85	14.28	-2.43	0.22	0.13	0.16
g_h$_t$_1	16.84	15.18	17.28	8.59RP	4.45	2.51	45.88	14.36	-2.12	0.23	0.13	0.16
g_h$_t$_2	16.90	15.24	17.37	8.50RP	4.46	2.50	45.96	14.35	-2.19	0.23	0.13	0.16
g_h$_t$_3	17.01	15.35	17.57	8.29RP	4.47	2.49	46.11	14.28	-2.33	0.23	0.13	0.16
g_h$_t$_4	16.92	15.34	17.24	9.43RP	4.47	2.41	46.09	13.88	-1.67	0.23	0.13	0.16
g_ch$_t$_w	18.93	18.26	19.51	8.41R	4.83	1.35	49.81	8.58	0.15	0.24	0.17	0.18
g_ch$_t$_0	17.71	17.16	19.87	9.17RP	4.70	1.13	48.46	7.96	-2.86	0.21	0.16	0.18
g_ch$_t$_1	17.89	17.33	20.07	9.09RP	4.72	1.14	48.67	8.00	-2.88	0.21	0.16	0.19
g_ch$_t$_2	17.97	17.38	20.00	9.86RP	4.72	1.18	48.74	8.19	-2.64	0.22	0.16	0.19
g_ch$_t$_3	18.19	17.63	20.40	9.20RP	4.75	1.15	49.04	8.05	-2.86	0.22	0.16	0.19
g_ch$_t$_4	18.07	17.62	20.34	9.99RP	4.75	1.01	49.03	7.46	-2.77	0.21	0.16	0.19
g_lb$_t$_w	10.87	11.55	14.39	9.37BG	3.93	0.83	40.50	-0.63	-4.97	0.10	0.12	0.13
g_lb$_t$_0	10.57	11.17	14.87	6.28B	3.87	1.12	39.86	-0.14	-7.20	0.10	0.11	0.14
g_lb$_t$_1	10.35	10.98	14.73	5.91B	3.84	1.19	39.55	-0.49	-7.39	0.09	0.11	0.14
g_lb$_t$_2	10.42	11.02	14.66	6.07B	3.85	1.11	39.61	-0.20	-7.13	0.10	0.11	0.14
g_lb$_t$_3	10.44	11.06	14.77	6.10B	3.85	1.15	39.67	-0.30	-7.28	0.09	0.11	0.14
g_lb$_t$_4	10.43	11.08	14.56	4.66B	3.86	1.07	39.71	-0.52	-6.74	0.10	0.11	0.14
o_ll_w	12.24	13.26	36.36	1.56PB	4.18	8.14	43.15	-2.26	-37.46	0.01	0.15	0.36
o_ll_0	12.40	13.26	37.67	1.97PB	4.19	8.48	43.15	-1.18	-39.09	0.01	0.14	0.38
o_ll_1	11.39	12.46	32.22	1.10PB	4.07	7.37	41.94	-3.07	-34.02	0.02	0.14	0.32
o_ll_2	11.19	12.51	30.64	0.23PB	4.08	6.91	42.02	-4.86	-31.66	0.02	0.14	0.30
o_ll_3	9.32	10.51	25.00	9.67B	3.76	6.18	38.73	-5.21	-28.69	0.02	0.12	0.25
o_ll_4	9.50	10.92	24.85	8.67B	3.83	5.97	39.44	-6.72	-27.22	0.02	0.12	0.25
o_cg_w	13.33	15.14	9.70	3.33GY	4.44	3.09	45.83	-6.53	16.84	0.15	0.16	0.08
o_cg_0	15.27	17.36	11.16	3.49GY	4.72	3.22	48.71	-6.91	17.51	0.17	0.18	0.09
o_cg_1	9.40	10.60	7.57	3.89GY	3.78	2.45	38.89	-5.23	12.02	0.10	0.11	0.06
o_cg_2	9.83	11.06	8.09	4.02GY	3.85	2.38	39.68	-5.08	11.53	0.11	0.12	0.07
o_cg_3	8.40	9.29	7.67	4.55GY	3.55	1.85	36.54	-3.57	7.60	0.09	0.10	0.07
o_cg_4	8.40	9.31	7.70	4.74GY	3.55	1.85	36.57	-3.66	7.53	0.09	0.10	0.07
o_cy_w	68.76	72.28	6.82	4.90Y	8.69	14.29	88.10	0.51	99.68	1.08	0.69	-0.04
o_cy_0	69.21	72.78	9.74	4.86Y	8.72	12.95	88.34	0.45	90.03	1.08	0.70	-0.01

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
o_cy_1	67.40	69.88	7.24	4.45Y	8.58	13.93	86.94	2.53	96.07	1.07	0.66	-0.03
o_cy_2	65.19	67.55	5.01	4.51Y	8.46	14.93	85.78	2.60	103.45	1.05	0.64	-0.05
o_cy_3	58.23	58.73	7.36	3.61Y	7.98	12.72	81.15	6.28	85.62	0.95	0.54	-0.01
o_cy_4	55.36	55.84	6.63	3.67Y	7.81	12.70	79.52	6.17	85.64	0.90	0.51	-0.01
o_go_w	22.03	18.84	7.15	5.9YR	4.90	6.69	50.50	20.76	33.58	0.39	0.14	0.05
o_go_0	22.25	19.01	6.97	6.02YR	4.92	6.84	50.70	20.90	34.61	0.39	0.14	0.05
o_go_1	23.05	19.64	7.63	5.57YR	4.99	6.76	51.43	21.42	33.39	0.41	0.15	0.05
o_go_2	22.18	19.06	5.37	7.22YR	4.92	7.59	50.76	20.36	41.38	0.40	0.14	0.03
o_go_3	22.06	18.76	7.11	5.65YR	4.89	6.76	50.40	21.32	33.55	0.39	0.14	0.05
o_go_4	21.72	18.40	7.80	4.94YR	4.84	6.39	49.98	21.53	30.29	0.38	0.14	0.06
o_ru_w	6.31	5.99	5.57	4.55YR	2.87	1.27	29.39	7.02	3.67	0.08	0.05	0.05
o_ru_0	6.15	5.88	5.59	4.80YR	2.84	1.14	29.11	6.45	3.07	0.08	0.05	0.05
o_ru_1	7.10	6.83	6.23	6.59YR	3.06	1.27	31.42	6.31	4.30	0.09	0.06	0.06
o_ru_2	6.42	6.26	5.94	7.52YR	2.93	1.03	30.06	5.27	3.22	0.08	0.06	0.05
o_ru_3	6.42	6.19	6.05	4.72YR	2.91	1.01	29.88	6.06	2.42	0.08	0.06	0.05
o_ru_4	6.41	6.20	6.11	5.20YR	2.92	0.94	29.92	5.69	2.22	0.08	0.06	0.06
o_bs_w	9.70	8.68	7.67	0.48YR	3.44	2.22	35.36	12.45	5.57	0.14	0.07	0.07
o_bs_0	9.29	8.26	7.05	0.94YR	3.36	2.34	34.51	12.75	6.40	0.14	0.07	0.06
o_bs_1	8.40	7.24	5.93	0.22YR	3.15	2.67	32.34	14.56	7.16	0.13	0.06	0.05
o_bs_2	8.43	7.28	6.00	0.26YR	3.16	2.64	32.44	14.38	7.05	0.13	0.06	0.05
o_bs_3	8.62	7.44	6.26	9.74R	3.19	2.62	32.78	14.54	6.56	0.13	0.06	0.06
o_bs_4	8.57	7.42	6.14	0.33YR	3.19	2.61	32.76	14.24	7.01	0.13	0.06	0.05
o_ro_w	9.80	7.98	5.38	0.63YR	3.30	3.98	33.93	19.39	12.34	0.17	0.06	0.05
o_ro_0	10.33	8.41	6.09	9.65R	3.39	3.88	34.83	19.70	10.77	0.17	0.06	0.05
o_ro_1	9.51	7.85	4.92	1.97YR	3.28	3.98	33.66	18.28	14.02	0.16	0.06	0.04
o_ro_2	9.91	8.10	5.55	0.55YR	3.33	3.92	34.19	19.23	12.01	0.17	0.06	0.05
o_ro_3	9.90	8.01	5.96	8.95R	3.31	3.84	34.00	19.88	9.90	0.17	0.06	0.05
o_ro_4	9.84	7.98	6.00	8.87R	3.30	3.79	33.95	19.70	9.65	0.17	0.06	0.05
o_h_w	8.61	7.09	6.22	6.18R	3.12	3.11	32.01	17.82	5.36	0.14	0.05	0.06
o_h_0	9.23	7.69	6.98	5.66R	3.25	3.01	33.33	17.35	4.61	0.15	0.06	0.06
o_h_1	8.53	6.98	6.16	5.83R	3.10	3.15	31.77	18.15	5.20	0.14	0.05	0.06
o_h_2	8.75	7.18	6.27	6.14R	3.14	3.18	32.21	18.13	5.50	0.14	0.05	0.06
o_h_3	8.56	7.02	6.25	5.68R	3.10	3.12	31.85	18.01	4.99	0.14	0.05	0.06
o_h_4	8.58	7.08	6.24	6.14R	3.12	3.07	31.98	17.64	5.23	0.14	0.05	0.06
o_ch_w	9.64	9.28	9.43	2.39YR	3.55	1.05	36.51	7.02	1.63	0.12	0.08	0.09
o_ch_0	9.71	9.38	9.78	1.5YR	3.57	0.94	36.71	6.75	0.86	0.12	0.09	0.09
o_ch_1	7.61	7.03	7.10	8.20R	3.11	1.38	31.87	9.34	1.64	0.10	0.06	0.06
o_ch_2	7.56	7.04	7.12	9.00R	3.11	1.28	31.90	8.73	1.61	0.10	0.06	0.07
o_ch_3	7.60	6.96	7.00	7.74R	3.09	1.47	31.72	9.87	1.76	0.10	0.06	0.06
o_ch_4	7.58	6.96	6.93	8.39R	3.09	1.47	31.71	9.73	2.01	0.10	0.06	0.06
o_lb_w	4.90	5.15	5.89	3.20G	2.65	0.42	27.16	0.22	-1.59	0.05	0.05	0.05
o_lb_0	5.28	5.54	6.41	6.01G	2.75	0.40	28.22	0.31	-1.95	0.05	0.06	0.06
o_lb_1	5.31	5.57	6.46	6.34G	2.76	0.40	28.30	0.33	-1.99	0.05	0.06	0.06

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
o_lb_2	5.38	5.66	6.45	2.81G	2.78	0.44	28.53	0.17	-1.56	0.06	0.06	0.06
o_lb_3	5.42	5.66	6.54	4.22G	2.78	0.34	28.53	0.62	-1.91	0.06	0.06	0.06
o_lb_4	5.38	5.66	6.47	3.53G	2.78	0.44	28.53	0.18	-1.66	0.06	0.06	0.06
o_td_w	88.89	94.06	95.33	5.7GY	9.67	1.19	97.66	-0.53	3.69	0.96	0.94	0.87
o_td_0	89.61	94.73	96.70	5.79GY	9.69	1.14	97.92	-0.36	3.24	0.97	0.95	0.88
o_td_1	87.97	93.68	90.71	5.20GY	9.65	1.49	97.50	-1.56	6.58	0.96	0.94	0.82
o_td_2	87.82	93.51	90.24	5.11GY	9.64	1.50	97.43	-1.55	6.80	0.96	0.94	0.81
o_td_3	85.24	90.32	81.57	1.62GY	9.51	1.88	96.13	-0.76	10.80	0.97	0.90	0.73
o_td_4	84.34	89.71	78.88	1.71GY	9.49	2.07	95.88	-1.36	12.39	0.96	0.90	0.70
o_ll$_t$_w	54.65	59.71	77.98	2.87G	8.03	2.50	81.68	-4.91	-11.40	0.46	0.62	0.73
o_ll$_t$_0	56.34	61.27	81.57	4.29G	8.12	2.66	82.52	-4.31	-12.66	0.48	0.64	0.77
o_ll$_t$_1	60.24	66.55	80.19	5.89BG	8.40	2.07	85.28	-6.69	-6.88	0.53	0.70	0.75
o_ll$_t$_2	59.80	66.19	78.19	4.22BG	8.39	2.01	85.09	-6.95	-5.67	0.53	0.69	0.72
o_ll$_t$_3	57.75	64.52	64.73	1.22G	8.30	2.16	84.24	-8.21	3.83	0.56	0.68	0.58
o_ll$_t$_4	57.44	64.15	62.86	0.33G	8.28	2.21	84.04	-8.15	5.14	0.56	0.67	0.57
o_cg$_t$_w	53.89	58.78	54.28	6.59GY	7.98	2.02	81.17	-4.65	8.17	0.57	0.60	0.48
o_cg$_t$_0	54.00	58.95	54.40	6.65GY	7.99	2.04	81.27	-4.79	8.23	0.57	0.61	0.48
o_cg$_t$_1	58.65	64.32	57.24	6.32GY	8.29	2.32	84.13	-5.59	10.44	0.63	0.66	0.51
o_cg$_t$_2	58.79	64.48	56.80	6.14GY	8.30	2.37	84.22	-5.60	11.00	0.63	0.66	0.50
o_cg$_t$_3	55.43	60.72	46.60	3.25GY	8.09	3.09	82.23	-5.30	17.90	0.63	0.62	0.40
o_cg$_t$_4	54.91	60.07	44.85	2.52GY	8.05	3.23	81.88	-5.12	19.22	0.63	0.61	0.38
o_cy$_t$_w	72.57	78.55	19.35	6.39Y	8.99	10.27	91.03	-3.95	71.55	1.05	0.78	0.08
o_cy$_t$_0	72.61	78.69	19.58	6.48Y	9.00	10.21	91.09	-4.15	71.21	1.05	0.78	0.09
o_cy$_t$_1	72.62	78.09	19.17	5.98Y	8.97	10.30	90.82	-2.96	71.53	1.06	0.77	0.08
o_cy$_t$_2	71.70	77.18	18.45	6.05Y	8.93	10.40	90.40	-3.11	72.23	1.04	0.76	0.08
o_cy$_t$_3	66.41	69.77	16.32	4.79Y	8.57	10.33	86.88	0.58	70.63	1.00	0.67	0.07
o_cy$_t$_4	64.55	67.61	18.29	4.67Y	8.46	9.53	85.81	1.02	64.66	0.96	0.65	0.09
o_go$_t$_w	64.63	65.04	49.37	0.93Y	8.33	3.46	84.51	6.83	18.89	0.85	0.61	0.43
o_go$_t$_0	63.48	63.40	47.60	0.23Y	8.24	3.62	83.65	7.89	19.28	0.85	0.59	0.41
o_go$_t$_1	64.11	64.52	45.98	1.17Y	8.30	3.90	84.23	6.81	22.04	0.86	0.61	0.39
o_go$_t$_2	64.06	64.44	46.16	1.11Y	8.29	3.87	84.19	6.87	21.77	0.86	0.61	0.39
o_go$_t$_3	63.96	64.43	45.28	1.30Y	8.29	3.99	84.19	6.68	22.73	0.86	0.61	0.38
o_go$_t$_4	63.61	63.99	44.83	1.20Y	8.27	4.03	83.96	6.85	22.83	0.85	0.60	0.38
o_ru$_t$_w	37.98	37.42	29.76	9.23YR	6.59	2.87	67.59	8.26	13.69	0.51	0.35	0.26
o_ru$_t$_0	36.83	36.29	28.68	9.31YR	6.51	2.88	66.74	8.18	13.83	0.49	0.34	0.25
o_ru$_t$_1	36.66	36.18	28.40	9.53YR	6.50	2.89	66.66	7.97	14.11	0.49	0.34	0.25
o_ru$_t$_2	36.11	35.64	27.62	9.63YR	6.46	2.95	66.24	7.94	14.58	0.48	0.33	0.24
o_ru$_t$_3	37.01	36.41	26.11	9.81YR	6.52	3.45	66.83	8.39	17.96	0.51	0.34	0.22
o_ru$_t$_4	36.72	36.22	26.39	9.96YR	6.50	3.32	66.69	8.05	17.27	0.50	0.33	0.23
o_bs$_t$_w	41.75	39.38	33.88	3.44YR	6.74	3.28	69.02	13.91	10.41	0.58	0.35	0.30
o_bs$_t$_0	41.51	39.11	33.75	3.30YR	6.72	3.28	68.83	14.00	10.25	0.58	0.35	0.30
o_bs$_t$_1	40.93	38.58	32.29	3.94YR	6.68	3.40	68.45	13.89	11.58	0.57	0.34	0.29
o_bs$_t$_2	41.24	38.88	32.08	4.20YR	6.70	3.48	68.66	13.91	12.24	0.58	0.34	0.28

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
o_bs$_t$_3	40.04	37.84	29.31	5.50YR	6.62	3.71	67.91	13.45	14.90	0.57	0.33	0.25
o_bs$_t$_4	40.14	37.96	29.65	5.43YR	6.63	3.65	67.99	13.39	14.54	0.57	0.34	0.26
o_ro$_t$_w	48.09	45.71	40.89	3.20YR	7.18	3.11	73.36	13.59	9.06	0.65	0.41	0.37
o_ro$_t$_0	47.56	45.19	39.75	3.54YR	7.14	3.19	73.01	13.59	9.83	0.65	0.40	0.35
o_ro$_t$_1	48.08	45.75	39.86	3.89YR	7.18	3.21	73.38	13.44	10.34	0.66	0.41	0.35
o_ro$_t$_2	47.05	44.70	38.49	3.99YR	7.11	3.28	72.70	13.56	10.82	0.65	0.40	0.34
o_ro$_t$_3	47.83	45.47	37.02	5.03YR	7.16	3.57	73.20	13.56	13.51	0.67	0.40	0.33
o_ro$_t$_4	47.64	45.43	36.48	5.57YR	7.16	3.59	73.17	13.13	14.16	0.66	0.41	0.32
o_h$_t$_w	15.67	13.62	13.94	2.83R	4.24	3.08	43.68	17.12	1.61	0.23	0.11	0.13
o_h$_t$_0	15.36	13.44	13.87	2.74R	4.21	2.94	43.42	16.49	1.32	0.22	0.11	0.13
o_h$_t$_1	16.39	14.46	14.93	3.03R	4.35	2.88	44.89	16.07	1.34	0.23	0.12	0.14
o_h$_t$_2	16.30	14.36	14.94	2.64R	4.34	2.90	44.74	16.20	1.07	0.23	0.12	0.14
o_h$_t$_3	16.13	14.17	14.44	3.39R	4.31	2.94	44.48	16.37	1.79	0.23	0.12	0.13
o_h$_t$_4	16.17	14.23	14.51	3.42R	4.32	2.91	44.56	16.22	1.75	0.23	0.12	0.13
o_ch$_t$_w	20.33	19.92	22.74	2.76R	5.02	0.97	51.75	7.25	-2.44	0.24	0.19	0.21
o_ch$_t$_0	20.90	20.48	23.41	2.52R	5.08	0.98	52.37	7.31	-2.51	0.25	0.19	0.22
o_ch$_t$_1	19.60	19.16	21.41	5.83R	4.93	1.02	50.87	7.41	-1.57	0.23	0.18	0.20
o_ch$_t$_2	19.81	19.33	21.59	5.54R	4.95	1.07	51.07	7.61	-1.56	0.24	0.18	0.20
o_ch$_t$_3	18.60	18.24	19.10	2.75YR	4.83	1.06	49.78	6.97	0.91	0.23	0.17	0.18
o_ch$_t$_4	18.53	18.21	19.19	2.82YR	4.82	1.00	49.75	6.76	0.68	0.22	0.17	0.18
o_lb$_t$_w	10.53	11.16	14.07	1.06B	3.87	0.83	39.85	-0.41	-5.30	0.10	0.11	0.13
o_lb$_t$_0	10.82	11.47	14.57	1.92B	3.92	0.88	40.36	-0.42	-5.63	0.10	0.12	0.14
o_lb$_t$_1	10.15	10.79	13.62	0.66B	3.81	0.87	39.23	-0.64	-5.29	0.10	0.11	0.13
o_lb$_t$_2	9.96	10.59	13.29	0.11B	3.78	0.83	38.88	-0.60	-5.08	0.09	0.11	0.12
o_lb$_t$_3	10.53	11.21	13.73	7.13BG	3.88	0.78	39.93	-0.72	-4.36	0.10	0.11	0.13
o_lb$_t$_4	10.32	11.03	13.38	5.32BG	3.85	0.83	39.64	-1.13	-3.98	0.10	0.11	0.12
t_ll_w	10.75	12.29	11.39	9.58GY	4.04	2.06	41.67	-6.60	4.75	0.10	0.13	0.10
t_ll_0	7.53	7.89	17.38	2.24PB	3.29	4.47	33.75	0.45	-23.24	0.04	0.08	0.17
t_ll_1	7.90	8.34	18.75	1.99PB	3.37	4.81	34.68	-0.03	-24.45	0.03	0.09	0.19
t_ll_2	7.58	7.99	17.96	2.05PB	3.31	4.70	33.95	0.11	-24.10	0.03	0.08	0.18
t_ll_3	7.57	7.90	19.72	2.45PB	3.29	5.56	33.78	0.76	-27.88	0.03	0.08	0.20
t_ll_4	7.90	8.26	20.76	2.39PB	3.36	5.75	34.53	0.61	-28.56	0.03	0.09	0.21
t_cg_w	18.39	20.62	12.48	1.99GY	5.09	3.48	52.53	-5.97	20.52	0.22	0.21	0.10
t_cg_0	15.94	17.67	11.45	1.63GY	4.76	3.01	49.10	-4.62	17.38	0.19	0.18	0.09
t_cg_1	15.54	17.31	11.17	1.96GY	4.72	3.03	48.65	-5.03	17.38	0.18	0.18	0.09
t_cg_2	15.84	17.65	11.59	2.11GY	4.76	2.99	49.07	-5.06	16.93	0.18	0.18	0.10
t_cg_3	15.22	16.99	11.56	2.62GY	4.68	2.85	48.25	-5.23	15.61	0.17	0.18	0.10
t_cg_4	16.00	17.95	12.05	2.89GY	4.79	2.99	49.44	-5.75	16.35	0.18	0.19	0.10
t_cy_w	66.75	68.05	10.09	3.79Y	8.48	12.54	86.03	5.02	84.96	1.07	0.63	0.00
t_cy_0	65.50	66.37	8.24	3.67Y	8.39	13.22	85.18	5.87	89.45	1.06	0.61	-0.01
t_cy_1	65.49	66.53	9.79	3.69Y	8.40	12.50	85.26	5.51	84.56	1.05	0.62	0.00
t_cy_2	63.27	64.05	9.40	3.60Y	8.27	12.39	83.99	5.95	83.56	1.02	0.59	0.00
t_cy_3	58.02	58.63	9.63	3.56Y	7.97	11.62	81.09	6.02	77.86	0.93	0.54	0.01

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
t_cy_4	56.24	56.76	9.25	3.54Y	7.87	11.53	80.04	6.14	77.25	0.90	0.52	0.01
t_go_w	33.89	30.05	10.19	7.54YR	6.00	7.86	61.70	19.93	42.71	0.59	0.24	0.07
t_go_0	30.83	27.45	9.92	7.61YR	5.77	7.32	59.39	18.88	39.57	0.53	0.22	0.07
t_go_1	30.44	27.12	9.74	7.66YR	5.74	7.30	59.09	18.73	39.58	0.52	0.22	0.06
t_go_2	30.33	26.95	9.77	7.52YR	5.72	7.28	58.93	18.99	39.21	0.52	0.22	0.07
t_go_3	30.57	27.26	10.04	7.61YR	5.75	7.20	59.22	18.66	38.89	0.52	0.22	0.07
t_go_4	29.92	26.65	9.96	7.54YR	5.70	7.10	58.65	18.62	38.17	0.51	0.21	0.07
t_ru_w	9.75	8.87	6.43	5.16YR	3.48	2.64	35.73	11.26	10.94	0.15	0.07	0.06
t_ru_0	8.60	8.02	6.46	5.43YR	3.31	2.00	34.01	9.09	7.86	0.12	0.07	0.06
t_ru_1	8.97	8.34	6.61	5.49YR	3.37	2.09	34.68	9.34	8.38	0.13	0.07	0.06
t_ru_2	8.77	8.20	6.67	5.55YR	3.35	1.96	34.39	8.89	7.67	0.12	0.07	0.06
t_ru_3	8.85	8.24	6.65	5.26YR	3.35	2.03	34.47	9.27	7.90	0.13	0.07	0.06
t_ru_4	8.70	8.15	6.61	5.72YR	3.34	1.95	34.29	8.77	7.71	0.12	0.07	0.06
t_bs_w	11.29	9.21	5.99	0.94YR	3.54	4.28	36.39	20.19	13.91	0.19	0.07	0.05
t_bs_0	11.68	9.72	7.05	0.28YR	3.63	3.80	37.33	18.91	11.24	0.19	0.07	0.06
t_bs_1	11.04	9.22	6.80	0.27YR	3.54	3.63	36.40	18.28	10.61	0.18	0.07	0.06
t_bs_2	11.34	9.54	7.20	0.21YR	3.60	3.52	37.01	17.88	10.11	0.18	0.07	0.06
t_bs_3	11.64	9.72	7.18	0.15YR	3.63	3.71	37.33	18.62	10.74	0.19	0.07	0.06
t_bs_4	11.34	9.55	6.90	0.86YR	3.60	3.63	37.01	17.85	11.28	0.19	0.07	0.06
t_ro_w	16.91	13.17	7.38	0.17YR	4.17	6.09	43.01	27.10	19.79	0.31	0.09	0.06
t_ro_0	15.23	12.21	7.50	0.49YR	4.03	5.20	41.55	23.75	16.85	0.27	0.08	0.06
t_ro_1	15.08	12.12	7.39	0.65YR	4.02	5.17	41.40	23.48	16.99	0.27	0.08	0.06
t_ro_2	15.41	12.39	7.59	0.59YR	4.06	5.20	41.82	23.62	16.99	0.27	0.09	0.06
t_ro_3	15.43	12.39	7.67	0.44YR	4.06	5.19	41.82	23.72	16.71	0.27	0.09	0.06
t_ro_4	16.19	13.09	7.96	0.81YR	4.16	5.25	42.90	23.50	17.52	0.28	0.09	0.07
t_h_w	9.18	7.37	6.06	6.65R	3.18	3.63	32.63	19.97	7.10	0.15	0.05	0.05
t_h_0	8.90	7.22	6.24	5.95R	3.15	3.37	32.30	19.04	5.81	0.15	0.05	0.06
t_h_1	8.99	7.30	6.27	6.10R	3.16	3.39	32.48	19.05	5.97	0.15	0.05	0.06
t_h_2	8.95	7.27	6.24	6.21R	3.16	3.36	32.42	18.92	6.01	0.15	0.05	0.06
t_h_3	8.94	7.23	6.18	6.09R	3.15	3.43	32.33	19.28	6.08	0.15	0.05	0.06
t_h_4	8.82	7.16	6.21	5.90R	3.13	3.34	32.17	18.94	5.70	0.14	0.05	0.06
t_ch_w	7.70	6.89	6.39	9.19R	3.08	1.90	31.56	11.58	3.91	0.11	0.06	0.06
t_ch_0	7.79	7.08	6.89	8.51R	3.12	1.64	31.98	10.51	2.62	0.11	0.06	0.06
t_ch_1	7.77	7.08	6.88	8.83R	3.12	1.62	31.99	10.36	2.71	0.11	0.06	0.06
t_ch_2	7.92	7.22	7.02	8.94R	3.15	1.62	32.31	10.30	2.71	0.11	0.06	0.06
t_ch_3	7.83	7.13	6.94	8.62R	3.13	1.63	32.09	10.45	2.63	0.11	0.06	0.06
t_ch_4	7.85	7.14	6.96	8.58R	3.13	1.64	32.13	10.48	2.62	0.11	0.06	0.06
t_lb_w	4.85	5.10	5.78	1.73G	2.64	0.43	27.00	0.21	-1.38	0.05	0.05	0.05
t_lb_0	5.38	5.64	6.54	6.38G	2.78	0.39	28.48	0.38	-2.01	0.05	0.06	0.06
t_lb_1	5.41	5.69	6.54	4.72G	2.79	0.43	28.60	0.21	-1.82	0.06	0.06	0.06
t_lb_2	5.44	5.72	6.59	4.88G	2.80	0.43	28.70	0.18	-1.83	0.06	0.06	0.06
t_lb_3	5.30	5.58	6.47	6.84G	2.76	0.44	28.33	0.13	-1.98	0.05	0.06	0.06
t_lb_4	5.34	5.60	6.54	8.31G	2.77	0.38	28.38	0.41	-2.18	0.05	0.06	0.06

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
t_td_w	87.31	91.38	82.44	7.52Y	9.56	1.90	96.57	1.25	10.91	1.01	0.90	0.73
t_td_0	83.54	87.45	77.07	7.12Y	9.39	2.06	94.93	1.21	12.14	0.98	0.86	0.68
t_td_1	84.51	88.88	78.41	8.68Y	9.45	2.04	95.53	0.46	12.15	0.98	0.88	0.69
t_td_2	84.59	89.12	81.16	0.38GY	9.46	1.81	95.63	0.18	10.25	0.97	0.89	0.72
t_td_3	84.56	89.84	87.18	4.94GY	9.49	1.46	95.93	-1.17	6.36	0.92	0.90	0.79
t_td_4	84.56	89.65	86.49	4.19GY	9.48	1.47	95.85	-0.83	6.72	0.93	0.90	0.78
t_ll$_t$_w	66.34	71.70	74.56	9.82GY	8.67	1.42	87.82	-3.64	1.86	0.68	0.73	0.68
t_ll$_t$_0	63.87	68.90	70.32	8.67GY	8.53	1.45	86.46	-3.31	2.93	0.66	0.70	0.64
t_ll$_t$_1	64.67	69.96	71.76	9.24GY	8.58	1.48	86.98	-3.73	2.65	0.66	0.72	0.65
t_ll$_t$_2	64.25	69.63	71.19	9.30GY	8.56	1.52	86.82	-3.99	2.84	0.66	0.71	0.65
t_ll$_t$_3	63.85	69.31	71.95	0.20G	8.55	1.50	86.66	-4.21	1.94	0.65	0.71	0.65
t_ll$_t$_4	64.32	69.97	73.26	0.91G	8.58	1.53	86.98	-4.56	1.45	0.64	0.72	0.67
t_cg$_t$_w	57.71	62.82	57.82	6.38GY	8.21	2.02	83.35	-4.48	8.54	0.62	0.64	0.52
t_cg$_t$_0	52.45	57.10	52.79	6.44GY	7.89	1.98	80.23	-4.36	8.04	0.56	0.58	0.47
t_cg$_t$_1	52.85	57.90	52.95	6.72GY	7.93	2.14	80.68	-5.23	8.65	0.56	0.60	0.47
t_cg$_t$_2	53.00	58.03	53.64	6.90GY	7.94	2.07	80.75	-5.15	8.09	0.56	0.60	0.48
t_cg$_t$_3	53.16	58.11	54.28	7.01GY	7.94	2.00	80.80	-4.94	7.54	0.56	0.60	0.48
t_cg$_t$_4	52.79	58.00	53.35	7.05GY	7.94	2.15	80.74	-5.62	8.34	0.55	0.60	0.48
t_cy$_t$_w	75.36	80.96	27.98	6.06Y	9.11	8.46	92.11	-2.84	58.63	1.06	0.80	0.17
t_cy$_t$_0	73.59	78.44	25.71	5.48Y	8.99	8.74	90.98	-1.61	60.24	1.05	0.77	0.15
t_cy$_t$_1	73.72	78.58	26.29	5.49Y	9.00	8.62	91.04	-1.62	59.40	1.05	0.77	0.16
t_cy$_t$_2	71.99	76.78	26.22	5.57Y	8.91	8.43	90.22	-1.68	58.10	1.02	0.75	0.16
t_cy$_t$_3	68.99	73.17	26.10	5.24Y	8.74	8.09	88.53	-0.83	55.38	0.98	0.71	0.16
t_cy$_t$_4	67.08	71.53	25.38	5.68Y	8.66	8.04	87.74	-1.64	55.19	0.95	0.70	0.16
t_go$_t$_w	67.33	68.03	51.20	1.32Y	8.48	3.50	86.02	6.33	19.62	0.88	0.64	0.44
t_go$_t$_0	63.71	63.84	47.34	0.60Y	8.26	3.67	83.88	7.43	19.96	0.85	0.60	0.41
t_go$_t$_1	64.34	64.67	47.90	0.91Y	8.31	3.65	84.31	7.00	20.11	0.85	0.61	0.41
t_go$_t$_2	64.09	64.46	47.68	0.98Y	8.29	3.65	84.20	6.89	20.15	0.85	0.61	0.41
t_go$_t$_3	64.00	64.33	48.22	0.86Y	8.29	3.56	84.14	6.99	19.46	0.84	0.61	0.41
t_go$_t$_4	63.55	63.95	48.06	0.98Y	8.27	3.53	83.94	6.80	19.29	0.84	0.60	0.41
t_ru$_t$_w	44.91	45.19	37.95	0.86Y	7.14	2.44	73.01	6.07	12.04	0.57	0.43	0.33
t_ru$_t$_0	40.33	40.25	34.17	9.95YR	6.80	2.37	69.64	6.86	11.09	0.52	0.38	0.30
t_ru$_t$_1	40.57	40.53	34.37	0.07Y	6.82	2.37	69.85	6.76	11.18	0.52	0.38	0.30
t_ru$_t$_2	40.66	40.76	34.62	0.44Y	6.84	2.33	70.01	6.34	11.12	0.52	0.38	0.31
t_ru$_t$_3	40.46	40.35	34.38	9.82YR	6.81	2.36	69.72	6.97	10.93	0.52	0.38	0.30
t_ru$_t$_4	40.08	40.10	34.21	0.23Y	6.79	2.30	69.54	6.52	10.86	0.51	0.38	0.30
t_bs$_t$_w	50.14	49.04	43.22	6.82YR	7.40	2.66	75.47	10.06	10.01	0.66	0.45	0.38
t_bs$_t$_0	52.29	50.18	42.92	5.02YR	7.47	3.23	76.18	12.72	11.57	0.71	0.45	0.38
t_bs$_t$_1	52.87	50.95	43.62	5.48YR	7.52	3.16	76.65	12.18	11.58	0.71	0.46	0.39
t_bs$_t$_2	52.48	50.61	43.75	5.38YR	7.50	3.08	76.44	12.07	11.08	0.70	0.46	0.39
t_bs$_t$_3	52.11	50.07	43.33	4.96YR	7.46	3.14	76.11	12.52	10.99	0.70	0.45	0.38
t_bs$_t$_4	51.65	49.78	43.25	5.23YR	7.44	3.04	75.93	12.09	10.77	0.69	0.45	0.38
t_ro$_t$_w	49.71	47.49	42.31	3.77YR	7.30	3.06	74.50	13.08	9.38	0.67	0.43	0.38

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L*	a*	b*	R	G	B
t_ro$_t$_0	47.46	45.12	40.52	3.16YR	7.14	3.07	72.97	13.49	8.84	0.64	0.40	0.36
t_ro$_t$_1	47.58	45.36	40.51	3.55YR	7.16	3.04	73.13	13.16	9.12	0.64	0.41	0.36
t_ro$_t$_2	47.45	45.24	40.38	3.57YR	7.15	3.04	73.05	13.14	9.13	0.64	0.41	0.36
t_ro$_t$_3	47.58	45.26	40.79	3.12YR	7.15	3.04	73.06	13.44	8.67	0.64	0.40	0.37
t_ro$_t$_4	47.31	45.19	40.36	3.78YR	7.15	2.99	73.02	12.87	9.11	0.64	0.41	0.36
t_h$_t$_w	23.75	21.57	23.32	1.65R	5.20	2.87	53.57	15.33	-0.29	0.32	0.18	0.22
t_h$_t$_0	21.59	19.52	21.50	0.30R	4.97	2.83	51.29	15.27	-1.00	0.29	0.17	0.20
t_h$_t$_1	21.79	19.73	21.59	0.78R	5.00	2.81	51.54	15.16	-0.76	0.30	0.17	0.20
t_h$_t$_2	21.84	19.84	21.71	0.89R	5.01	2.76	51.65	14.93	-0.76	0.29	0.17	0.20
t_h$_t$_3	21.55	19.57	21.48	0.72R	4.98	2.74	51.35	14.84	-0.87	0.29	0.17	0.20
t_h$_t$_4	21.59	19.62	21.50	0.85R	4.98	2.72	51.41	14.77	-0.82	0.29	0.17	0.20
t_ch$_t$_w	34.01	33.67	35.74	3.31YR	6.30	1.11	64.70	7.44	0.50	0.41	0.32	0.33
t_ch$_t$_0	37.94	36.77	37.91	0.81YR	6.54	1.83	67.10	10.24	1.90	0.48	0.34	0.35
t_ch$_t$_1	37.38	36.41	37.52	1.61YR	6.52	1.69	66.83	9.63	1.91	0.46	0.34	0.34
t_ch$_t$_2	37.12	36.09	37.17	1.37YR	6.49	1.73	66.59	9.79	1.93	0.46	0.33	0.34
t_ch$_t$_3	37.59	36.36	37.62	0.36YR	6.51	1.85	66.80	10.44	1.72	0.47	0.33	0.34
t_ch$_t$_4	37.28	36.17	37.70	0.42YR	6.50	1.74	66.65	10.04	1.37	0.46	0.33	0.35
t_lb$_t$_w	20.79	22.19	27.15	7.49BG	5.26	0.98	54.22	-1.16	-5.42	0.20	0.23	0.25
t_lb$_t$_0	19.42	20.68	26.08	1.22B	5.10	1.10	52.60	-0.96	-6.54	0.18	0.21	0.24
t_lb$_t$_1	19.63	20.97	26.26	9.99BG	5.13	1.10	52.92	-1.24	-6.28	0.18	0.21	0.25
t_lb$_t$_2	19.75	21.09	26.36	9.80BG	5.14	1.09	53.05	-1.25	-6.21	0.18	0.22	0.25
t_lb$_t$_3	19.45	20.83	26.19	0.05B	5.12	1.17	52.76	-1.51	-6.43	0.18	0.21	0.25
t_lb$_t$_4	19.40	20.77	26.04	9.78BG	5.11	1.14	52.7	-1.47	-6.29	0.18	0.21	0.24
w_ll_w	7.50	7.58	18.64	3.74PB	3.22	5.27	33.09	3.04	-26.96	0.03	0.08	0.19
w_ll_0	7.49	7.58	19.51	3.60PB	3.22	5.66	33.09	2.93	-28.66	0.03	0.08	0.19
w_ll_1	7.15	7.20	17.47	3.89PB	3.14	5.01	32.26	3.25	-26.01	0.03	0.07	0.17
w_ll_2	7.56	7.58	21.36	3.78PB	3.22	6.43	33.10	3.55	-32.12	0.02	0.08	0.21
w_ll_3	7.59	7.74	21.73	3.25PB	3.26	6.49	33.43	2.45	-32.23	0.02	0.08	0.22
w_ll_4	7.53	7.67	21.38	3.27PB	3.24	6.39	33.29	2.47	-31.83	0.02	0.08	0.21
w_cg_w	10.13	11.73	8.69	6.01GY	3.96	2.64	40.78	-7.47	11.38	0.10	0.13	0.07
w_cg_0	9.17	10.30	7.94	4.76GY	3.73	2.21	38.37	-4.87	9.80	0.10	0.11	0.07
w_cg_1	9.46	10.61	8.15	4.65GY	3.78	2.22	38.92	-4.86	10.00	0.10	0.11	0.07
w_cg_2	7.28	8.12	7.44	7.02GY	3.33	1.62	34.24	-3.99	4.43	0.07	0.08	0.07
w_cg_3	7.29	8.10	7.57	7.20GY	3.33	1.53	34.19	-3.72	3.90	0.07	0.08	0.07
w_cg_4	7.40	8.22	7.77	7.50GY	3.35	1.50	34.43	-3.73	3.59	0.07	0.09	0.07
w_cy_w	69.30	71.04	9.59	3.98Y	8.63	13.06	87.51	4.25	89.04	1.11	0.67	-0.01
w_cy_0	67.69	68.94	9.68	3.77Y	8.53	12.84	86.47	5.19	86.98	1.09	0.64	0.00
w_cy_1	66.22	67.54	9.24	3.84Y	8.46	12.85	85.77	4.94	87.17	1.06	0.63	0.00
w_cy_2	63.71	65.01	8.70	3.91Y	8.32	12.77	84.49	4.79	86.71	1.02	0.61	-0.01
w_cy_3	58.20	59.02	9.40	3.70Y	8.00	11.73	81.30	5.52	78.94	0.93	0.55	0.01
w_cy_4	54.81	55.40	9.17	3.62Y	7.79	11.36	79.27	5.87	76.18	0.88	0.51	0.01
w_go_w	28.02	24.52	8.42	7.11YR	5.49	7.41	56.61	20.10	39.58	0.49	0.19	0.05
w_go_0	25.00	21.72	8.44	6.35YR	5.21	6.76	53.73	20.09	34.52	0.43	0.17	0.06

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
w_go_1	25.02	21.83	8.66	6.47YR	5.22	6.63	53.85	19.63	33.99	0.43	0.17	0.06
w_go_2	25.18	21.91	8.71	6.33YR	5.23	6.67	53.93	19.94	33.97	0.44	0.17	0.06
w_go_3	24.06	20.87	8.38	6.16YR	5.12	6.56	52.80	19.97	33.13	0.42	0.16	0.06
w_go_4	23.98	20.78	8.50	6.04YR	5.11	6.50	52.71	20.02	32.59	0.42	0.16	0.06
w_ru_w	7.63	7.19	5.59	7.06YR	3.14	1.96	32.23	8.01	8.46	0.11	0.06	0.05
w_ru_0	6.58	6.42	5.93	8.15YR	2.97	1.12	30.45	5.25	3.92	0.08	0.06	0.05
w_ru_1	7.05	6.92	6.41	8.63YR	3.08	1.11	31.62	5.03	3.94	0.09	0.06	0.06
w_ru_2	6.91	6.73	6.14	8.06YR	3.04	1.19	31.19	5.48	4.28	0.09	0.06	0.06
w_ru_3	6.53	6.44	6.03	9.05YR	2.97	1.02	30.49	4.61	3.53	0.08	0.06	0.05
w_ru_4	6.45	6.37	6.02	9.07YR	2.96	0.98	30.32	4.51	3.29	0.08	0.06	0.05
w_bs_w	9.18	7.68	5.65	0.69YR	3.24	3.35	33.32	16.99	10.05	0.15	0.06	0.05
w_bs_0	7.73	6.60	5.31	0.26YR	3.01	2.71	30.87	14.77	7.39	0.12	0.05	0.05
w_bs_1	7.92	6.80	5.56	0.18YR	3.05	2.64	31.34	14.50	7.06	0.12	0.05	0.05
w_bs_2	7.84	6.64	5.17	0.54YR	3.02	2.89	30.98	15.31	8.23	0.13	0.05	0.05
w_bs_3	7.52	6.36	4.98	0.44YR	2.96	2.85	30.31	15.21	7.96	0.12	0.05	0.04
w_bs_4	7.55	6.35	4.86	0.58YR	2.95	2.96	30.28	15.59	8.49	0.12	0.05	0.04
w_ro_w	11.95	9.41	6.07	9.68R	3.57	4.84	36.76	23.27	14.17	0.21	0.06	0.05
w_ro_0	12.34	9.90	6.80	9.53R	3.66	4.52	37.67	22.08	12.80	0.21	0.07	0.06
w_ro_1	11.67	9.30	6.29	9.58R	3.55	4.53	36.56	22.17	12.94	0.20	0.06	0.05
w_ro_2	11.67	9.25	6.17	9.53R	3.54	4.64	36.46	22.62	13.26	0.21	0.06	0.05
w_ro_3	11.46	9.15	6.26	9.54R	3.53	4.44	36.28	21.87	12.57	0.20	0.06	0.05
w_ro_4	11.44	9.14	6.20	9.64R	3.53	4.46	36.25	21.85	12.76	0.20	0.06	0.05
w_h_w	10.02	7.90	6.27	6.57R	3.29	4.09	33.77	21.90	8.19	0.17	0.05	0.06
w_h_0	10.01	8.07	6.60	6.88R	3.32	3.74	34.13	20.24	7.50	0.17	0.06	0.06
w_h_1	9.92	8.04	6.65	6.78R	3.31	3.64	34.06	19.86	7.16	0.16	0.06	0.06
w_h_2	9.31	7.52	6.26	6.54R	3.21	3.57	32.95	19.71	6.82	0.16	0.05	0.06
w_h_3	9.49	7.77	6.67	6.36R	3.26	3.37	33.49	18.82	6.10	0.15	0.06	0.06
w_h_4	9.28	7.57	6.50	6.30R	3.22	3.37	33.08	18.88	6.08	0.15	0.05	0.06
w_ch_w	8.90	7.50	6.32	8.32R	3.21	2.94	32.91	16.38	6.50	0.14	0.06	0.06
w_ch_0	8.20	7.53	7.09	0.66YR	3.21	1.66	32.98	10.01	3.61	0.11	0.06	0.06
w_ch_1	8.47	7.75	7.23	0.73YR	3.26	1.73	33.46	10.29	3.90	0.12	0.07	0.07
w_ch_2	8.69	7.58	6.73	8.88R	3.22	2.39	33.10	13.79	5.21	0.13	0.06	0.06
w_ch_3	8.59	7.55	6.70	9.31R	3.22	2.30	33.03	13.26	5.20	0.13	0.06	0.06
w_ch_4	8.44	7.44	6.64	9.25R	3.19	2.24	32.78	13.03	5.00	0.13	0.06	0.06
w_lb_w	5.19	5.45	6.18	1.35G	2.73	0.42	27.98	0.30	-1.39	0.05	0.05	0.06
w_lb_0	5.68	5.97	6.82	2.83G	2.86	0.41	29.32	0.30	-1.65	0.06	0.06	0.06
w_lb_1	5.70	5.99	6.81	1.96G	2.87	0.42	29.39	0.27	-1.51	0.06	0.06	0.06
w_lb_2	5.36	5.66	6.41	2.52G	2.78	0.48	28.52	-0.02	-1.43	0.05	0.06	0.06
w_lb_3	5.32	5.59	6.47	6.22G	2.77	0.43	28.36	0.17	-1.94	0.05	0.06	0.06
w_lb_4	5.24	5.51	6.34	4.83G	2.75	0.42	28.13	0.23	-1.82	0.05	0.06	0.06
w_td_w	90.22	95.77	100.63	7.81GY	9.74	1.05	98.34	-1.05	1.38	0.95	0.96	0.92
w_td_0	89.45	94.76	100.70	8.14GY	9.70	0.98	97.94	-0.72	0.63	0.94	0.95	0.92
w_td_1	88.73	94.08	99.78	8.17GY	9.67	1.01	97.66	-0.85	0.76	0.93	0.95	0.91

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Table 2: Paint sample color conversions.

	X	Y	Z	H	V	C	L^*	a^*	b^*	R	G	B
w_td_2	87.83	93.58	96.73	7.57GY	9.65	1.18	97.46	-1.66	2.43	0.93	0.94	0.88
w_td_3	90.16	95.75	100.53	7.86GY	9.74	1.07	98.33	-1.14	1.43	0.95	0.96	0.92
w_td_4	89.52	95.13	99.26	7.61GY	9.71	1.10	98.08	-1.23	1.83	0.94	0.96	0.90
w_ll_t_w	81.95	87.84	97.23	3.36G	9.41	1.11	95.09	-2.57	-1.99	0.82	0.89	0.89
w_ll_t_0	78.98	84.74	95.82	6.30G	9.27	1.14	93.77	-2.69	-3.33	0.78	0.86	0.88
w_ll_t_1	78.81	84.73	95.47	6.04G	9.27	1.19	93.77	-3.01	-3.11	0.78	0.87	0.88
w_ll_t_2	77.81	83.71	95.01	7.21G	9.23	1.21	93.32	-3.09	-3.56	0.76	0.86	0.88
w_ll_t_3	78.92	84.87	96.01	6.67G	9.28	1.20	93.83	-3.06	-3.36	0.77	0.87	0.89
w_ll_t_4	77.99	83.92	94.22	5.61G	9.24	1.21	93.42	-3.13	-2.86	0.77	0.86	0.87
w_cg_t_w	58.97	64.45	60.58	7.20GY	8.29	1.98	84.20	-5.10	7.46	0.62	0.66	0.54
w_cg_t_0	52.63	57.81	54.94	7.88GY	7.93	1.99	80.63	-5.59	6.61	0.54	0.60	0.49
w_cg_t_1	52.07	57.21	54.58	8.01GY	7.89	1.98	80.29	-5.59	6.37	0.54	0.59	0.49
w_cg_t_2	51.31	56.54	53.57	8.06GY	7.85	2.06	79.92	-5.99	6.72	0.53	0.59	0.48
w_cg_t_3	50.25	55.38	53.25	8.53GY	7.79	1.99	79.26	-5.97	5.89	0.51	0.57	0.48
w_cg_t_4	49.37	54.36	52.43	8.53GY	7.72	1.96	78.67	-5.8	5.70	0.50	0.56	0.47
w_cy_t_w	77.79	83.98	33.33	6.60Y	9.24	7.67	93.44	-3.64	53.25	1.06	0.84	0.22
w_cy_t_0	76.34	82.18	30.07	6.26Y	9.16	8.12	92.65	-3.19	56.45	1.06	0.81	0.19
w_cy_t_1	75.59	81.32	29.99	6.24Y	9.12	8.05	92.27	-3.08	55.92	1.05	0.81	0.19
w_cy_t_2	73.15	78.57	25.35	6.04Y	9.00	8.80	91.04	-2.79	60.91	1.04	0.78	0.15
w_cy_t_3	69.43	74.12	24.64	5.67Y	8.78	8.51	88.98	-1.81	58.52	0.99	0.73	0.15
w_cy_t_4	66.65	70.82	23.49	5.39Y	8.62	8.43	87.40	-1.09	57.73	0.95	0.69	0.14
w_go_t_w	68.82	69.71	51.61	1.59Y	8.57	3.60	86.85	6.03	20.64	0.90	0.66	0.44
w_go_t_0	64.22	64.44	47.19	0.78Y	8.29	3.75	84.19	7.25	20.66	0.86	0.61	0.40
w_go_t_1	63.77	64.05	46.88	0.89Y	8.27	3.74	83.99	7.08	20.64	0.85	0.60	0.40
w_go_t_2	63.29	63.38	46.02	0.65Y	8.24	3.82	83.64	7.49	20.97	0.85	0.59	0.39
w_go_t_3	61.24	61.24	44.53	0.55Y	8.12	3.81	82.51	7.61	20.66	0.82	0.57	0.38
w_go_t_4	60.30	60.02	43.62	0.14Y	8.05	3.86	81.85	8.23	20.55	0.81	0.56	0.37
w_ru_t_w	54.19	55.04	46.93	1.71Y	7.77	2.39	79.07	5.18	12.09	0.68	0.53	0.41
w_ru_t_0	46.47	46.79	40.78	0.63Y	7.25	2.22	74.05	6.05	10.40	0.58	0.44	0.36
w_ru_t_1	46.24	46.63	40.68	0.80Y	7.24	2.19	73.95	5.87	10.33	0.58	0.44	0.36
w_ru_t_2	48.31	48.65	41.48	0.75Y	7.37	2.40	75.23	6.13	11.60	0.61	0.46	0.37
w_ru_t_3	45.86	46.20	40.24	0.69Y	7.21	2.21	73.67	5.98	10.38	0.58	0.44	0.36
w_ru_t_4	44.03	44.25	38.95	0.39Y	7.08	2.13	72.39	6.17	9.74	0.55	0.42	0.35
w_bs_t_w	60.72	59.39	52.88	6.24YR	8.02	2.82	81.51	10.71	10.14	0.79	0.55	0.47
w_bs_t_0	48.93	47.20	43.67	4.00YR	7.28	2.65	74.32	11.75	7.51	0.64	0.43	0.39
w_bs_t_1	45.96	44.15	41.28	3.28YR	7.07	2.62	72.33	12.04	6.84	0.60	0.40	0.37
w_bs_t_2	43.67	42.09	39.69	3.48YR	6.93	2.45	70.93	11.44	6.32	0.57	0.38	0.36
w_bs_t_3	39.97	38.16	36.52	1.94YR	6.65	2.49	68.14	12.24	5.43	0.53	0.34	0.33
w_bs_t_4	37.08	35.34	34.20	1.37YR	6.43	2.41	66.01	12.14	4.78	0.49	0.32	0.31
w_ro_t_w	53.40	51.47	46.81	4.18YR	7.55	2.85	76.96	12.23	8.60	0.71	0.47	0.42
w_ro_t_0	46.70	44.03	40.35	1.77YR	7.07	3.15	72.25	14.48	7.80	0.64	0.39	0.36
w_ro_t_1	45.70	42.82	39.21	1.17YR	6.98	3.27	71.43	15.15	7.77	0.63	0.38	0.35
w_ro_t_2	45.70	42.90	37.84	2.38YR	6.99	3.39	71.49	14.95	9.54	0.63	0.38	0.34

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Table 2: Paint sample color conversions.

	X	**Y**	**Z**	**H**	**V**	**C**	**L***	**a***	**b***	**R**	**G**	**B**
w_ro$_t$_3	43.91	41.02	37.17	1.20YR	6.86	3.33	70.19	15.34	8.14	0.61	0.36	0.33
w_ro$_t$_4	43.37	40.37	36.84	0.67YR	6.81	3.36	69.73	15.72	7.76	0.60	0.35	0.33
w_h$_t$_w	34.07	32.44	36.52	0.74R	6.20	2.14	63.70	11.93	-2.22	0.42	0.29	0.34
w_h$_t$_0	24.53	22.71	27.02	5.78RP	5.31	2.52	54.77	13.52	-4.27	0.31	0.20	0.25
w_h$_t$_1	23.28	21.50	25.85	5.16RP	5.19	2.53	53.49	13.55	-4.62	0.29	0.19	0.24
w_h$_t$_2	18.45	16.68	19.70	6.52RP	4.64	2.61	47.85	14.53	-3.58	0.24	0.14	0.18
w_h$_t$_3	16.93	15.29	17.91	7.02RP	4.46	2.48	46.03	14.20	-3.17	0.22	0.13	0.17
w_h$_t$_4	16.58	15.01	17.37	7.71RP	4.43	2.39	45.65	13.89	-2.71	0.22	0.13	0.16
w_ch$_t$_w	52.75	52.26	54.98	3.47YR	7.60	1.47	77.44	8.49	1.06	0.63	0.49	0.50
w_ch$_t$_0	46.38	45.57	49.67	9.07R	7.17	1.47	73.27	9.19	-0.81	0.55	0.43	0.46
w_ch$_t$_1	45.49	44.60	48.76	8.25R	7.10	1.50	72.63	9.41	-0.96	0.55	0.42	0.45
w_ch$_t$_2	42.51	41.59	45.48	7.89R	6.90	1.48	70.59	9.47	-0.94	0.51	0.39	0.42
w_ch$_t$_3	39.32	38.25	43.01	3.18R	6.65	1.60	68.20	9.92	-2.28	0.47	0.35	0.40
w_ch$_t$_4	37.92	36.70	41.61	1.29R	6.54	1.75	67.05	10.39	-2.65	0.46	0.34	0.39
w_lb$_t$_w	16.46	17.61	24.06	6.29B	4.75	1.70	49.02	-1.33	-9.40	0.14	0.18	0.23
w_lb$_t$_0	14.20	15.11	21.13	7.80B	4.44	1.73	45.78	-0.77	-9.84	0.12	0.15	0.20
w_lb$_t$_1	14.11	15.03	20.95	7.52B	4.43	1.71	45.67	-0.87	-9.69	0.12	0.15	0.20
w_lb$_t$_2	12.76	13.59	18.55	6.60B	4.23	1.47	43.63	-0.81	-8.60	0.11	0.14	0.18
w_lb$_t$_3	12.28	12.98	17.92	8.01B	4.14	1.47	42.73	-0.20	-8.88	0.11	0.13	0.17
w_lb$_t$_4	11.89	12.58	17.29	7.61B	4.09	1.41	42.12	-0.29	-8.61	0.11	0.13	0.16

2.2 Effect of Binding Media

To study how different binding media affect the appearance of a single pigment, a specific time and pigment are held constant. Given this situation, there are eight spectral reflectance curves for a given pigment-time combination (since there are eight different binders). Plotted against each other, this allows for comparisons of how the binder affects the absorption and scattering of wavelengths of light of a paint sample. These changes of light behavior are important to how we perceive color differences, since any change in the reflectance spectra will incite a change in our perception of the color–our eye integrates the surface reflectance with the incident light against our color sensitivity matching functions.

In order to manage the dataset, an interactive viewer was made to browse between the 126 pigment-time combinations (included with this work as *effectOfMedia.html*). This allowed for easier viewing of the data as one can quickly see the relationships between different samples. The online application was written in JavaScript, allowing for instant feedback from a user-specified pigment and time combination. After selecting the input parameters, the system presents a spectral reflectance plot of the eight different binding media for the chosen input data. The setup for the viewer is seen in Figure 3 for Lapis Lazuli samples that have been dry for one day. The input data is chosen via drop-down menus in the top-left of the screen. To tint the chosen pigment, the checkbox is selected. Updating the graphics with new selections is done with the display button.

A photograph of the pigment is shown for reference in the top-right (for tints, titanium dioxide white is also shown). Also presented is the corresponding digital photograph for each paint sample, as spectral graphs are not a very intuitive way to analyze subtle color shifts. Yet, it is important to note that the spectral data is what is critical. Displays have significant limitations: monitors approximate colors using only three phosphors (red, green and blue), while printers only use fours inks (cyan, magenta, yellow and black) to create images. As a result, many real-world colors

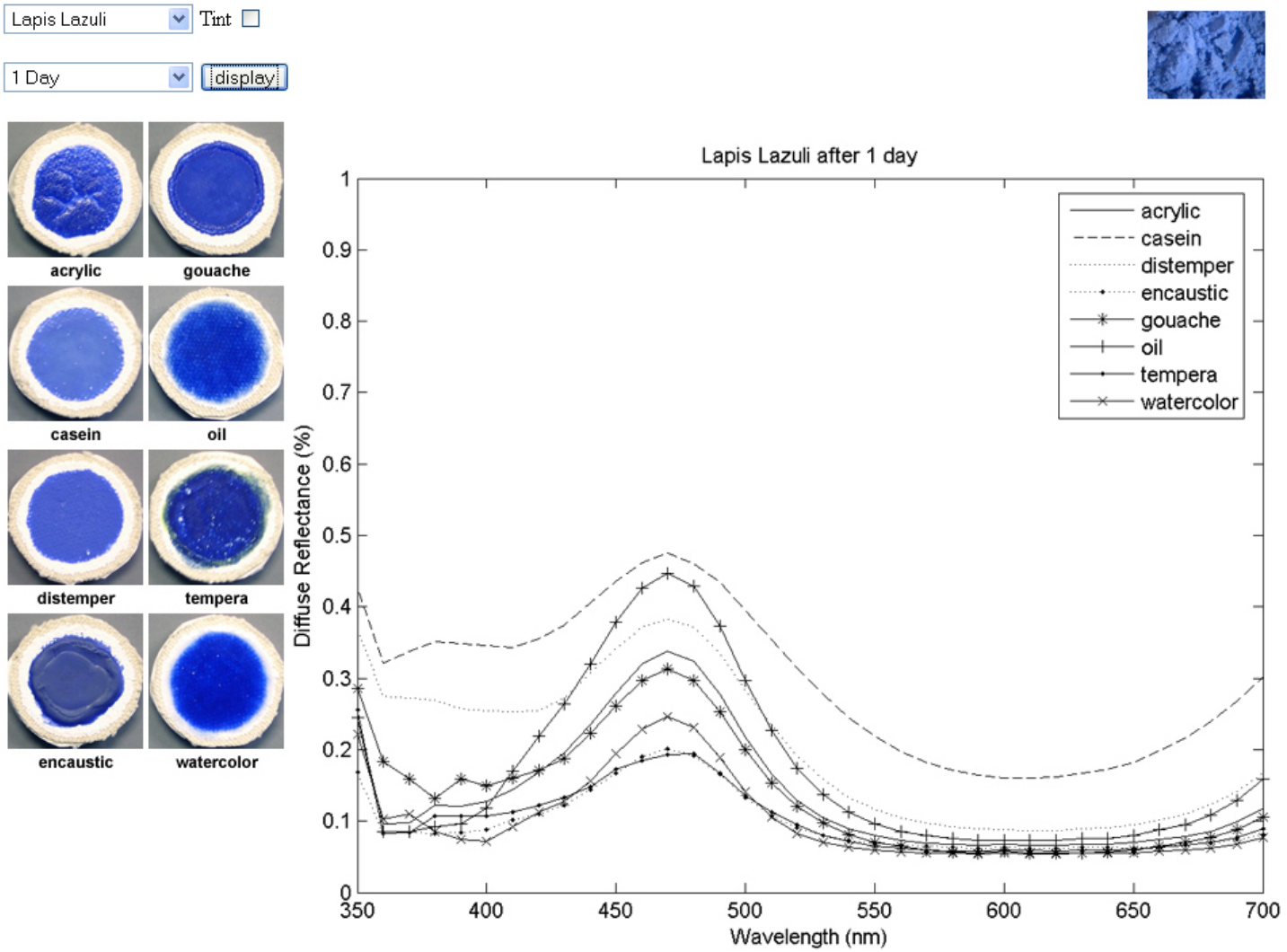

Figure 3: Lapis Lazuli in different binding media after one day.

cannot be captured by these devices. Therefore, any photographic representation will be an inadequate representation of the actual colors.

The importance of the spectral plots is that they show the behavior of light at *all* wavelengths in the visible spectrum. The spectral data combined with an illuminant and the eye's response curves can be predictive with no loss of information. However, while the photographs are not completely physically accurate depictions of the actual color of the samples, they do give the viewer a reasonable subjective comparison.

Using the Munsell color space, perceptual differences between colors can be evaluated, as it is built on the physical comparison between experimentally proven, perceptually equidistant samples. The Lapis Lazuli samples converted into the Munsell color space are illustrated in Figure 4.

The Munsell quasi-cylindrical solid is shown in the top-left of the figure. The solid is comprised of ten leaves rotated around a central axis. Each leaf corresponds to the main hue pages of the Munsell color system (10RP, 10R, 10YR, 10Y, 10GY, 10G, 10BG, 10B, 10PB, and 10P). Note that the hue designations are red R, yellow Y, green G, blue B, and purple P. The ten leaf images (from [Gre06]) are each texture mapped onto a plane at equidistant angles around the center ($\theta = \frac{2\pi}{10}$). The maximum value of one hue (10) is the minimum of the adjacent hue (0). For example, the hue *red* goes from 0 (or 10RP) to 10R (or 0YR).

Looking down the vertical axis of the cylindrical solid yields the polar coordinate plot in the bottom-left of the image. This illustrates the hue versus chroma relationship of the eight samples. The top-right image in the figure can be thought of as a leaf in the solid. It contains the value versus chroma information in a two-dimensional Cartesian plot.

The bottom-right image of the figure provides a closer view of the relationships between the eight colors in three dimensions. A sphere is placed at the point in space where the color exists in the Munsell color solid. Each sphere has a diffuse material, colored with the converted RGB values. The relevant color conversions for the Lapis

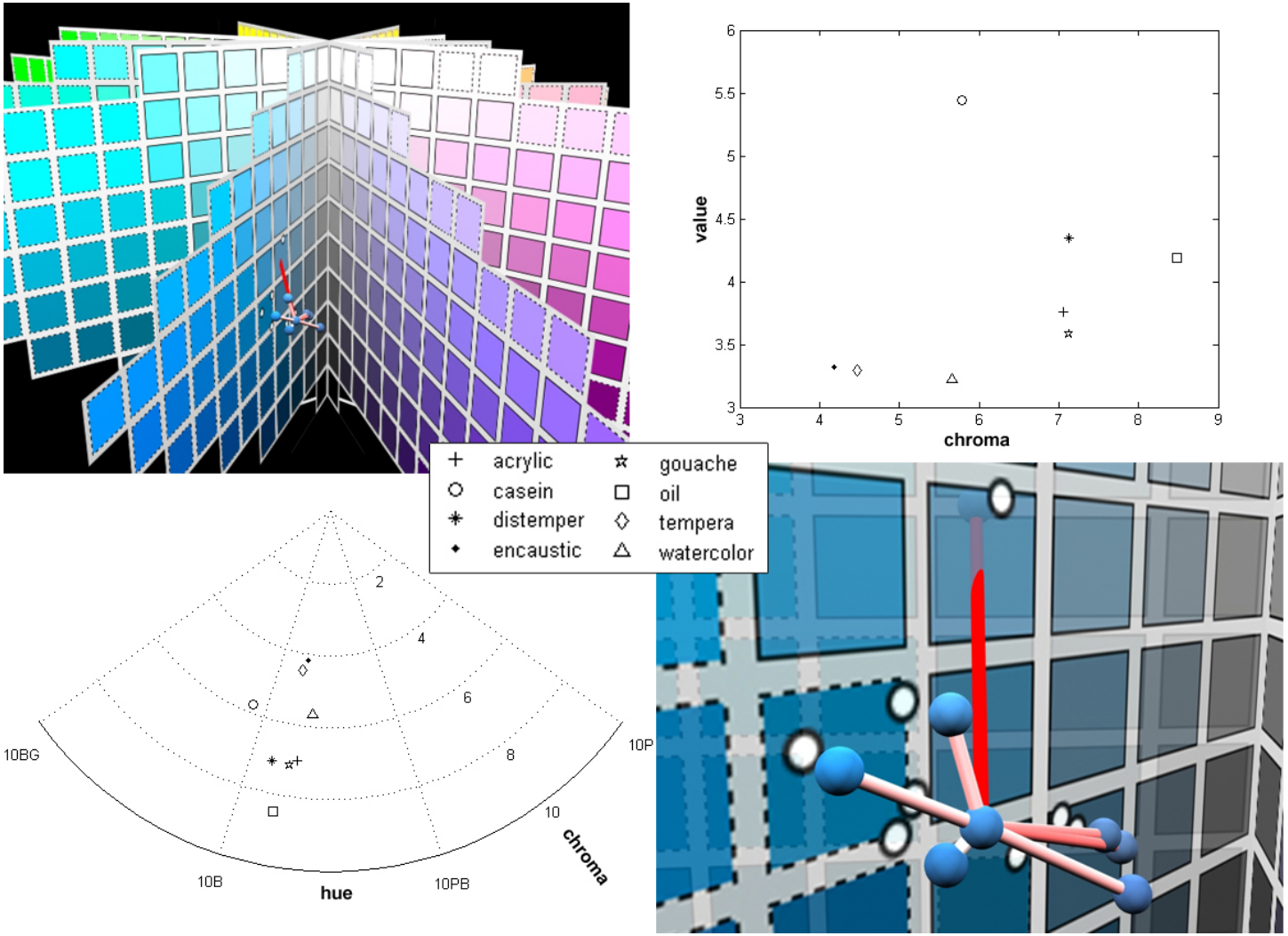

Figure 4: Munsell plots of Lapis Lazuli in different binding media after one day.

Table 3: Color conversions from the spectral reflectances of the samples of Lapis Lazuli in different binding media, dry after one day.

	X	**Y**	**Z**	**H**	**V**	**C**	L^*	a^*	b^*
acrylic	10.04	10.50	28.19	2.54PB	3.76	7.06	38.73	0.67	-33.74
casein	21.35	24.01	45.42	8.86B	5.44	5.78	56.10	-6.60	-25.85
distemper	13.28	14.43	35.06	1.29PB	4.35	7.12	44.85	-2.62	-32.83
encaustic	7.75	8.06	17.09	2.54PB	3.32	4.18	34.12	0.96	-22.00
gouache	9.03	9.46	26.48	2.43PB	3.58	7.13	36.85	0.53	-34.33
oil	12.40	13.26	37.67	1.97PB	4.19	8.48	43.15	-1.18	-39.09
tempera	7.53	7.89	17.38	2.25PB	3.29	4.47	33.75	0.46	-23.24
watercolor	7.49	7.58	19.51	3.60PB	3.22	5.66	33.09	2.93	-28.66

Lazuli samples from the large data set (Table 2) are shown in Table 3.

Projected onto each leaf are white dots showing the value-chroma plots of the three-dimensional points. The leaves also define the boundary of the displayable gamut for a typical CRT display monitor. The Munsell color swatches that are surrounded via a dotted line are unable to be realized by a typical CRT monitor (and thus will not appear as they do in real life). Many of the converted colors from the samples fall in or near this range.

The eight spheres are all connected via a series of lines, originating from the acrylic sample. This is to give a sense of the spatial relationship between the points, as there is no easy way to represent the data in only two dimensions. A relationship-connecting line between colors i and j has a saturation of red r_{sat}, such that

$$r_{sat} = r_{maxSat}\left(\frac{\Delta E_{i,j}}{\Delta E_{max}}\right) \tag{5}$$

where

r_{maxSat} is red with the maximum saturation

$\Delta E_{i,j}$ is the Euclidean distance between colors i and j in $L^*a^*b^*$ space

ΔE_{max} is the Euclidean distance between the most dissimilar colors in $L^*a^*b^*$

Hence, all of the distances are scaled by the largest distance. The more dissimilar

Table 4: Table of perceptual differences ΔE between colors using the $L^*a^*b^*$ color space. The colors are converted from samples of Lapis Lazuli in different binding media, dry after one day.

	acrylic	**casein**	**distemper**	**encaustic**	**gouache**	**oil**	**tempera**
casein	20.416						
distemper	7.008	13.825					
encaustic	12.616	23.561	15.660				
gouache	1.975	22.211	8.728	12.636			
oil	7.182	19.297	6.645	19.447	8.079		
tempera	11.623	23.583	14.989	1.387	11.515	18.501	
watercolor	7.920	25.064	13.656	7.021	7.214	15.063	5.993

colors will have a more vivid red line, while the more alike colors will have paler line colors. The Euclidean distances between the Lapis Lazuli samples in $L^*a^*b^*$ space are shown in Table 4.

Ultimately, the images show a vast amount of data in a very concise setting. The resulting conclusion from this information is that the material that adheres the pigment to the support has a great influence on the resulting color, inciting differences in the multi-dimensional space of hue, value and chroma. The differences are many times that of the threshold of the human observer and easily perceptible from many sources. This includes viewing either the spectral data, coordinates from any of the converted color spaces or even direct observation from photographs. Five more examples of this behavior for different pigment-time combinations follow.

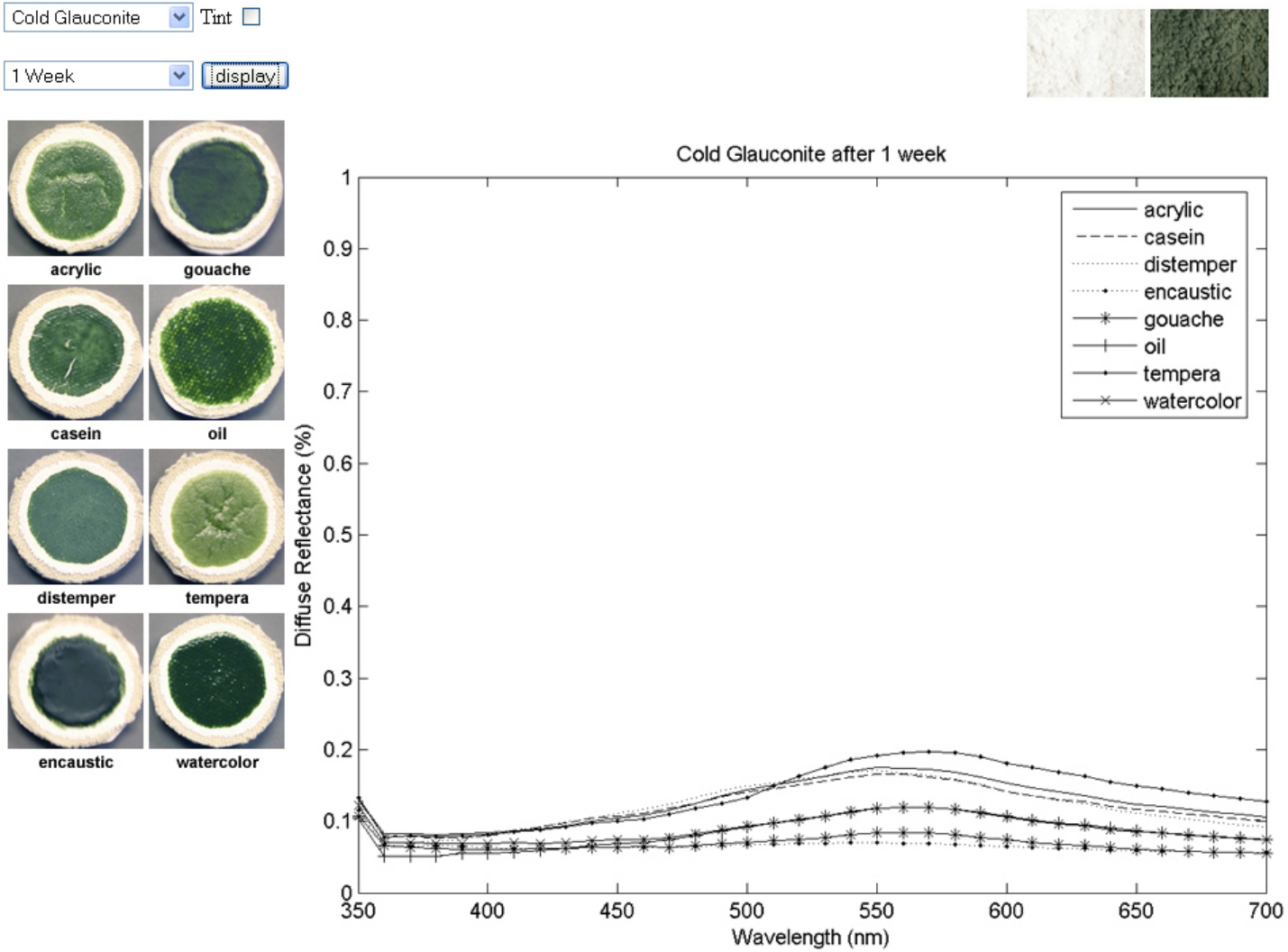

Figure 5: Cold Glauconite in different binding media after one week.

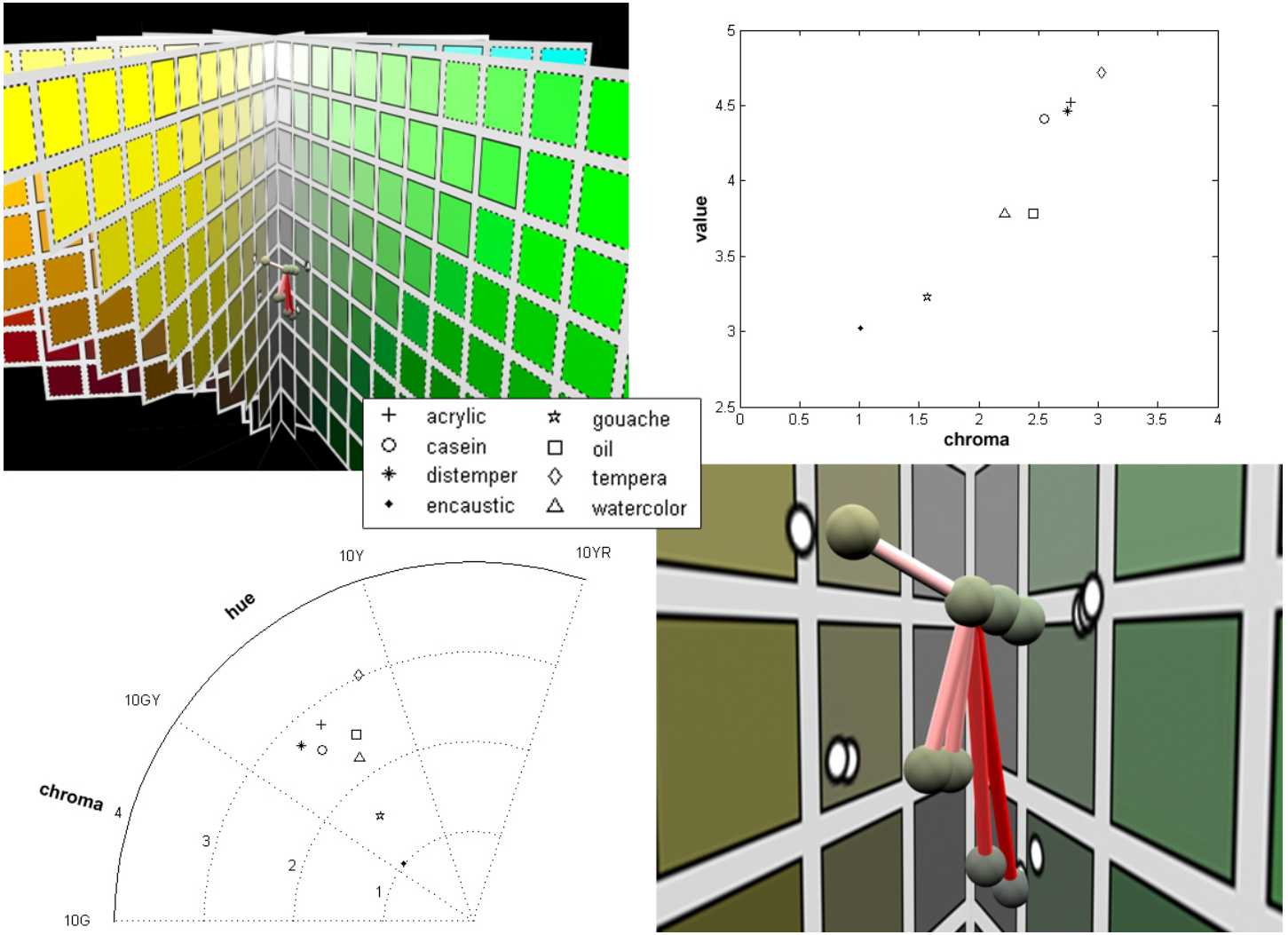

Figure 6: Munsell plots of Cold Glauconite in different binding media after one week.

Table 5: Color conversions from the spectral reflectances of the samples of Cold Glauconite in different binding media, after one week.

	X	**Y**	**Z**	**H**	**V**	**C**	L^*	a^*	b^*
acrylic	13.75	15.73	15.73	5.52GY	4.52	2.77	46.62	-7.25	2.51
casein	13.00	14.91	11.85	6.52GY	4.41	2.55	45.51	-7.31	10.09
distemper	13.11	15.30	12.21	7.38GY	4.46	2.74	46.04	-8.85	10.04
encaustic	6.13	6.66	6.88	8.95GY	3.02	1.01	31.03	-2.06	1.02
gouache	6.85	7.60	6.91	6.51GY	3.23	1.57	33.13	-3.57	4.56
oil	9.39	10.60	7.57	3.90GY	3.78	2.46	38.89	-5.24	12.02
tempera	15.54	17.31	11.17	1.95GY	4.72	3.03	48.65	-5.03	17.38
watercolor	9.46	10.61	8.15	4.65GY	3.78	2.22	38.92	-4.86	10.00

Table 6: Table of perceptual differences ΔE between colors using the $L^*a^*b^*$ color space. The colors are converted from samples of Cold Glauconite in different binding media, after one week.

	acrylic	**casein**	**distemper**	**encaustic**	**gouache**	**oil**	**tempera**
casein	7.661						
distemper	7.720	1.629					
encaustic	16.499	17.875	18.782				
gouache	14.132	14.065	14.986	4.384			
oil	12.419	7.200	8.251	13.889	9.572		
tempera	15.171	8.259	8.676	24.227	20.183	11.137	
watercolor	11.005	7.031	8.162	12.277	8.049	2.056	12.213

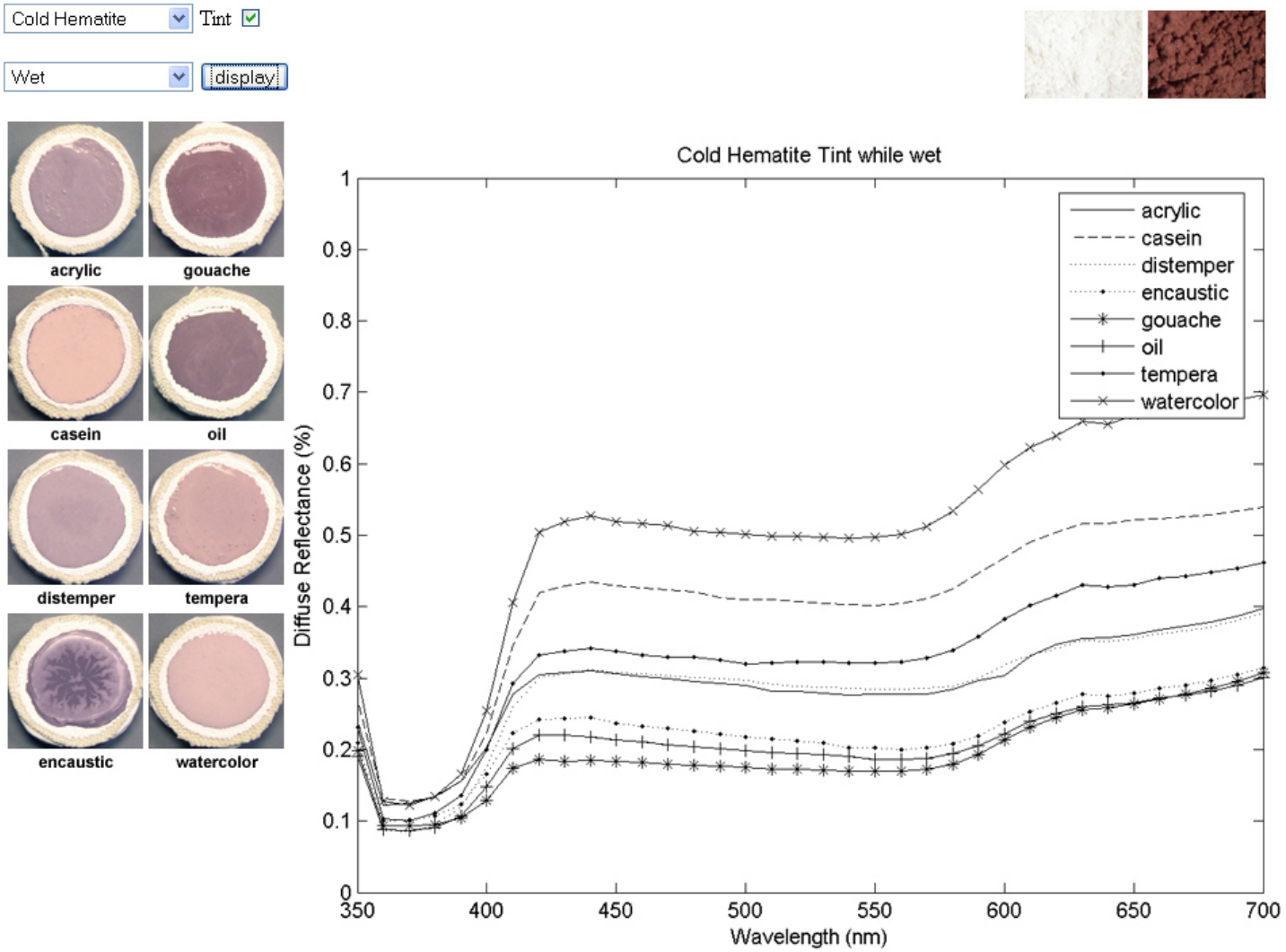

Figure 7: Cold Hematite Tint in different binding media freshly painted.

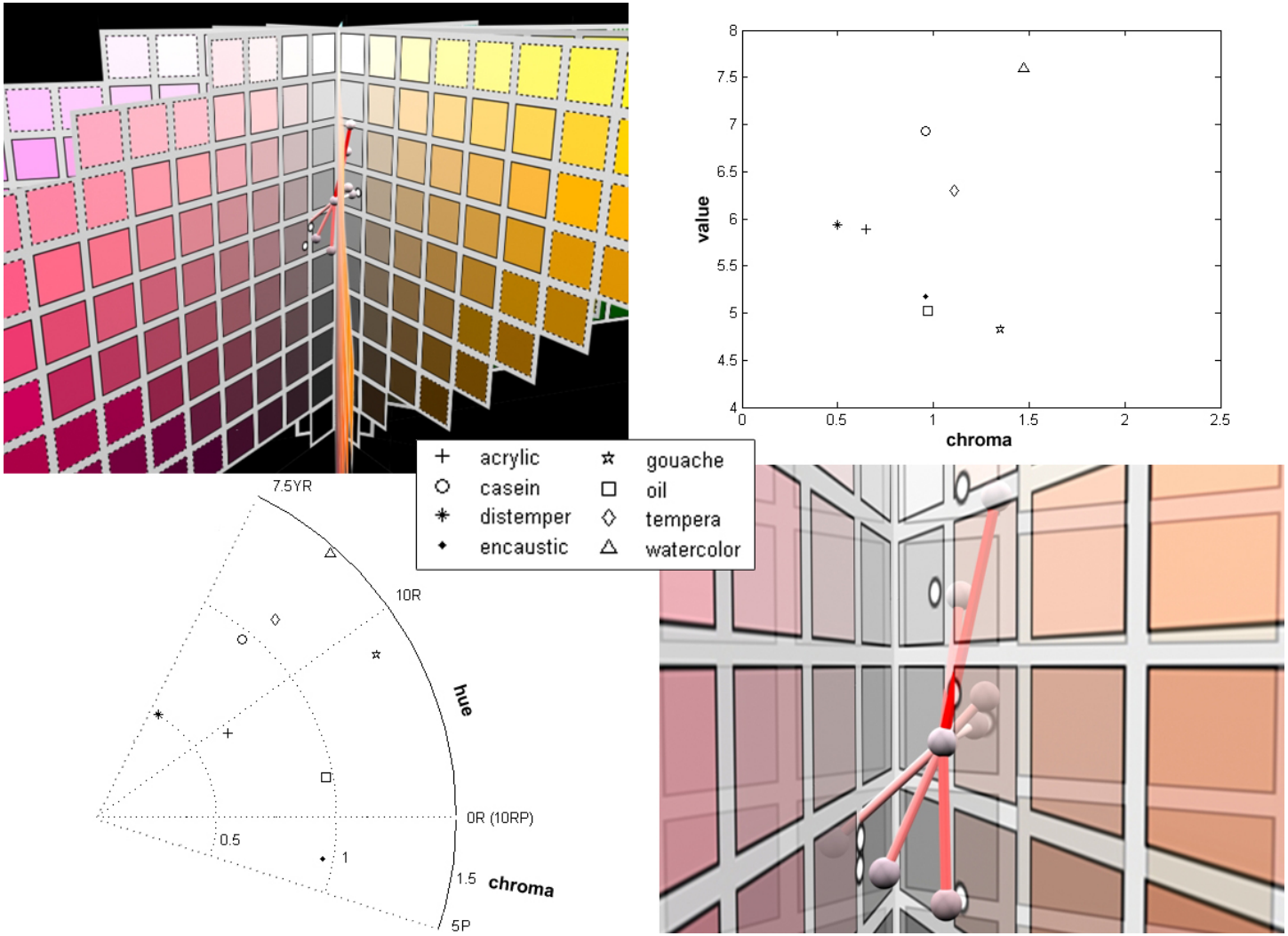

Figure 8: Munsell plots of Cold Hematite Tint in different binding media freshly painted.

Table 7: Color conversions from the spectral reflectances of the samples of Cold Hematite Tint in different binding media, freshly painted.

	X	**Y**	**Z**	**H**	**V**	**C**	L^*	a^*	b^*
acrylic	28.82	28.75	32.47	9.12R	5.89	0.65	60.56	6.20	-2.28
casein	42.16	42.07	45.44	4.11YR	6.93	0.96	70.92	6.99	-.34
distemper	29.13	29.37	32.64	6.38YR	5.94	0.50	61.11	5.05	-1.56
encaustic	21.85	21.46	25.22	7.12RP	5.18	0.96	53.45	7.20	-3.70
gouache	18.93	18.26	19.51	8.40R	4.83	1.35	49.81	8.58	0.15
oil	20.33	19.92	22.74	2.75R	5.02	0.97	51.75	7.25	-2.44
tempera	34.01	33.67	35.74	3.31YR	6.30	1.11	64.70	7.44	0.50
watercolor	52.75	52.26	54.98	3.47YR	7.60	1.47	77.44	8.50	1.06

Table 8: Table of perceptual differences ΔE between colors using the $L^*a^*b^*$ color space. The colors are converted from samples of Cold Hematite Tint in different binding media, freshly painted.

	acrylic	**casein**	**distemper**	**encaustic**	**gouache**	**oil**	**tempera**
casein	10.569						
distemper	1.464	10.074					
encaustic	7.319	17.791	8.239				
gouache	11.275	21.176	11.961	5.475			
oil	8.874	19.286	9.655	2.117	3.499		
tempera	5.139	6.293	4.780	12.011	14.938	13.281	
watercolor	17.360	6.837	16.895	24.492	27.645	25.957	12.796

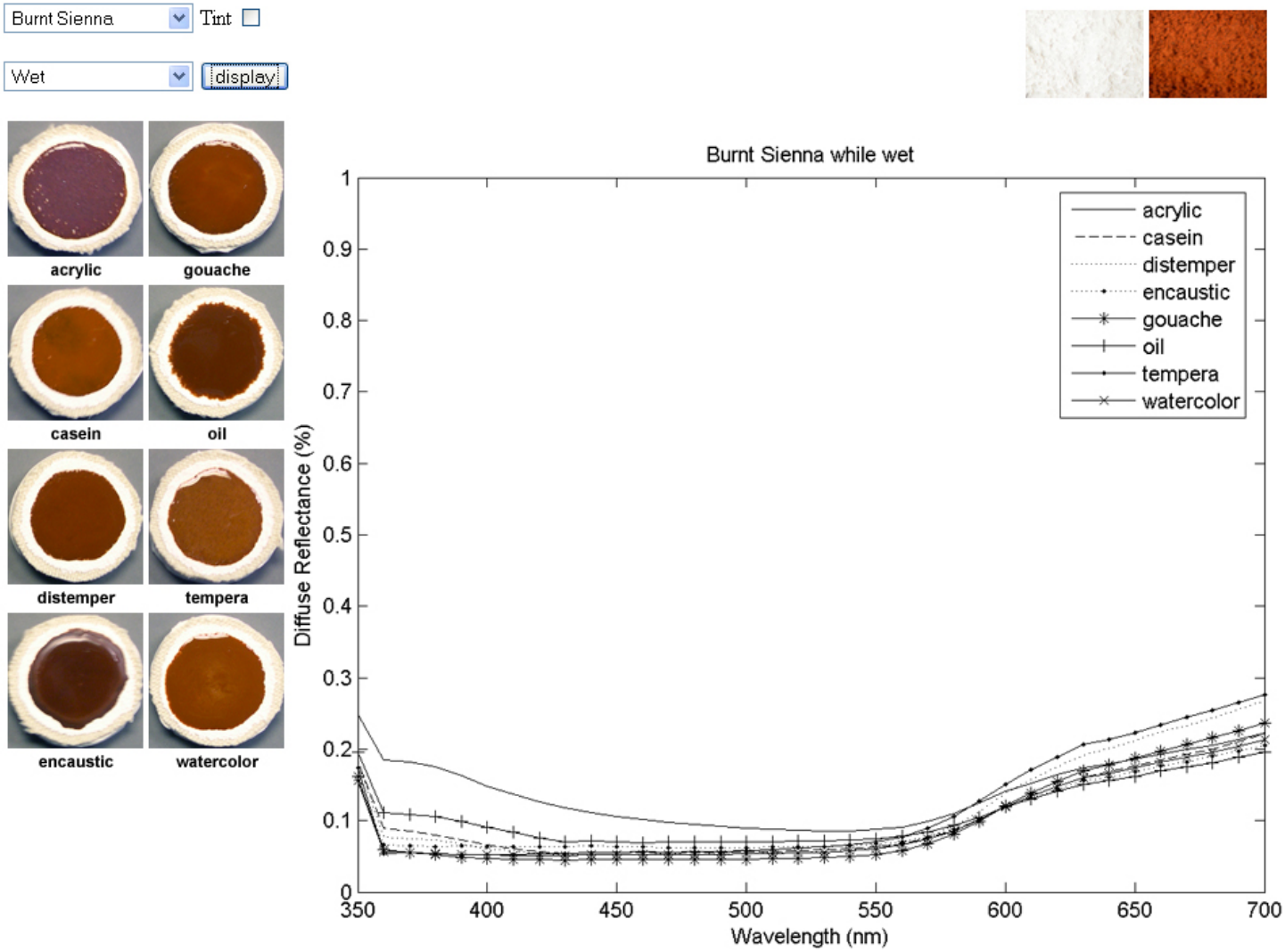

Figure 9: Burnt Sienna in different binding media freshly painted.

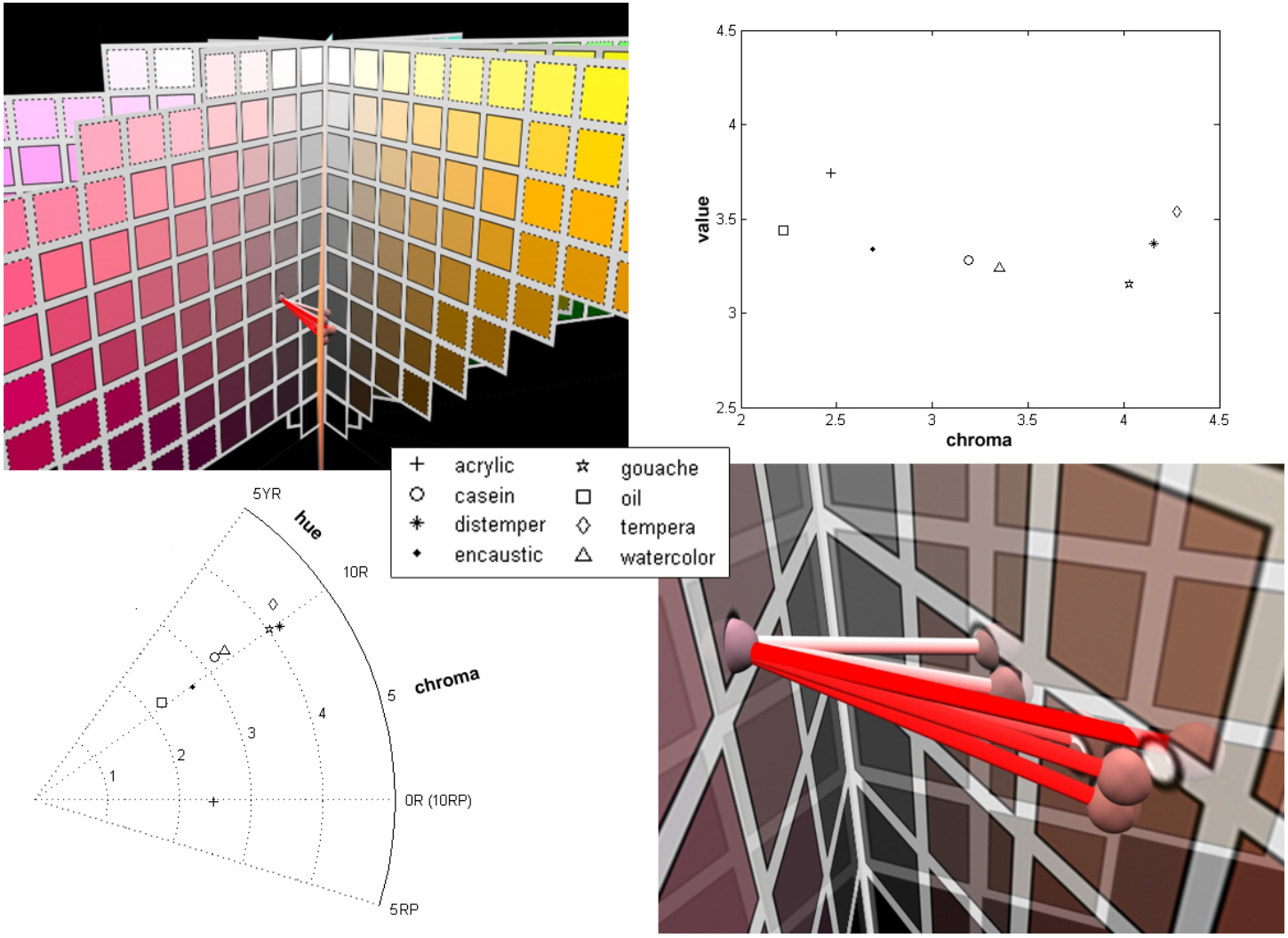

Figure 10: Munsell plots of Burnt Sienna in different binding media freshly painted.

Table 9: Color conversions from the spectral reflectances of the samples of Burnt Sienna in different binding media, freshly painted.

	X	**Y**	**Z**	**H**	**V**	**C**	L^*	a^*	b^*
acrylic	11.82	10.37	11.49	9.89RP	3.74	2.47	38.50	14.88	-1.00
casein	9.31	7.88	5.96	0.69YR	3.28	3.19	33.73	16.35	9.42
distemper	10.34	8.312	5.72	9.83R	3.37	4.16	34.62	20.68	12.00
encaustic	9.41	8.156	6.83	9.93R	3.34	2.69	34.31	14.68	6.86
gouache	9.06	7.238	4.91	9.99R	3.15	4.03	32.34	20.20	11.80
oil	9.70	8.68	7.67	0.48YR	3.44	2.22	35.36	12.45	5.57
tempera	11.29	9.214	5.99	0.94YR	3.54	4.28	36.39	20.19	13.91
watercolor	9.18	7.684	5.65	0.69YR	3.24	3.35	33.32	16.99	10.05

Table 10: Table of perceptual differences ΔE between colors using the $L^*a^*b^*$ color space. The colors are converted from samples of Burnt Sienna in different binding media, freshly painted.

	acrylic	**casein**	**distemper**	**encaustic**	**gouache**	**oil**	**tempera**
casein	11.554						
distemper	14.755	5.118					
encaustic	8.909	3.111	7.907				
gouache	15.169	4.735	2.339	7.665			
oil	7.677	5.718	10.470	2.782	10.392		
tempera	15.967	6.479	2.650	9.186	4.567	11.425	
watercolor	12.385	0.987	4.371	4.061	3.785	6.697	5.879

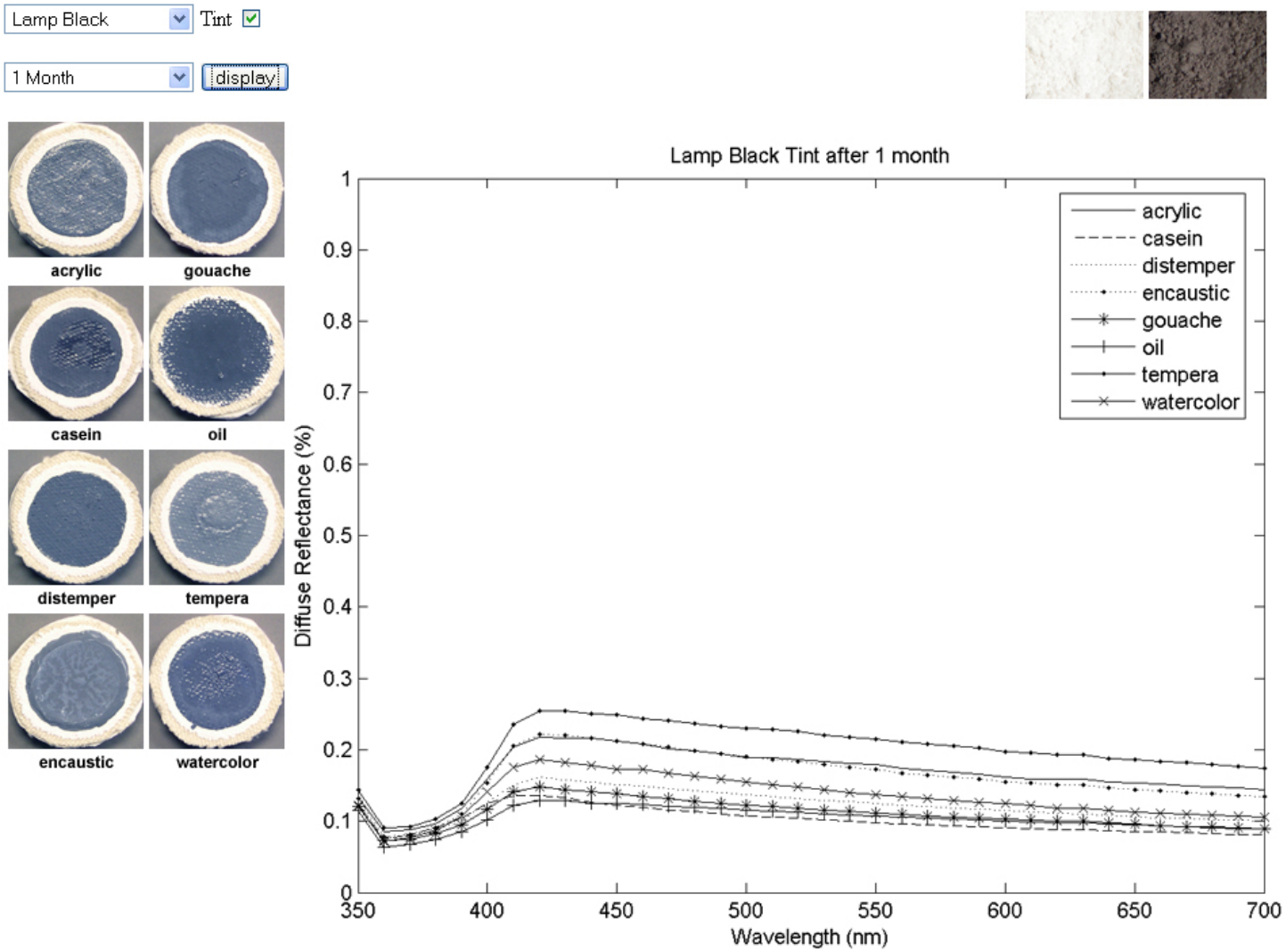

Figure 11: Lampblack Tint in different binding media after one month.

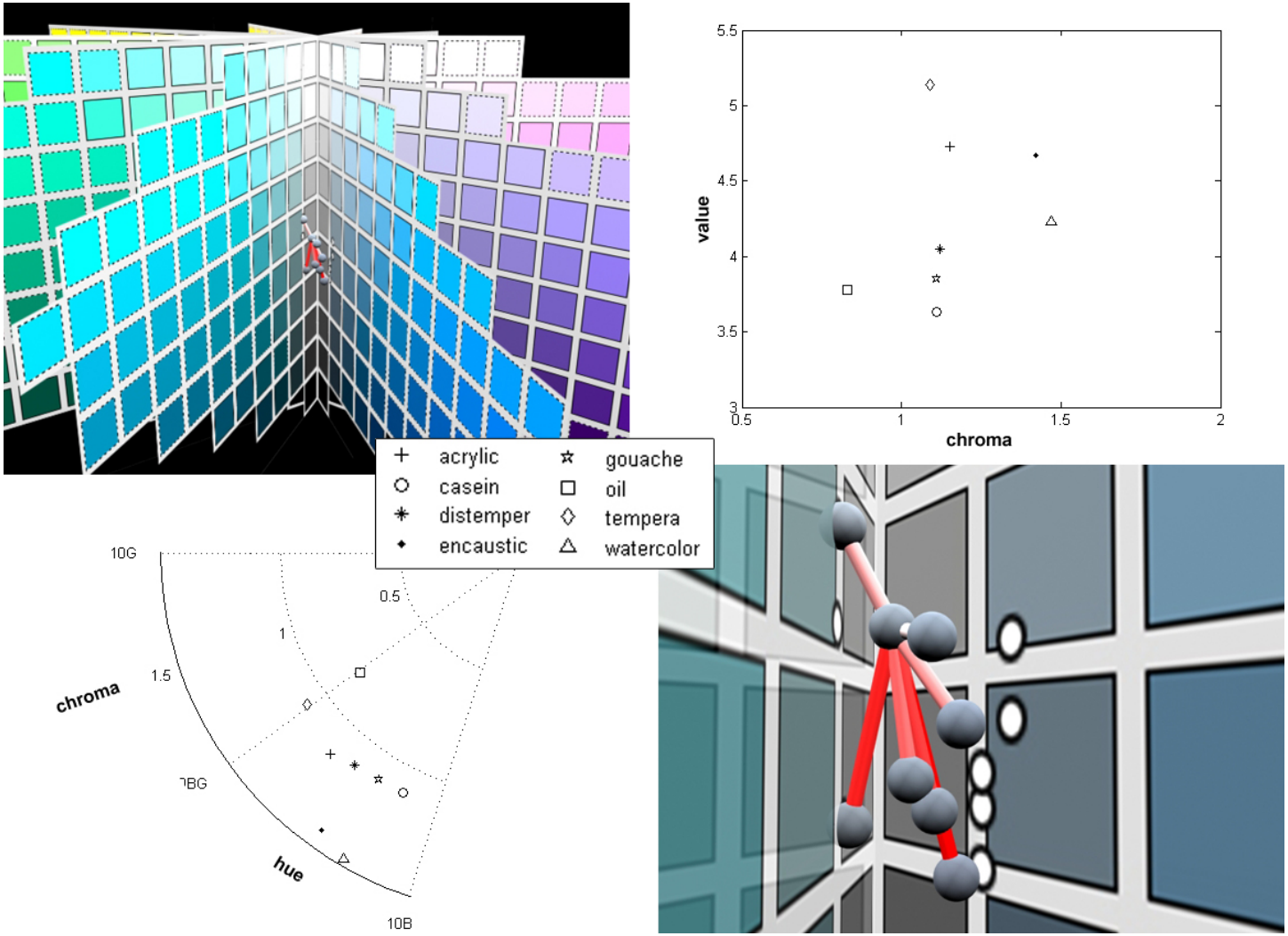

Figure 12: Munsell plots of Lampblack Tint in different binding media after one month.

Table 11: Color conversions from the spectral reflectances of the samples of Lampblack Tint in different binding media, after one month.

	X	**Y**	**Z**	**H**	**V**	**C**	L^*	a^*	b^*
acrylic	16.39	17.45	22.41	2.89B	4.73	1.15	48.82	-0.85	-6.90
casein	9.25	9.73	13.16	7.69B	3.63	1.11	37.34	0.24	-7.40
distemper	11.58	12.31	16.15	4.43B	4.05	1.12	41.71	-0.65	-6.90
encaustic	15.87	16.94	22.50	5.03B	4.67	1.42	48.18	-1.07	-8.17
gouache	10.42	11.02	14.66	6.07B	3.85	1.11	39.61	-0.20	-7.13
oil	9.96	10.59	13.29	0.11B	3.78	0.83	38.88	-0.60	-5.08
tempera	19.75	21.09	26.36	9.80BG	5.14	1.09	53.05	-1.25	-6.21
watercolor	12.76	13.59	18.55	6.60B	4.23	1.47	43.63	-0.81	-8.60

Table 12: Table of perceptual differences ΔE between colors using the $L^*a^*b^*$ color space. The colors are converted from samples of Lampblack Tint in different binding media, after one month.

	acrylic	**casein**	**distemper**	**encaustic**	**gouache**	**oil**	**tempera**
casein	11.543						
distemper	7.113	4.488					
encaustic	1.439	10.946	6.607				
gouache	9.236	2.328	2.160	8.677			
oil	10.108	2.909	3.365	9.811	2.213		
tempera	4.305	15.825	11.377	5.253	13.512	14.230	
watercolor	5.462	6.489	2.569	4.578	4.324	5.916	9.728

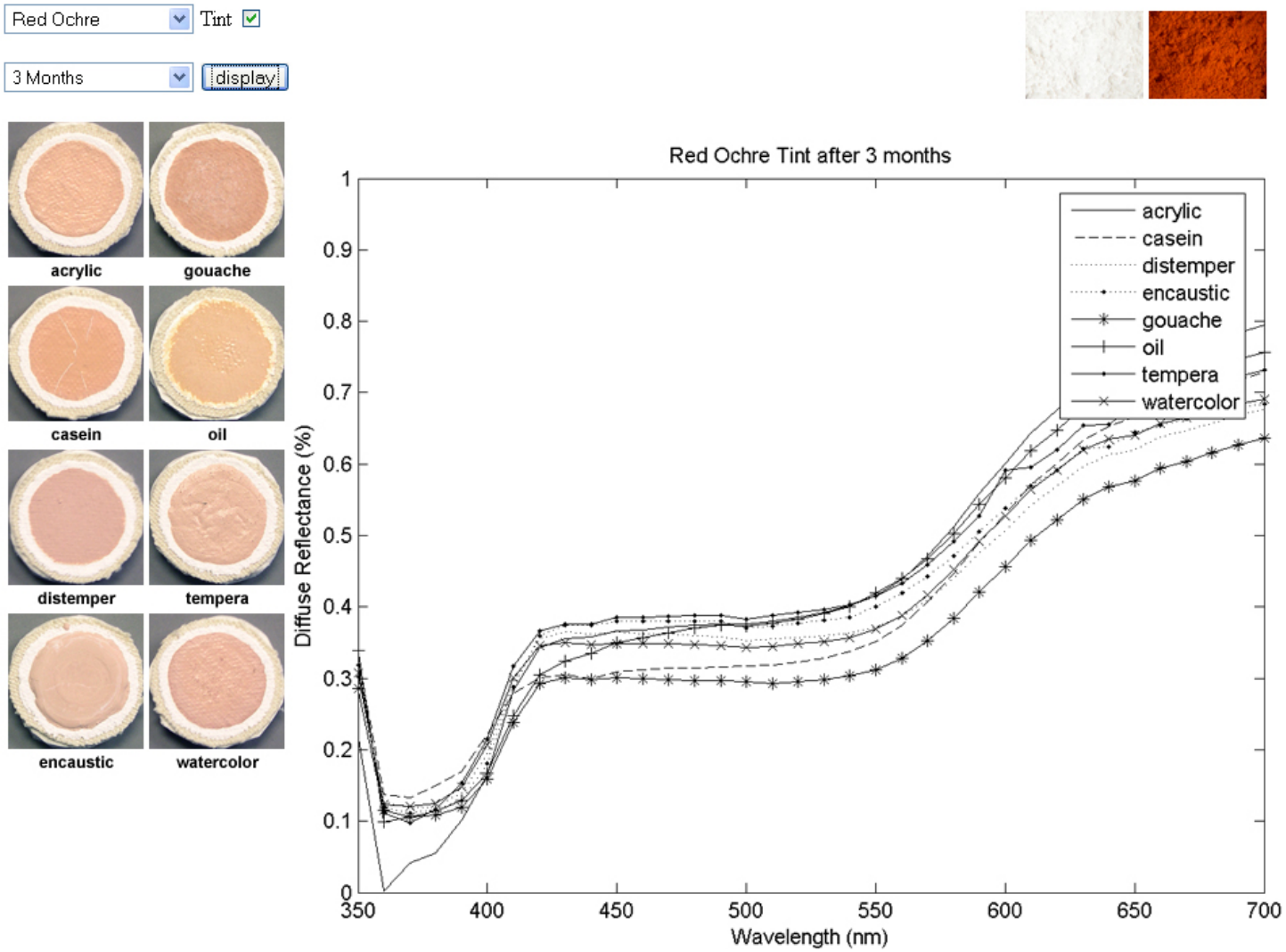

Figure 13: Red Ochre Tint in different binding media after three months.

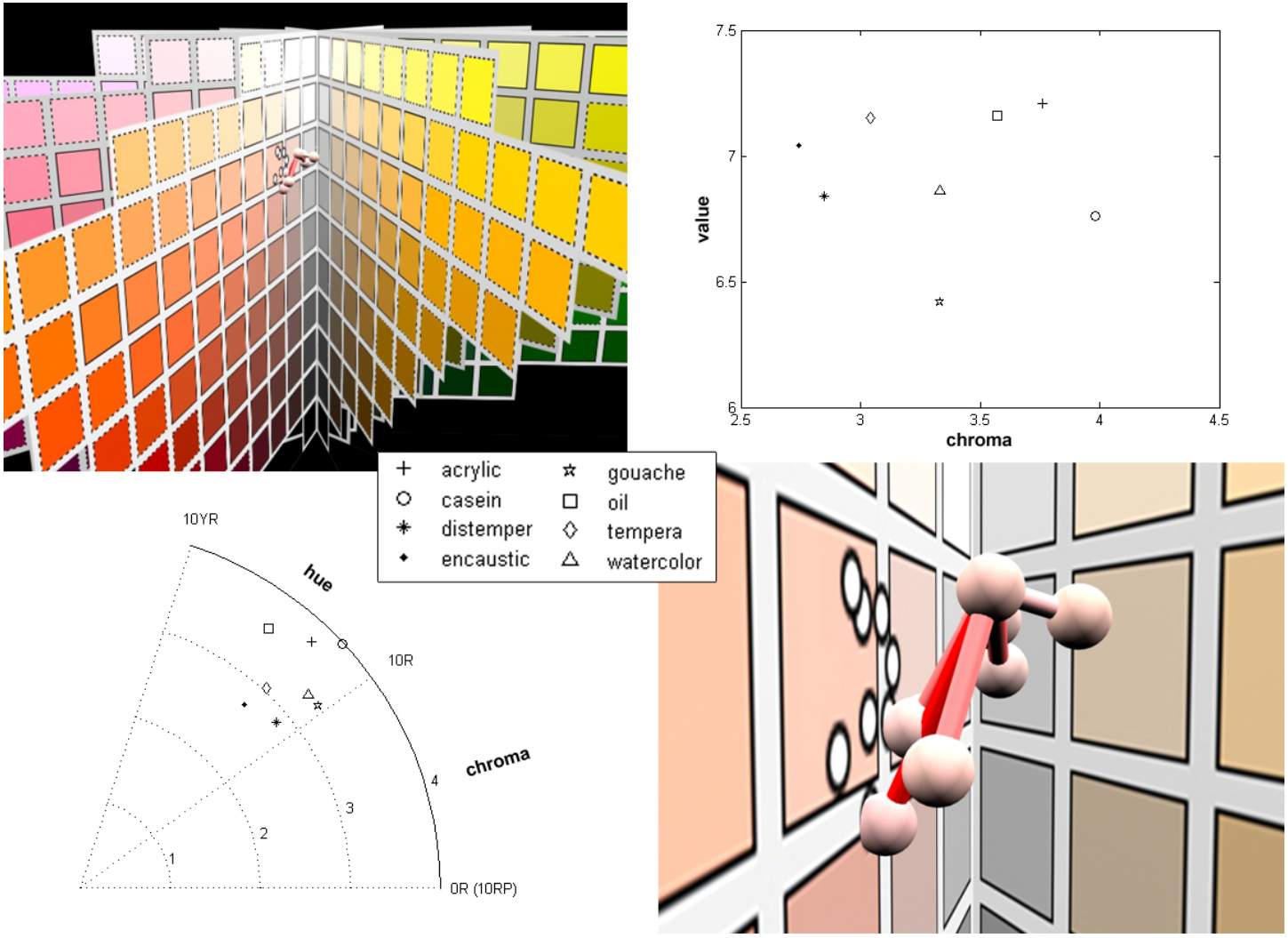

Figure 14: Munsell plots of Red Ochre Tint in different binding media after three months.

Table 13: Color conversions from the spectral reflectances of the samples of Red Ochre Tint in different binding media, after three months.

	X	**Y**	**Z**	**H**	**V**	**C**	L^*	a^*	b^*
acrylic	49.34	46.17	38.84	2.99YR	7.21	3.76	73.65	15.74	12.04
casein	43.16	39.72	33.08	1.94YR	6.76	3.98	69.27	17.09	11.90
distemper	43.17	40.84	38.62	1.21YR	6.84	2.85	70.06	13.69	6.12
encaustic	45.47	43.36	40.15	3.42YR	7.04	2.74	71.98	12.33	7.55
gouache	38.02	35.17	31.87	0.45YR	6.42	3.33	65.88	15.79	7.73
oil	47.83	45.47	37.02	5.03YR	7.16	3.57	73.20	13.56	13.51
tempera	47.58	45.26	40.79	3.12YR	7.15	3.04	73.06	13.44	8.67
watercolor	43.91	41.02	37.17	1.20YR	6.86	3.33	70.19	15.34	8.14

Table 14: Table of perceptual differences ΔE between colors using the $L^*a^*b^*$ color space. The colors are converted from samples of Red Ochre Tint in different binding media, after three months.

	acrylic	**casein**	**distemper**	**encaustic**	**gouache**	**oil**	**tempera**
casein	4.586						
distemper	7.221	6.752					
encaustic	5.880	6.995	2.753				
gouache	8.886	5.529	4.947	7.015			
oil	2.668	5.523	8.031	6.207	9.590		
tempera	4.123	6.174	3.945	1.911	7.613	4.844	
watercolor	5.229	4.248	2.612	3.551	4.353	6.408	3.483

2.3 Effect of Time

In order to study the effect of time on the appearance of a paint, a specific pigment and media are held constant. This allows for comparison of the appearance of the sample, at different stages over time. In our experiment, there are six time intervals, each with its own spectral reflectance curve for a given pigment-binding media combination. In viewing these plots together, one can translate nonlinear changes in the absorption and scattering of the material into perceptually distinct color changes that the material undergoes over time.

Similarly to the previous section, another interactive JavaScript viewer was created for ease of manipulating the dataset (included with this work as *effectOfTime.html*). There are 168 pigment-media combinations in total from which to browse through. After selecting the desired pigment and media input parameters, the application plots the spectral reflectances of the six time intervals. This work studied samples from when they were freshly painted up until six months of aging. The setup for the viewer is seen in Figure 15 for the evolution of Lapis Lazuli samples in gouache. The layout for the system is quite similar to the previous one.

Figure 16 displays the paint sample as it evolves over time in the Munsell color space. In this diagram, the start and end points of the study are labeled as green and red, respectively (corresponding to the reflectance of the sample as it is first painted and again after six months). The intermediate stages (one day, one week, one month, three months) are indicated by coordinates between the two endpoints. In the three-dimensional plot, an interpolating curve connects the intermediate time interval points. The spline is lofted into a ribbon to aid visualization of the curve.

For each paint sample, the following is included: spectral plots and corresponding photographs, three-dimensional Munsell color plots, color space conversions, and the perceptual differences ΔE between colors in the $L^*a^*b^*$ color space.

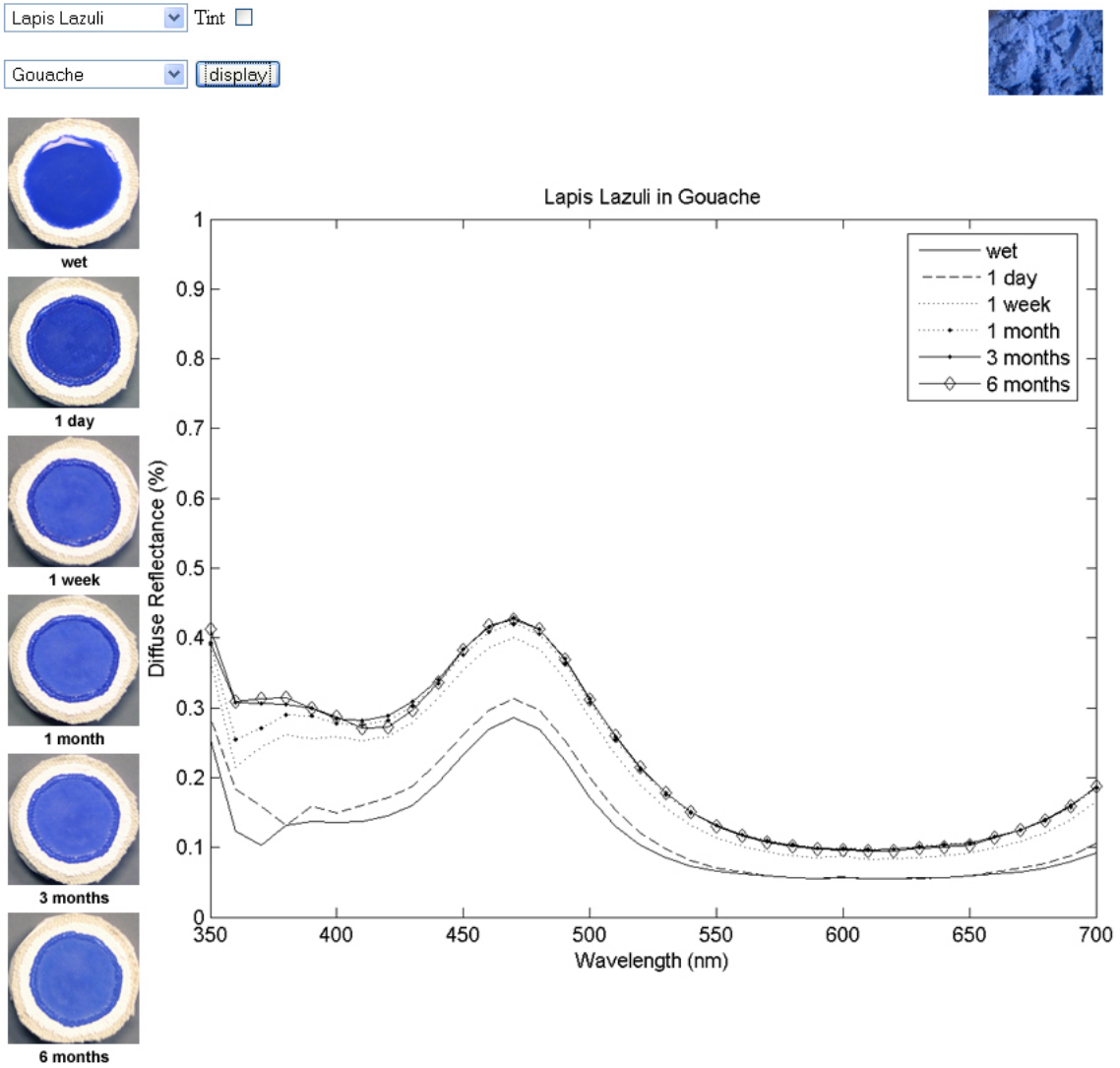

Figure 15: Variation of spectral reflectance curves of Lapis Lazuli in Gouache over time.

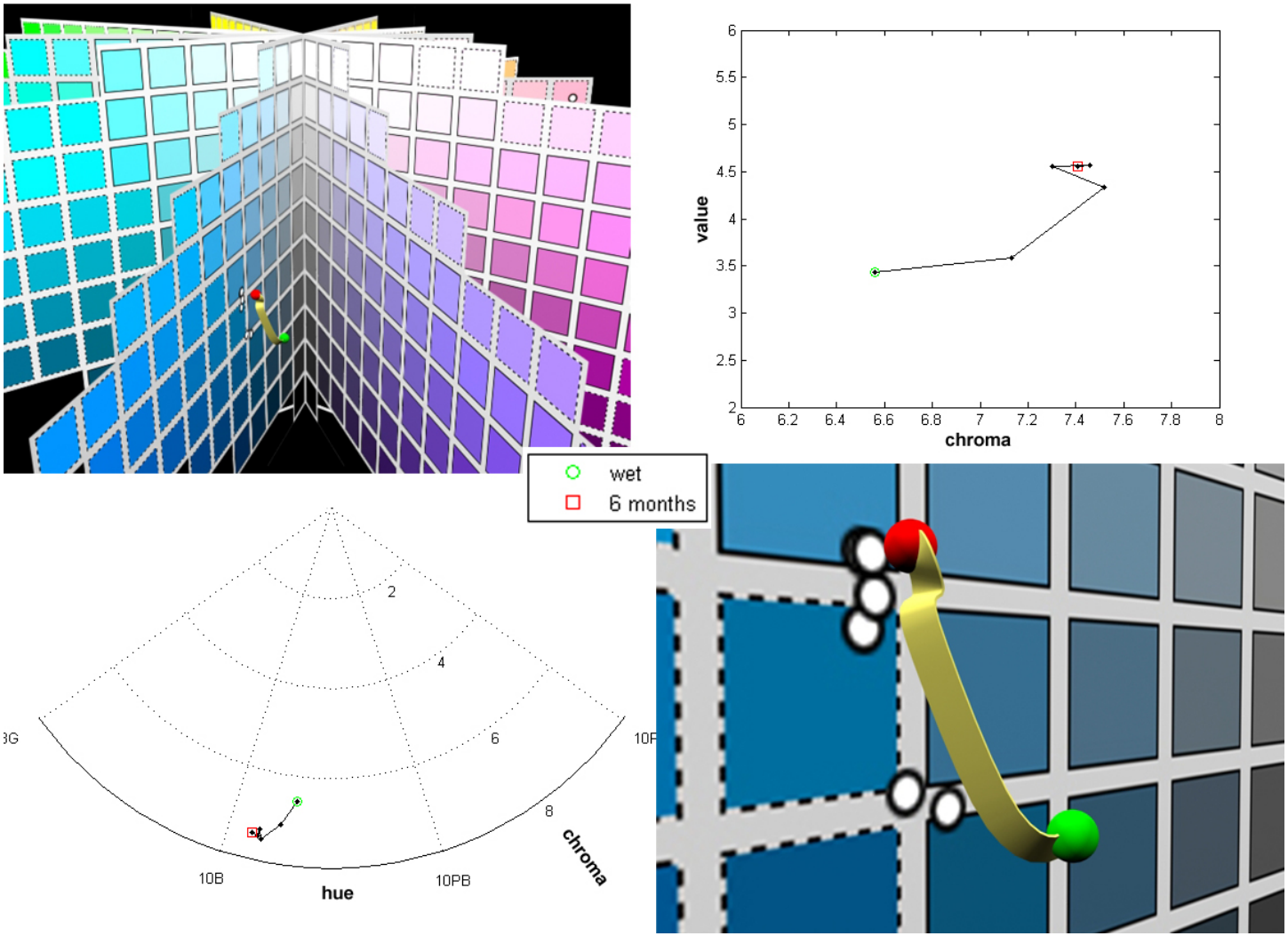

Figure 16: Munsell plots of Lapis Lazuli in Gouache over time.

Table 15: Color conversions of Lapis Lazuli in Gouache over time. ΔE is the distance from the previous to current $L^*a^*b^*$ color.

	X	**Y**	**Z**	**H**	**V**	**C**	L^*	a^*	b^*	ΔE
wet	8.42	8.63	23.53	3.13PB	3.43	6.56	35.27	2.10	-32.21	
1 day	9.03	9.46	26.48	2.43PB	3.58	7.13	36.85	0.53	-34.33	3.08
1 week	13.23	14.28	36.17	1.61PB	4.33	7.52	44.63	-1.96	-34.66	8.18
1 month	14.78	16.00	38.51	1.48PB	4.55	7.30	46.97	-2.34	-33.55	2.62
3 months	14.86	16.11	39.23	1.46PB	4.57	7.46	47.11	-2.48	-34.20	0.68
6 months	14.67	16.03	38.84	1.16PB	4.56	7.41	47.01	-3.20	-33.88	0.30

Table 16: Color conversions of Chrome Yellow in Distemper over time. ΔE is the distance from the previous to current $L^*a^*b^*$ color.

	X	**Y**	**Z**	**H**	**V**	**C**	**L**	**a**	**b**	ΔE
wet	70.94	74.41	9.49	4.75Y	8.80	13.26	89.12	0.83	92.11	
1 day	68.26	68.93	9.30	3.49Y	8.53	13.09	86.47	6.46	88.15	7.38
1 week	67.24	67.90	9.25	3.50Y	8.47	12.99	85.96	6.42	87.44	0.88
1 month	65.22	65.93	8.40	3.58Y	8.37	13.12	84.96	6.22	88.50	1.47
3 months	62.10	62.78	8.61	3.60Y	8.20	12.61	83.33	6.10	85.00	3.86
6 months	59.52	60.18	8.74	3.61Y	8.06	12.19	81.94	5.99	82.17	0.44

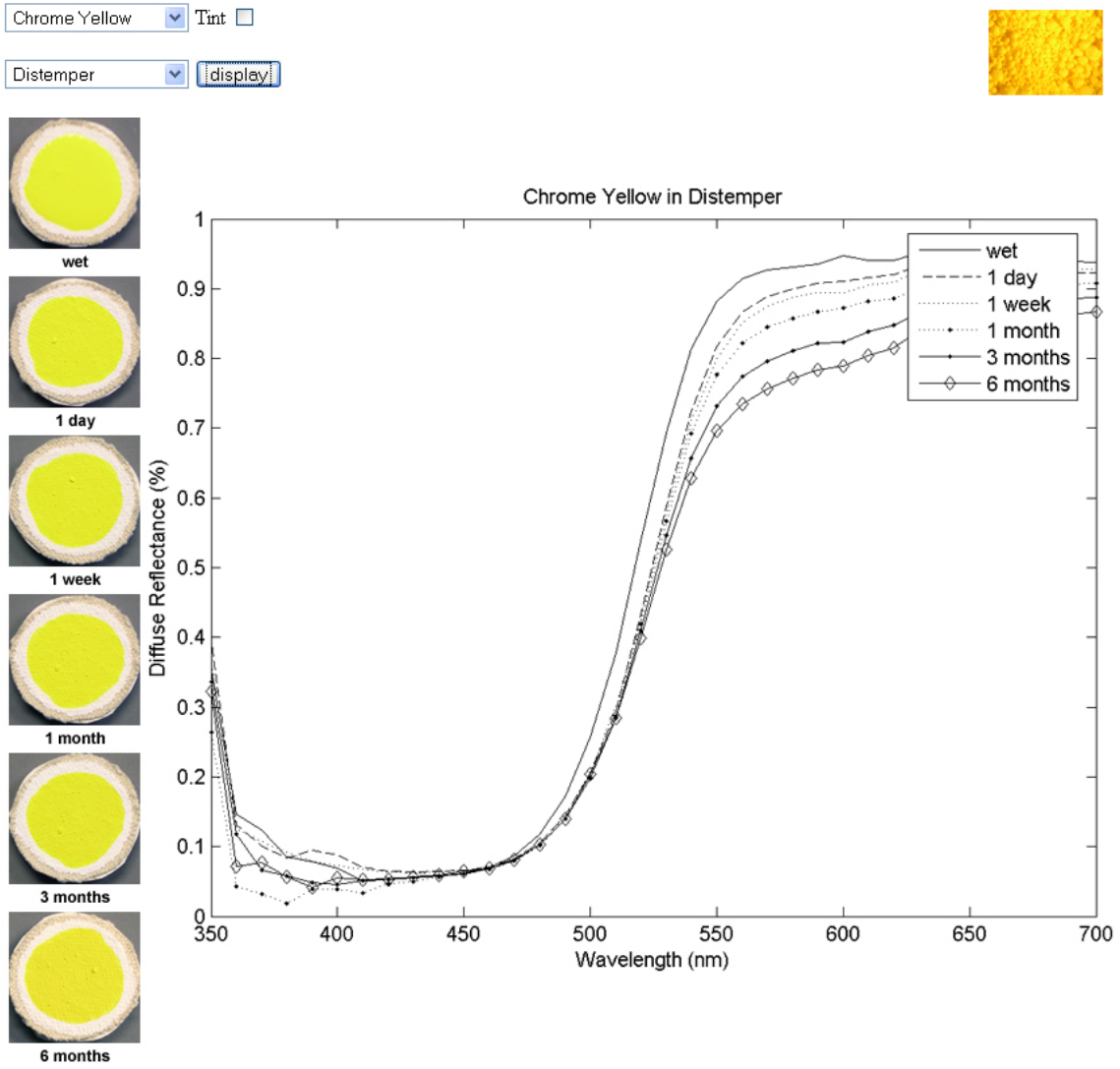

Figure 17: Variation of spectral reflectance curves of Chrome Yellow in Distemper over time.

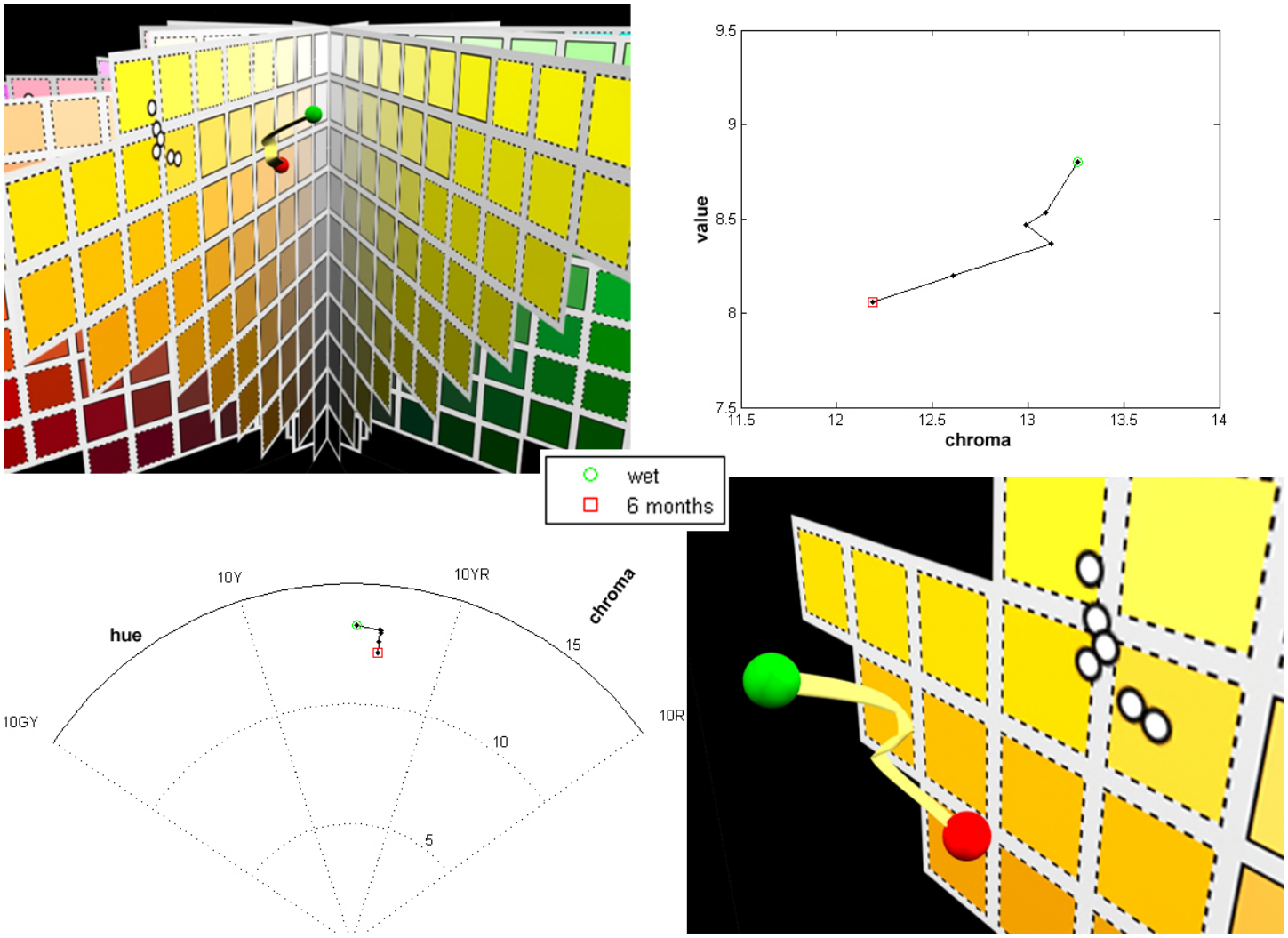

Figure 18: Munsell plots of Chrome Yellow in Distemper over time.

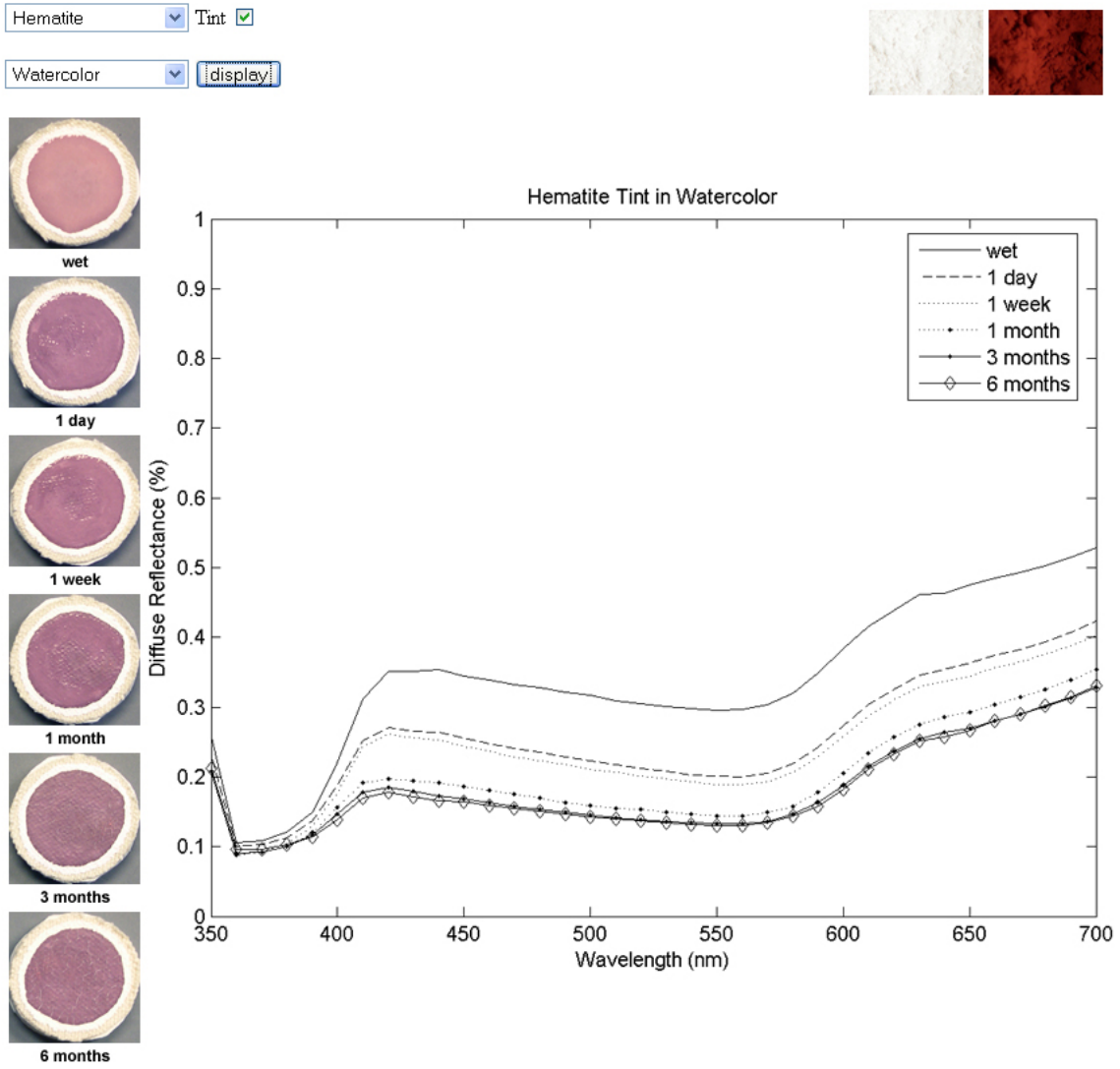

Figure 19: Variation of spectral reflectance curves of Hematite Tint in Watercolor over time.

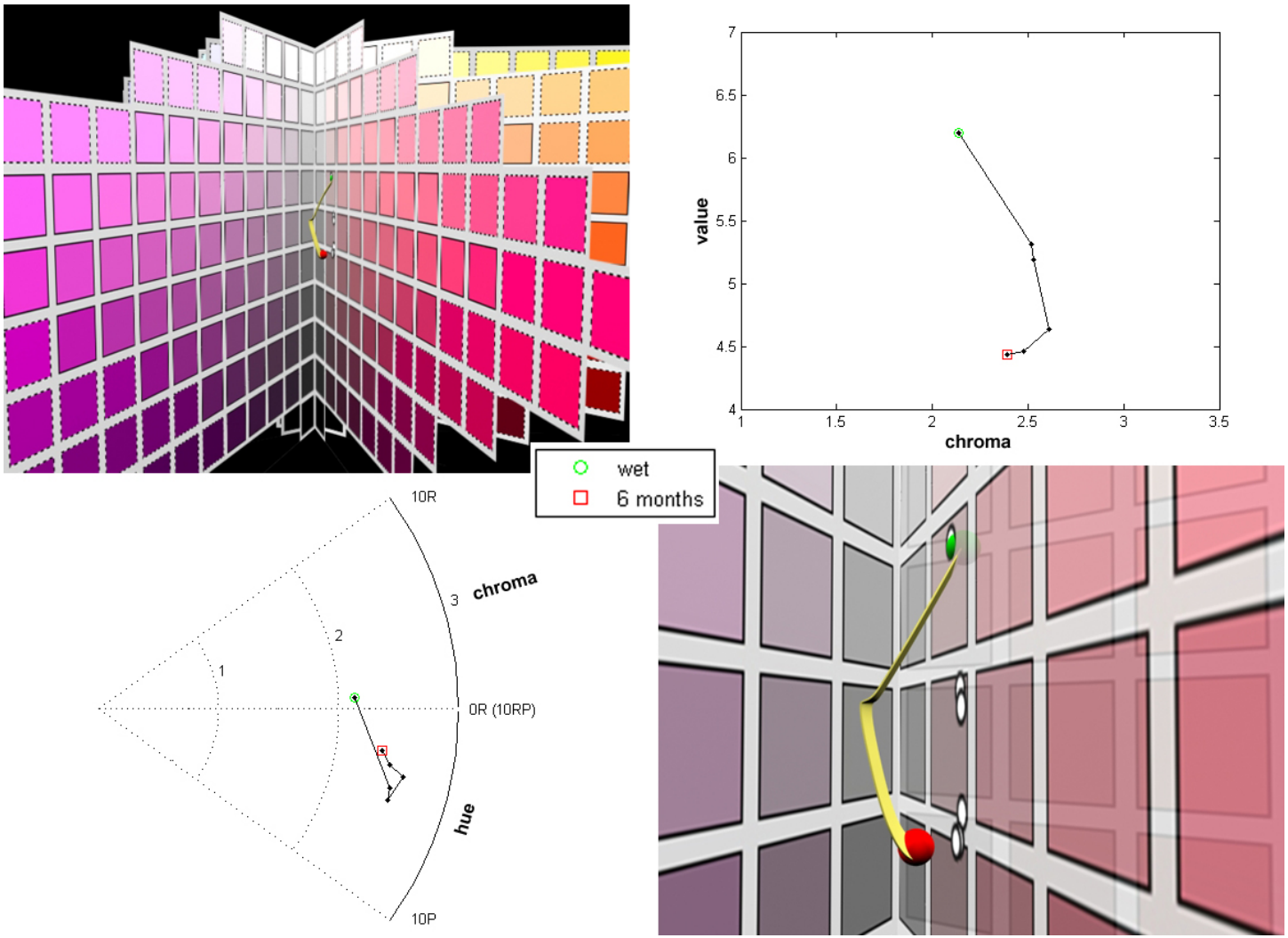

Figure 20: Munsell plots of Hematite Tint in Watercolor over time.

Table 17: Color conversions of Hematite Tint in Watercolor over time. ΔE is the distance from the previous to current $L^*a^*b^*$ color.

	X	**Y**	**Z**	**H**	**V**	**C**	**L**	**a**	**b**	ΔE
wet	34.07	32.44	36.52	0.74R	6.20	2.14	63.70	11.93	-2.22	
1 day	24.53	22.71	27.02	5.78RP	5.31	2.52	54.77	13.52	-4.27	9.30
1 week	23.28	21.50	25.85	5.16RP	5.19	2.53	53.49	13.55	-4.62	1.33
1 month	18.45	16.68	19.70	6.51RP	4.64	2.61	47.85	14.53	-3.59	5.82
3 months	16.93	15.29	17.91	7.02RP	4.46	2.48	46.03	14.20	-3.17	1.90
6 months	16.58	15.01	17.37	7.71RP	4.43	2.39	45.65	13.89	-2.71	0.70

Table 18: Color conversions of Burnt Sienna Tint in Oil over time. ΔE is the distance from the previous to current $L^*a^*b^*$ color.

	X	**Y**	**Z**	**H**	**V**	**C**	**L**	**a**	**b**	ΔE
wet	41.75	39.38	33.88	3.44YR	6.74	3.28	69.02	13.91	10.41	
1 day	41.51	39.11	33.75	3.30YR	6.72	3.28	68.83	14.00	10.25	0.26
1 week	40.93	38.58	32.29	3.94YR	6.68	3.40	68.45	13.89	11.58	1.39
1 month	41.24	38.88	32.08	4.20YR	6.70	3.48	68.66	13.91	12.24	0.69
3 months	40.04	37.84	29.31	5.50YR	6.62	3.71	67.91	13.45	14.90	2.80
6 months	40.14	37.96	29.65	5.43YR	6.63	3.65	67.99	13.39	14.54	0.09

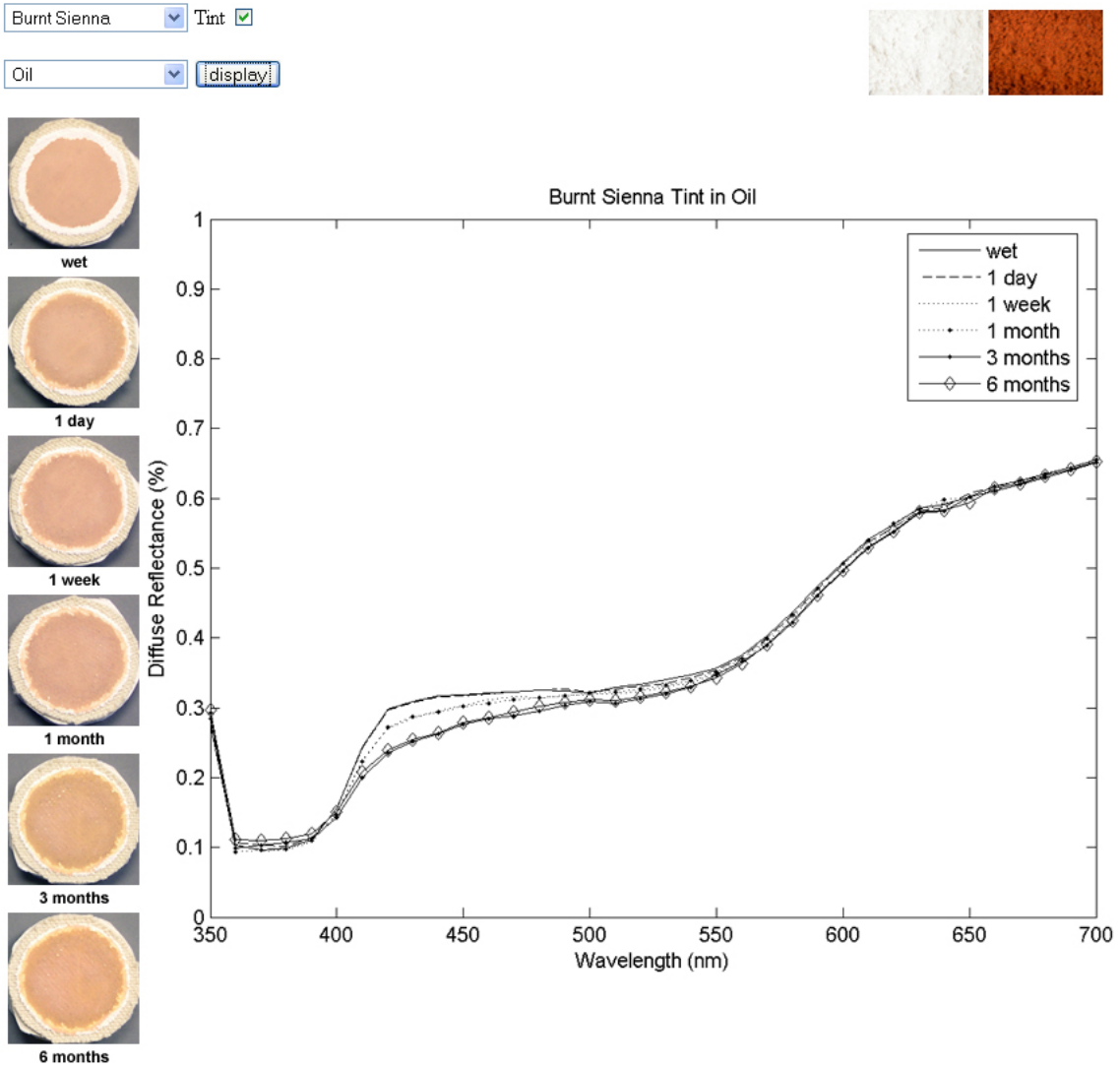

Figure 21: Variation of spectral reflectance curves of Burnt Sienna Tint in Oil over time.

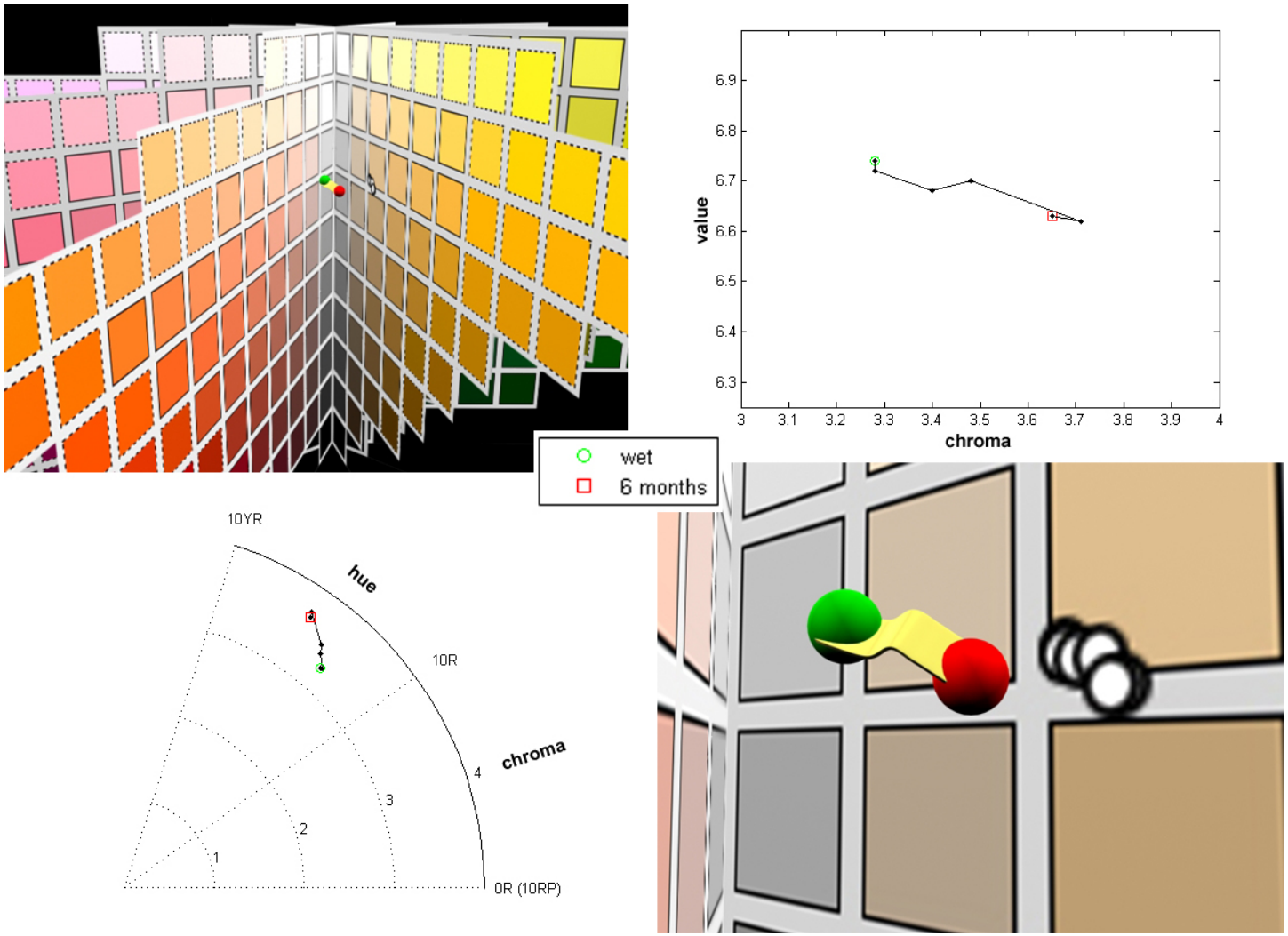

Figure 22: Munsell plots of Burnt Sienna Tint in Oil over time.

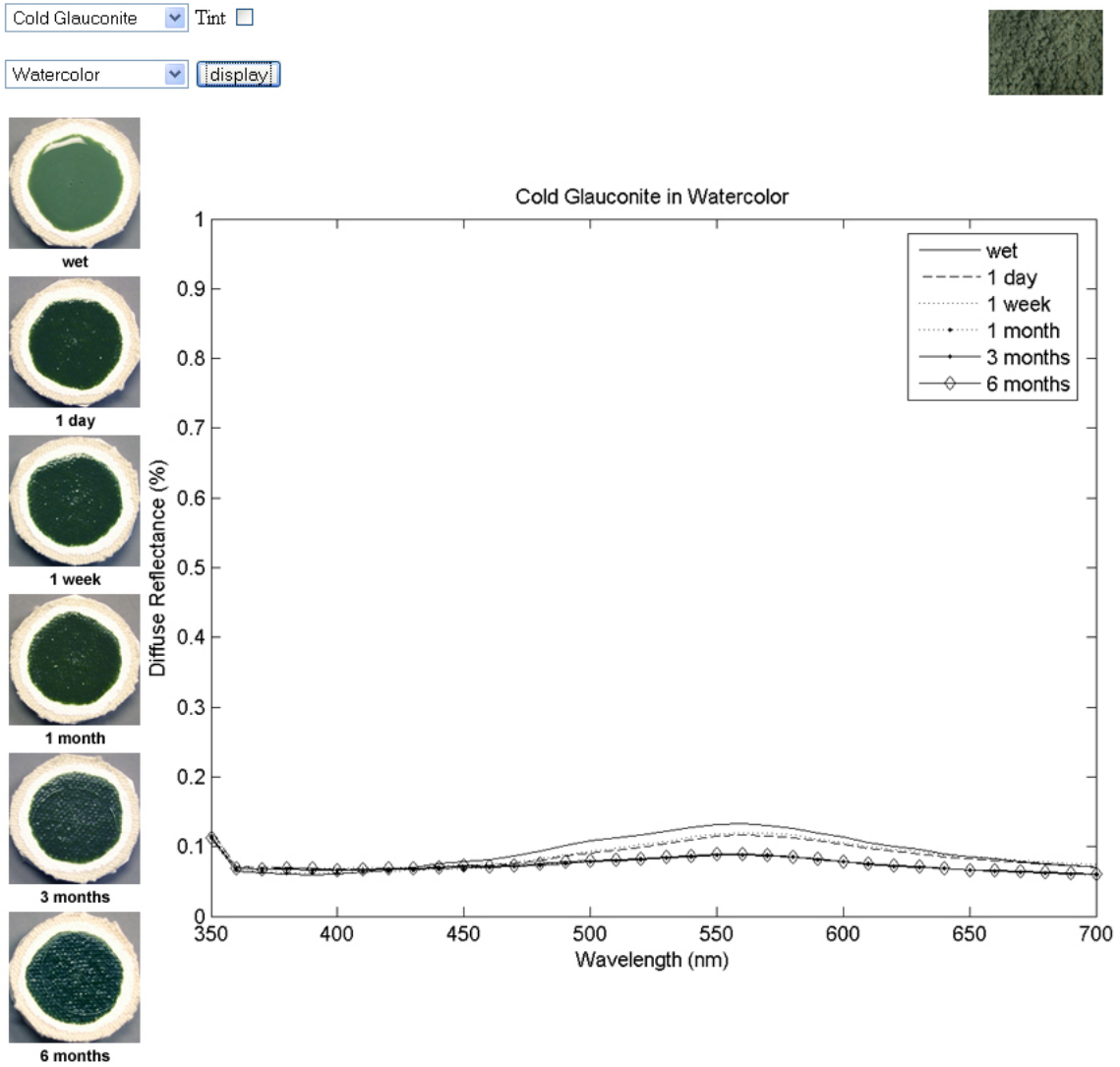

Figure 23: Variation of spectral reflectance curves of Cold Glaunconite in Watercolor over time.

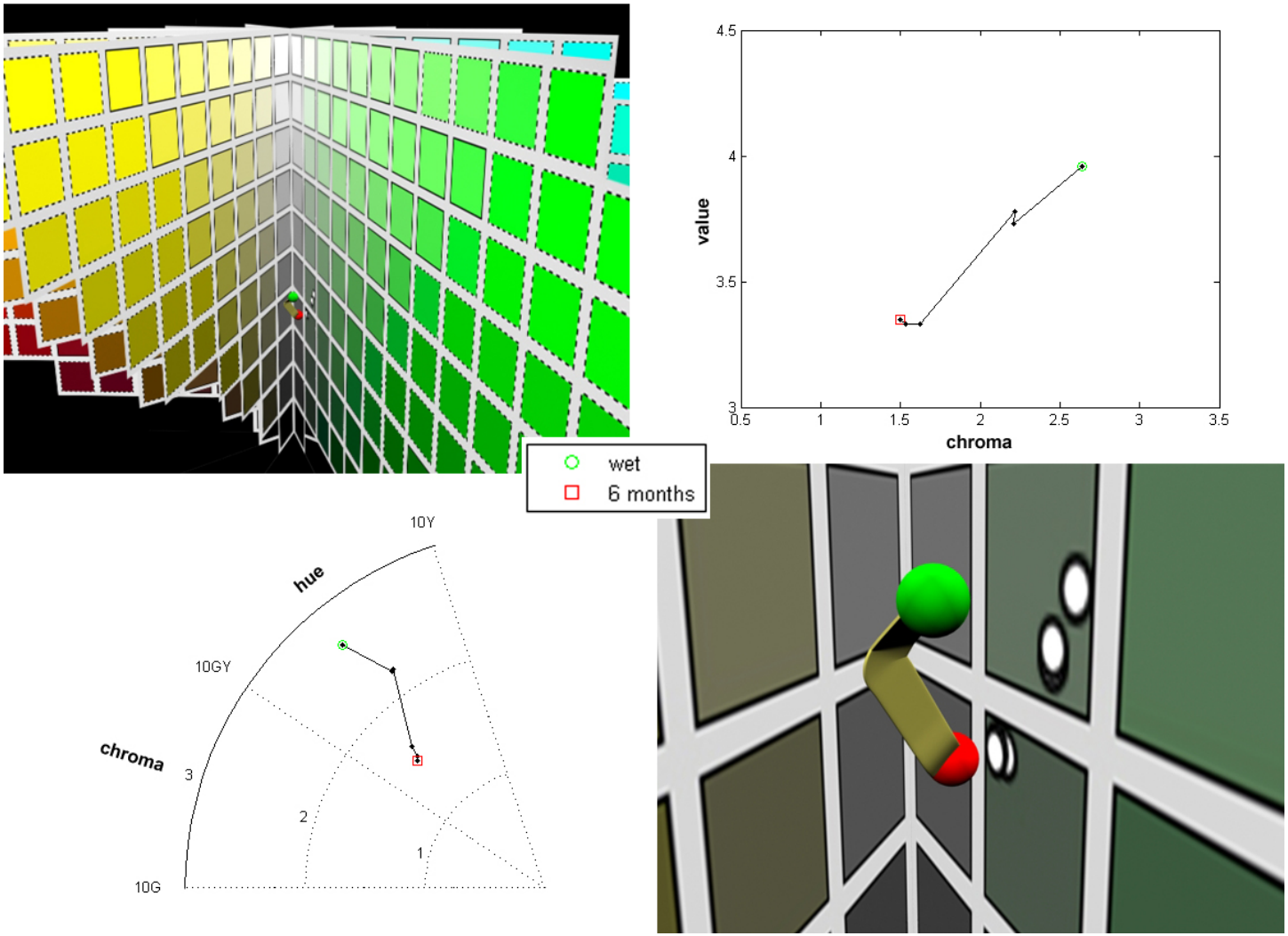

Figure 24: Munsell plots of Cold Glaunconite in Watercolor over time.

Table 19: Color conversions of Cold Glaunconite in Watercolor over time. ΔE is the distance from the previous to current $L^*a^*b^*$ color.

	X	**Y**	**Z**	**H**	**V**	**C**	**L**	**a**	**b**	ΔE
wet	10.13	11.73	8.69	6.01GY	3.96	2.64	40.78	-7.47	11.38	
1 day	9.17	10.30	7.94	4.76GY	3.73	2.21	38.37	-4.87	9.80	3.88
1 week	9.46	10.61	8.15	4.65GY	3.78	2.22	38.92	-4.86	10.00	0.59
1 month	7.28	8.12	7.44	7.02GY	3.33	1.62	34.24	-3.99	4.43	7.33
3 months	7.29	8.10	7.57	7.20GY	3.33	1.53	34.19	-3.72	3.90	0.60
6 months	7.40	8.22	7.77	7.50GY	3.35	1.50	34.43	-3.73	3.59	0.30

Table 20: Color conversions of Red Ochre Tint in Casein over time. ΔE is the distance from the previous to current $L^*a^*b^*$ color.

	X	**Y**	**Z**	**H**	**V**	**C**	**L**	**a**	**b**	ΔE
wet	52.41	49.22	39.34	4.09YR	7.41	4.03	75.58	15.59	14.76	
1 day	43.16	39.49	32.54	1.72YR	6.75	4.14	69.11	17.79	12.37	7.24
1 week	43.28	39.58	32.65	1.63YR	6.75	4.15	69.17	17.90	12.32	0.13
1 month	42.95	39.30	32.13	1.89YR	6.73	4.16	68.97	17.76	12.70	0.45
3 months	43.16	39.72	33.08	1.94YR	6.76	3.98	69.27	17.09	11.90	1.09
6 months	42.74	39.07	32.27	1.61YR	6.72	4.13	68.80	17.83	12.21	0.36

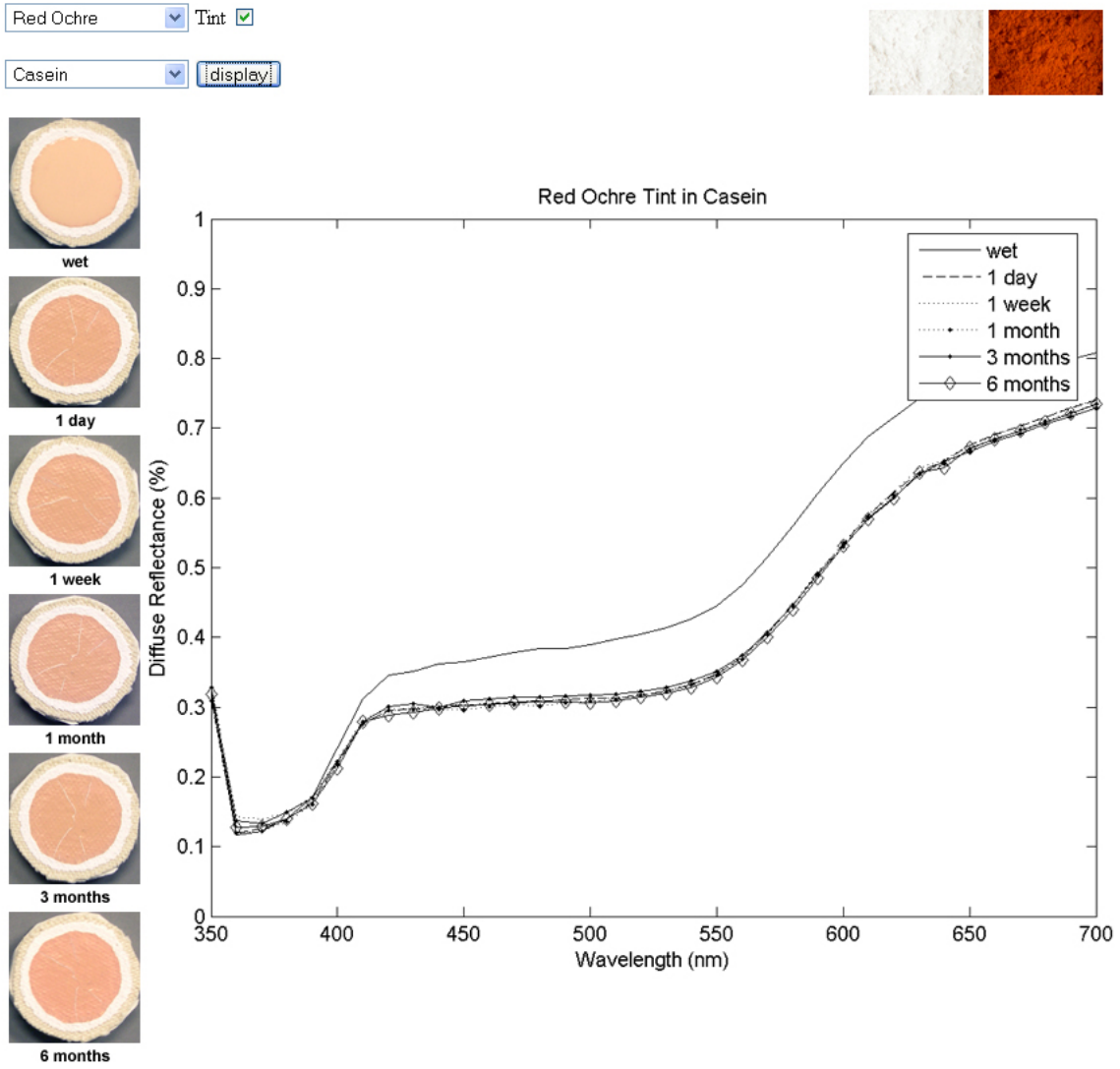

Figure 25: Variation of spectral reflectance curves of Red Ochre Tint in Casein over time.

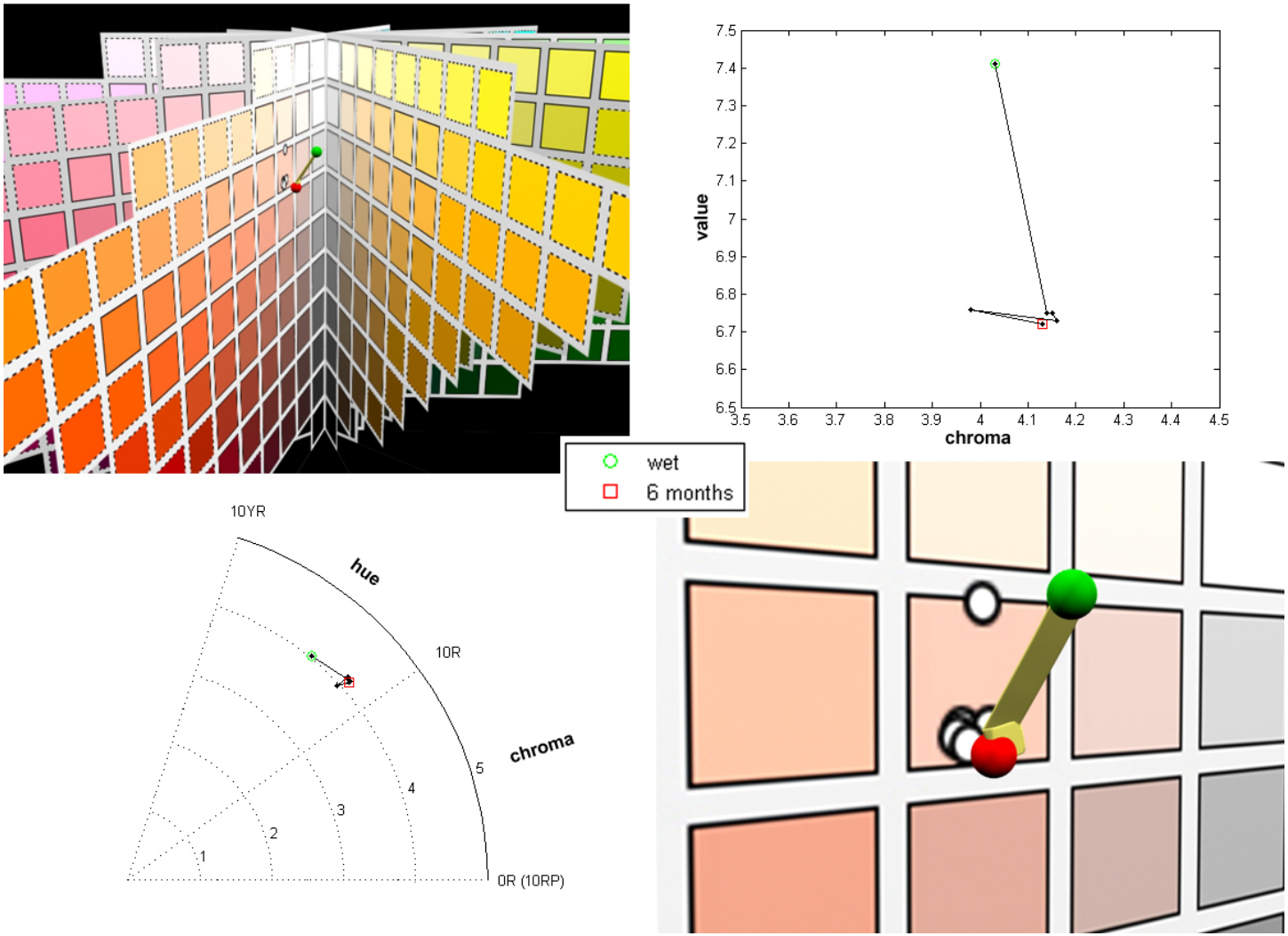

Figure 26: Munsell plots of Red Ochre Tint in Casein over time.

3 Interactive viewing

3.1 Introduction

Previously, it has been shown that reflectance data for different samples can be broken down into very intuitive perceptual changes through the use of different color spaces. This data supports that the appearance of paint changes over time, and a specific pigment appears different when dispersed in different materials.

However, the acquired data is limited to a discrete set of measurements, which are from a finite number of paint mixtures at specific times. In this form, one can only study an incomplete view of paint appearance. It is preferable to specify any combination of pigments in any binding media at any time, and see the resulting appearance. Fortunately, using research in subsurface scattering from the graphics literature, our captured reflectance data can be used in order to realistically simulate the appearance of many paints that have not been previously measured.

Therefore, we combine Kubelka Munk theory with our study of naturally occurring material changes to simulate the appearance of paint over time in an interactive viewer. In our application, Kubelka Munk theory is used to effectively predict the appearance of any arbitrary pigmented mixture. Further, with multiple K-M coefficients in time for a given pigment-media mixture, we simulate the reflectance of the arbitrary paint mixture over time. Also, it has been demonstrated recently that paint rendering using K-M theory can be simulated within the gamut of the display in real-time using graphics hardware [BWL04]. The code for our system and instructions for use are included with this work.

3.2 Kubelka Munk theory

The surfaces of many real world manufactured objects contain pigments, such as paint or painted items, plastic objects and textiles. To accurately describe how these object interact with light and the resulting color appearance, both the pigments and

the material that they are dispersed in must be accurately modeled.

A practical model that effectively simulates the appearance of pigmented materials was first introduced by Kubelka and Munk in 1931 [KM31]. The following includes the derivation of the solutions to the differential equations in Kubelka-Munk theory. Also presented are significant improvements to the theory from researchers over the years.

The original paper [KM31], is based on the assumption of a homogeneous pigmented material of a medium that is infinite in extent. By symmetry, all lateral flux can be ignored, since it will be balanced out by an equal and opposite flux. The model describes a material's appearance in terms of only two wavelength-dependent parameters: an absorption constant, $K(\lambda)$, and a scattering constant, $S(\lambda)$.

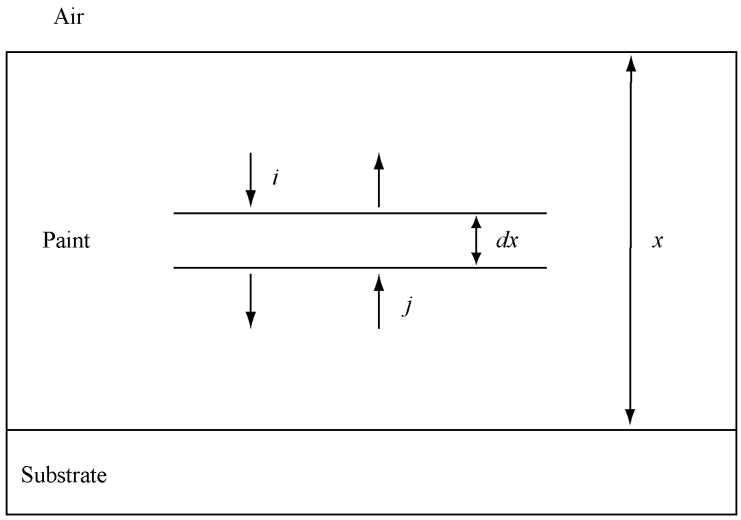

Figure 27: Coordinate system used to calculate energy scattering and absorption inside a pigmented surface. Adapted from [HM92].

The model assumes a surface that has been coated by a layer of paint with thickness h. We assume we know the reflectance R_0 of the substrate to which the homogeneous layer of paint with uniform thickness x has been applied (typically, the gesso ground in a painting).

Consider some differential horizontal thickness dx within the paint, as in Figure 27. The net flux that is descending toward the differential surface dx is labeled as i and

the upward-moving flux as j (note that these can be the result of multiple scattering events with the paint material). Now, to find the reflectance R_x of a layer of paint of thickness x, we must solve a light transport problem. Note that K, S, and reflectance R are all functions of wavelength. The derivation of this approach taken by Kubelka and Munk follows [HM92, Gla95, Kor69].

To begin, the loss in the descending and ascending fluxes due to a single scattering or absorption event is given by:

$$\begin{aligned} \Delta i^- &= (K+S)\, i\, dx \\ \Delta j^- &= (K+S)\, j\, dx \end{aligned} \tag{6}$$

On the other hand, the gains in each flux come from scattering alone. Assuming a single scattering event in the layer dx, the gains are:

$$\begin{aligned} \Delta i^+ &= S j\, dx \\ \Delta j^+ &= S i\, dx \end{aligned} \tag{7}$$

Then the total loss in each direction is the loss minus the gain. Note that the upward-moving quantity is negated so that we can measure both changes in the same coordinate system.

$$\begin{aligned} di &= \Delta i^- - \Delta i^+ \\ &= (K+S)\, i\, dx - S j\, dx \\ dj &= -\left[\Delta j^- - \Delta j^+\right] \\ &= (K+S)\, j\, dx - S i\, dx \end{aligned} \tag{8}$$

Letting the constant $a = \left(1 + \frac{K}{S}\right)$ yields the two differential equations:

$$\begin{aligned} \frac{di}{S\,dx} &= ai - j \\ -\frac{dj}{S\,dx} &= aj - i \end{aligned} \tag{9}$$

Adding these two equations together and rearranging the terms leads to:

$$\frac{i\,dj - j\,di}{i^2 S\,dx} = -2a\frac{j}{i} + \frac{j^2}{i^2} + 1 \tag{10}$$

From the Quotient rule, we observe that

$$\frac{d\left(\frac{j}{i}\right)}{S\,dx} = -2a\left(\frac{j}{i}\right) + \left(\frac{j}{i}\right)^2 + 1 \tag{11}$$

Setting $r = \frac{j}{i}$ then yields

$$\frac{dr}{S\,dx} = r^2 - 2ar + 1 \tag{12}$$

and therefore via rearrangement and integration

$$\int \frac{dr}{r^2 - 2ar + 1} = S\int dx = Sx \tag{13}$$

Since we have assumed the paint is homogeneous, the scattering coefficient S is constant throughout the material and can be brought outside the integral on the right hand side. Our goal is to find the value of the change in r as the thickness varies from zero to some thickness x. At a thickness of zero, the reflectance is simply the

reflectance of the substrate R_0. At thickness x, the reflectance is some R_x. Hence, we are interested in evaluating the integral on the left-hand side of Equation 13 over the range R_0 to R_x. To simplify the integral, we factor the integral by writing $b = \sqrt{a^2 - 1}$ and integrate via partial fractions:

$$\begin{aligned}\int_{R_0}^{R_x} \frac{dr}{r^2 - 2ar + 1} &= \frac{1}{2b}\int_{R_0}^{R_x} \frac{dr}{r - (a+b)} - \frac{1}{2b}\int_{R_0}^{R_x} \frac{dr}{r - (a-b)} \\ &= \frac{1}{2b}\ln\frac{(R_x - a - b)(R_0 - a + b)}{(R_x - a + b)(R_0 - a - b)} \end{aligned} \tag{14}$$

Equation 13 is now:

$$\frac{1}{2b}\ln\frac{(R_x - a - b)(R_0 - a + b)}{(R_x - a + b)(R_0 - a - b)} = Sx \tag{15}$$

Rearranging yields:

$$\ln\frac{(R_x - a - b)(R_0 - a + b)}{(R_x - a + b)(R_0 - a - b)} = 2Sxb \tag{16}$$

$$\frac{(R_x - a - b)(R_0 - a + b)}{e^{2Sxb}} = (R_x - a + b)(R_0 - a - b) \tag{17}$$

Assume that the paint is applied so thickly that the substrate is not visible. Then, $x \to \infty$ so $R_0 = 0$ and we make the substitution $R_x = R_\infty$. Since $e^\infty \to \infty$, the left-hand side of 17 goes to zero. We now have:

$$(R_\infty - a + b)(-a - b) = 0 \tag{18}$$

Solving for the reflectance R_∞, we find

$$R_\infty = a - b = \frac{1}{a + b} \tag{19}$$

Recall that $a = 1 + \frac{K}{S}$ and $b = \sqrt{a^2 - 1}$, hence we get

$$
\begin{aligned}
R_\infty &= \frac{1}{a + \sqrt{a^2 - 1}} \\
&= \frac{1}{1 + \frac{K}{S} + \sqrt{\left(1 + \frac{K}{S}\right)^2 - 1}}
\end{aligned} \tag{20}
$$

Equation 20 represents the solution to the most basic Kubelka-Munk differential equations as they were originally presented [KM31]. Fishkin describes the evolution of K-M theory through several years of improvements by a series of researchers [Fis83], which we only summarize here.

The Kubelka-Munk equations were generalized to allow arbitrary mixtures of pigments [Dun40]. If there are n multiple materials in the same layer with different scattering and absorption coefficients (ie: multiple pigments within the same layer of paint), they may be combined via linear weighting using their respective concentrations c_i:

$$
\begin{aligned}
S_{mixture}(\lambda) &= \sum_{i=1}^{n} c_i S_i(\lambda) \\
K_{mixture}(\lambda) &= \sum_{i=1}^{n} c_i K_i(\lambda)
\end{aligned} \tag{21}
$$

Kubelka extended the 1931 work in two subsequent articles. He first solved the differential equations of Equation 9 for a finite thickness of paint (originally, the infinite case was presented) [Kub48]. If the paint film has thickness x, then

$$
R_x = \frac{\frac{1}{R_\infty}(R_0 - R_\infty) - R_\infty \left(R_0 - \frac{1}{R_\infty}\right) e^{Sx\left(\frac{1}{R_\infty} - R_\infty\right)}}{(R_0 - R_\infty) - \left(R_0 - \frac{1}{R_\infty}\right) e^{Sx\left(\frac{1}{R_\infty} - R_\infty\right)}} \tag{22}
$$

Another form of this equation can be found using hyperbolic functions, allowing for simpler computation:

$$R_x = \frac{1 - R_0(a - b\coth bSx)}{a - R_0 + b\coth bSx} \tag{23}$$

where $a = 1 + \frac{K}{S}$ and $b = \sqrt{a^2 - 1}$ as earlier. When the paint becomes thick enough to hide the substrate, $R_0 \to 0$. Thus we have

$$R_x = \frac{1}{a + b\coth bSx} \tag{24}$$

and if the paint is infinitely thick, $x \to \infty$, so $bSx \to 1$ reducing to

$$R_\infty = \frac{1}{a + b} \tag{25}$$

which is exactly Equation 19, showing that the infinite-thickness solution is just a special case of the more general finite-thickness case. In the same work, Kubelka also found an analogous formula with hyperbolic terms representing transmittance T through a layer:

$$T = \frac{b}{a\sinh bSx + b\cosh bSx} \tag{26}$$

Later, Kubelka presented a simple method for computing the reflectance and transmittance of several layers composited on top of each other [Kub54]. Consider two homogeneous layers of different optical properties and possibly different thicknesses.

As seen in Figure 28, light entering such a material is reflected and transmitted multiple times, forming a tree-like structure for each incident ray. As the light flux from an incident ray hits the top layer, part is reflected (R_1) and part is transmitted (T_1). T_1 reaches the bottom layer and reflects T_1R_2, while transmitting T_1T_2. The

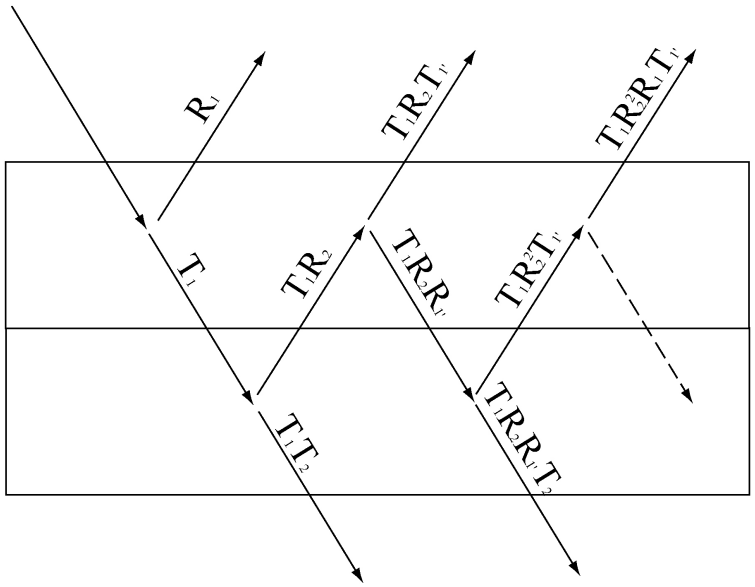

Figure 28: The path of light between two homogeneous layers. Adapted from [Kub54]

portion T_1R_2 hits the lower portion of the top layer and transmits $T_1R_2T_{1'}$ (which exits back into the air), while reflecting $T_1R_2R_1$ back into the lower layer $\cdots$ and so on, ad infinitum. Adding up the portions finally transmitted by the combined layered specimen, we have

$$T_{total} = T_1T_2(1 + R_{1'}R_2 + R_{1'}^2R_2^2 + \cdots) = \frac{T_1T_2}{1 - R_{1'}R_2} \tag{27}$$

Summing the portions reflected by the layered specimen, we have

$$R_{total} = R_1 + T_1T_{1'}R_2(1 + R_{1'}R_2 + R_{1'}^2R_2^2 + \cdots) = R_1 + \frac{T_1T_{1'}R_2}{1 - R_{1'}R_2} \tag{28}$$

For any homogeneous layer, $R_1 = R_{1'}$, or the material reflects light equally when illuminated from both sides. Also, it can be shown that $T_1 = T_{1'}$, or the transmittance has the same value, if we illuminate a homogeneous layer from one side or the other. Therefore, the formulas simplify to:

$$T_{total} = \frac{T_1 T_2}{1 - R_1 R_2} \tag{29}$$

$$R_{total} = R_1 + \frac{T_1^2 R_2}{1 - R_1 R_2} \tag{30}$$

The compositing equations can be used to calculate the reflectance of specimens that contain more than two layers (which is often the case in painting). One concatenates the layers into a single reflectance value by obtaining R and T from two layers, and using that value for the next compositing operation. For instance, a specimen with three homogeneous layers has reflectance R_1, R_2, R_3 and transmittance T_1, T_2, T_3:

$$R_{1,2} = \frac{T_1 T_2}{1 - R_1 R_2} \tag{31}$$

$$T_{1,2} = R_1 + \frac{T_1^2 R_2}{1 - R_1 R_2} \tag{32}$$

$$R_{1,2,3} = \frac{T_{1,2} T_3}{1 - R_{1,2} R_3} \tag{33}$$

$$T_{1,2,3} = R_{1,2} + \frac{T_{1,2}^2 R_3}{1 - R_{1,2} R_3} \tag{34}$$

3.3 Conversion to Kubelka Munk

Our conversion to K-M parameters is implemented in a similar manner to the work of William Baxter [BWL04]. We calculate the Kubelka Munk absorption K and scattering S coefficients for each paint sample at each wavelength. Given pigmented mixtures $1 < i < m$ of the pure pigments $1 < j < n$ in a specific binding media, we relate the reflectance of each mixture $R_{\infty,i}$ to the absorption K_j and scattering S_j values for the involved pigments:

$$\left(\frac{K}{S}\right)_{mixture,i} = \frac{\sum_j K_j c_{ij}}{\sum_j S_j c_{ij}} = \frac{(1-R_{\infty,i})^2}{2R_{\infty,i}}$$
$$\sum_j S_j c_{ij} = \sum_j K_j c_{ij} \left(\frac{2R_{\infty,i}}{1-2R_{\infty,i}+R_{\infty,i}^2}\right) \tag{35}$$

where

c_{ij} is the relative concentrations of each pigment i in paint mixture j

Pigments not involved in a particular paint mixture are assigned zero concentrations. This method is preferable to [BWL04](6), as small reflectance values do not interfere with the numerical stability of the equation. From Equation 35, we can assemble a linear system for each wavelength of the form

$$A = (-TC \quad C)\begin{pmatrix} K \\ S \end{pmatrix} = 0 \tag{36}$$

where $C = \{c_{ij}\}$ is an mxn matrix containing the pigment concentrations respective to each paint sample in the binding media, and T is an mxm diagonal matrix, containing the reflectance constant from the right-hand side of Equation 35 along the diagonals. The unknowns, K and S, are both $nx1$ vectors.

Since, generally the zero vector is the only solution, a nonnegative least squares solution that minimizes $A^T A$ is computed. Since K and S always appear in the form of a ratio, the usual K-M condition is to choose a value for the white pigment. Typically, one sets $S_k = 1$ corresponding to titanium dioxide white as the kth pigment. The K-M values for all of the pigments can be derived from the above procedure, as each pure pigment is related to titanium white via a tint.

3.4 Rendering System

The renderer was implemented in Java with NVIDIA'S Cg programming language. The simulated canvas is represented as a rectangular discrete set of points. The simulated canvas is similar to a three dimensional height field, as seen in world space in Figure 29. Each point (depicted as a white dot in the figure) has three-dimensional coordinates (x, y, height) and contains the various pigment concentrations and volume of paint deposited at that point. Initially, the heights are given values corresponding to a actual primed canvas by use of a texture map.

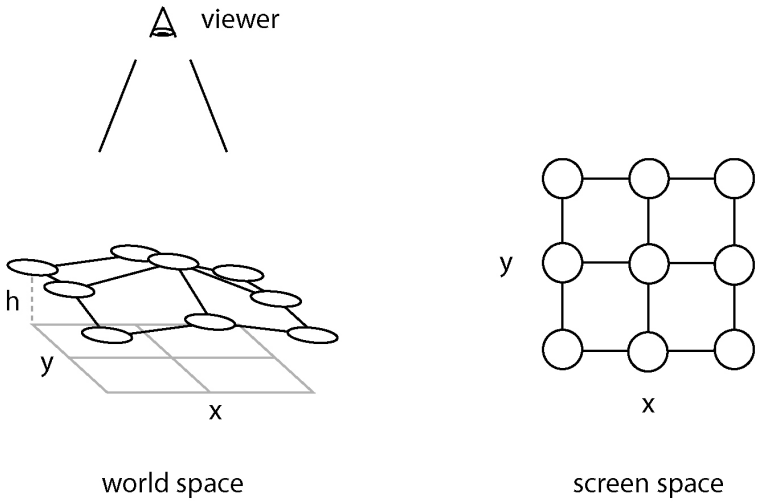

Figure 29: Our simulated canvas is discretized similarly to a height field. The user sees the top-down orthographic view of the simulated canvas, whereas every canvas point represents a pixel on the screen. Each point stores its paint volume, pigment concentrations, and normal.

The user sees the screen space version of this simulated canvas, which is the top-down orthographic view of world space. Here, each point in the simulated canvas corresponds to a pixel on the user's screen. Global canvas parameters are the current binding media used in the simulated painting, the lighting spectra and the current time.

As in previous K-M implementations, it is not feasible to store full-spectrum K and S values per pixel or compute them interactively. For a user-specified light spectrum, time, and binding media, the system chooses eight sample wavelengths to numerically

integrate over the spectra and XYZ matching functions. Eight wavelengths is a good fit with graphics hardware, as it can be stored in two floating-point textures.

Fragment shaders calculate the overall RGB reflectance of the painted canvas. Each texture with its four channels represents the concentrations of four pigments simultaneously allowed at any one point. Another texture is designated for the point's normal and thickness of paint at that point. Upon rendering the canvas, the normal for every point is calculated, via averaging the results from two cross-products. The vectors are made from the current point's three-space coordinates (x, y, height) to the four immediately surrounding points.

Each pixel undergoes the same rendering pipeline. First, $\left(\frac{K}{S}\right)_{mix}$ is calculated as a weighted average of the pigments using their respective concentrations in the mixture from Equation 21. Reflectance and transmittance of the layer is then calculated:

$$b = \sqrt{\left(\frac{K}{S}\right)\left(\frac{K}{S} + 2\right)} \tag{37}$$

$$R = \frac{1}{1 + \frac{K}{S} + b\,coth(bSd)} \tag{38}$$

$$T = bR\,csch(bSd) \tag{39}$$

where d represents the thickness of one layer of paint

Compositing multiple layers together (as well as the gesso ground) is done via Equation 30. If no pigments are present at a given pixel, the reflectance is solely the three-coat gesso. XYZ integrating functions are used to transform the eight wavelength reflectance values for display. Since K-M theory only gives us diffuse reflectance, the lighting computation is completed using Blinn-Phong specular highlights:

$$X = X\,(n \cdot l) + E\,\bar{x}\,(n \cdot h)^k$$
$$Y = Y\,(n \cdot l) + E\,\bar{y}\,(n \cdot h)^k$$
$$Z = Z\,(n \cdot l) + E\,\bar{z}\,(n \cdot h)^k \tag{40}$$

where

n is the normal at the current point

l is the vector from the current point to the light

$h = \dfrac{(l+e)}{2}$ is the half-vector, which avoids calculating the reflection vector

e is the vector from the current point to the camera

E is the spectral distribution of the illuminant

$\{\bar{x}, \bar{y}, \bar{z}\}$ are the observer matching functions

k is the specular exponent which controls the shininess of the material

Note that the Blinn-Phong shading model's use of an exponentiated cosine is an ad hoc approximation to specular highlights. A physically-accurate model of specular behavior would require a full temporally-varying BRDF for every sample.

The XYZ color is transformed into linear RGB values for display using the transformation matrix M from Equation 4. These values are then converted to nonlinear $sRGB$ before outputting to the display:

$$R_s = \begin{cases} 12.92R_l & ,\ R_l \leq .0031308 \\ 1.055R_l^{1/2.4} - 0.055 & ,\ \text{otherwise} \end{cases}$$
$$G_s = \begin{cases} 12.92G_l & ,\ G_l \leq .0031308 \\ 1.055G_l^{1/2.4} - 0.055 & ,\ \text{otherwise} \end{cases}$$

$$B_s = \begin{cases} 12.92B_l & , \ B_l \leq .0031308 \\ 1.055B_l^{1/2.4} - 0.055 & , \ \text{otherwise} \end{cases} \tag{41}$$

where $\{R, G, B\}_l$ are the linear RGB values

The implementation runs interactively on a 3.4GHz Pentium IV machine with a NVIDIA GeForce 6800 GT graphics card. The cost of the rendering is greatly reduced as the canvas is broken into tiles (each is 64x64 pixels). This drastically improves rendering speed, as only tiles that are modified need to be updated (i.e. only when new paint is applied to a tile). However, the entire canvas is rendered when the user changes global parameters such as lighting, binding media, or time.

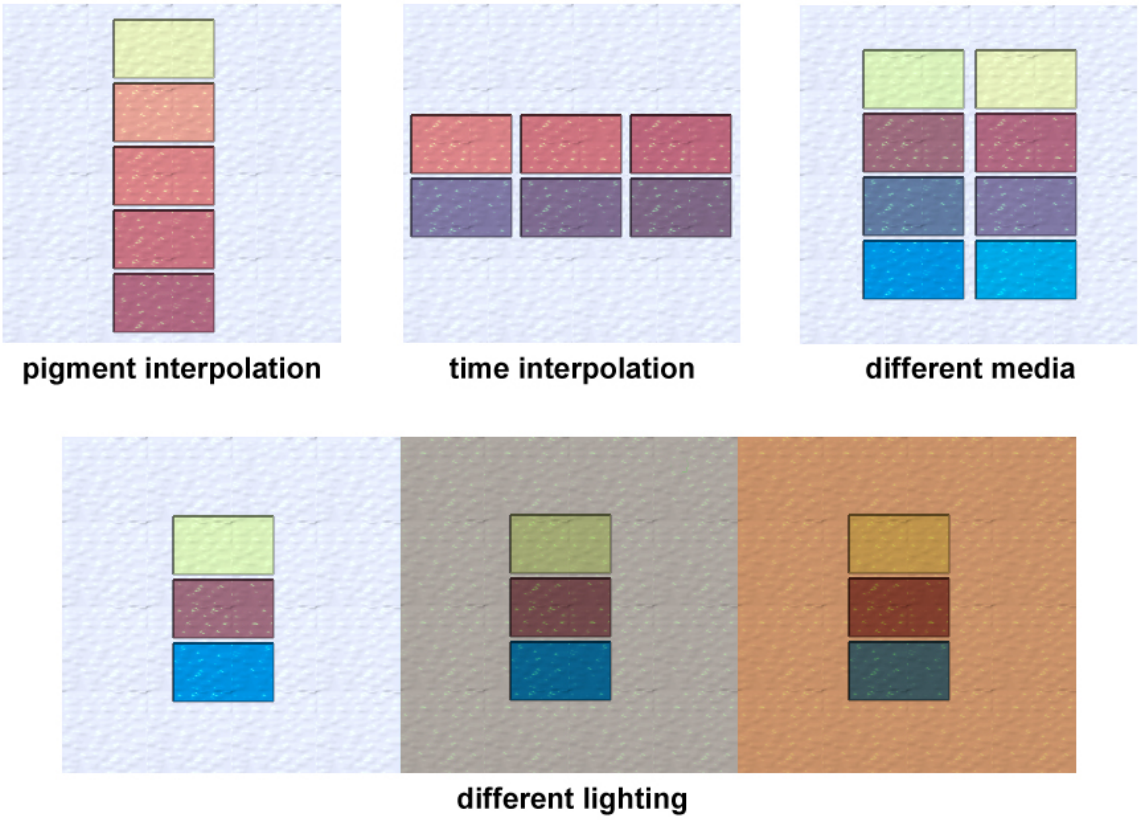

Figure 30: Features of our interactive viewer. Top left: K-M theory predicts the three middle paints from the relative concentrations of the other two. Top middle: the center paints are predicted using time as the interpolation weight. Top right: four pigments simulated in different binding media. Bottom: three paints under different illumination.

The system's features are illustrated in Figure 30. As in Baxter's work, Kubleka

Munk theory predicts the reflectance of any arbitrary pigment mixture (top left) as well as changes in illumination (bottom) in real time. However, in our system, one can also get instant visual feedback from manipulating the time (top middle) and binding media as well (top right).

In summary, our implementation provides a powerful tool in visualization. Provided is a simple method for laying down paint of varying pigment concentrations to see how they react under different conditions–all of the variables can be modified in real time. As computer processing improves, more wavelengths can be used in the lighting computation to better simulate the spectral reflectance. As display technology improves, the gamut of displayable colors will also expand, improving the conditions for which the colors are viewed.

3.5 Implementation issues

While this model is effective and can be computed in real time, there are some limitations to this theory of pigment modeling [Fis83, CAS+97]. The model assumes the paint is homogeneous. In fact, pigment particles tend to clump into aggregates and often contain inclusions or impurities. Also, the scattering assumptions in the transport theory were based on uniformly sized spherical particles. This is rarely the case for pigment particles as they are often of widely varying shapes and sizes. Further, all colorant layers are immersed in media of the same refractive index. This assumption is violated at the interface between the air and paint and paint to substrate. A fairly simple correction term for reflection and refraction at the paint's surface has been proposed [JW75] that could be used to increase accuracy.

While reasonably accurate, Kubelka Munk theory is only as good as the measurements behind it. Therefore, for more accurate prediction of color mixtures, many more mixtures of multiple pigments of varying concentrations are necessary to obtain better absorption and scattering coefficients.

In our work, only constant volume ratios of pigment-to-media are studied. In paint,

artists often manipulate the amount of binder and vehicle (as well as the addition of other materials) to achieve different tactile behaviors. Similarly, the fluid dynamics of the application of the eight different media are not considered, as this would be a huge undertaking. The study of how a media's tactile behavior changes as it dries or congeals would be an interesting research project.

Also, our work only encompasses a relatively short period of time of the life of a paint film. Remember that most paintings are expected to last indefinitely (at least a hundred years). Longer measurement intervals are needed for a more complete understanding of paint aging behavior. While many known historical samples exist, they were not considered this work, as they may be comprised of different materials or are from different origins. Further details supplementing this report can be found in [Bud07].

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