The Web Designer's Palette for Painting a Colorful Profit

Kevin Ferris, Computer Information Systems

Mentor: Dr. Sonya Zhang

Kellogg Honors College Capstone Project

ABSTRACT

Color, as a fundamental element of visual stimuli, has a substantial impact on our perception of what we see. Changing the hue or color scheme of any object will likewise have an effect on our emotional reaction. Web designers must pay careful attention to color theory and its effect on humans to develop successful websites. A good color scheme will convey unspoken persuasion to the user with a positive effect on brand perception and therefore sales.

First, a visual framework will be developed as a guide for novice designers to illustrate which factors to consider when deciding on a color scheme and help narrow the spectrum down to the most appropriate options for both web sites and web applications.

Second, a study and its results will be described that tested the effectiveness of the framework on students' ability to conceptualize effective color schemes for web design. The study was conducted through Google Forms and used multiple choice and open ended questions to evaluate each student's ability to select appropriate color schemes for a sample company. The control was evaluated based only off their personal knowledge, while the experimental group was introduced to the web color framework before being evaluated. The hypothesis for the test will be the following: The web color framework increases students' ability to make effective and appropriate color scheme choices for web design application by a statistically significant degree.

RESEARCH

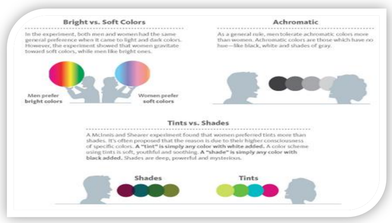
Business Strategy

Organizational Background

- Solid understanding of the product, mission, market, and priorities of the client

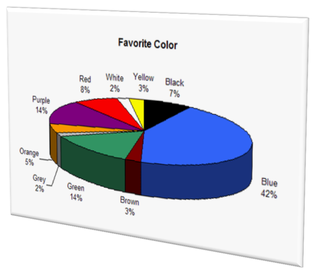
Target Audience

- "Cultural preferences and biases…impact what is deemed "user friendly," thus, usability issues must take on a cultural context" (Barber & Badre, 1998)



Competitor's Schemes

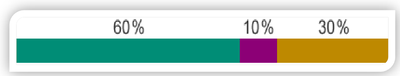
- "Whether you want to convey belonging within…your industry, or…stand out from the competition with your color scheme, getting a sense of the tones and textures used by comparable companies is a great start" (Gerber, 2013)



Color Theory

Number of Colors

- Three-Color scheme found to be the most versatile
- 60-30-10 rule states that the color scheme should be 60% the primary color, 30% the secondary color, and 10% the accent color

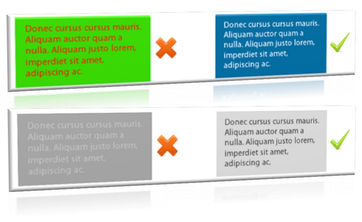


Color Harmony

- From left to right: Analogous, Complimentary, Split Complimentary, Triadic, and Tetradic

Text Overlay

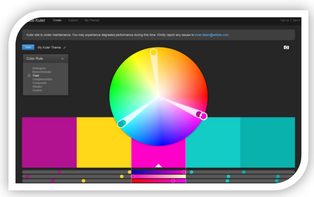
- Brightness formula (passing > 125) = ((Red value X 299) + (Green value X 587) + (Blue value X 114)) / 1000
- Difference formula (passing > 500) = (max (R value 1, R value 2) – min (R value 1, R value 2) + (max (G value 1, G value 2) - min (G value 1, G value 2)) + (max (B value 1, B value 2) - min (B value 1, B value 2))



Support

Scheme Generators

- "While these…systems provide the user with…potentially harmonious colour schemes, they are incapable of giving advice as to whether a colour scheme suits the…requirements" (Ou, Luo & Cui, 2009)



Alternative Schemes

- "To avoid any problems and especially to meet the deadline it is very wise for a designer to prepare several alternatives of color schemes" (Pintilie, 2011)

A/B and Multivariate Testing

- A/B Testing – Change one variable and test site performance to see if there is improvement
- Multivariate Testing – Change multiple variables at once and test to determine optimal combination

Choice

- Should be appropriate and effective
- Should have alternatives and variants

A Kansei scale value (degree of an impression) of an image is able to calculate with the next procedure.

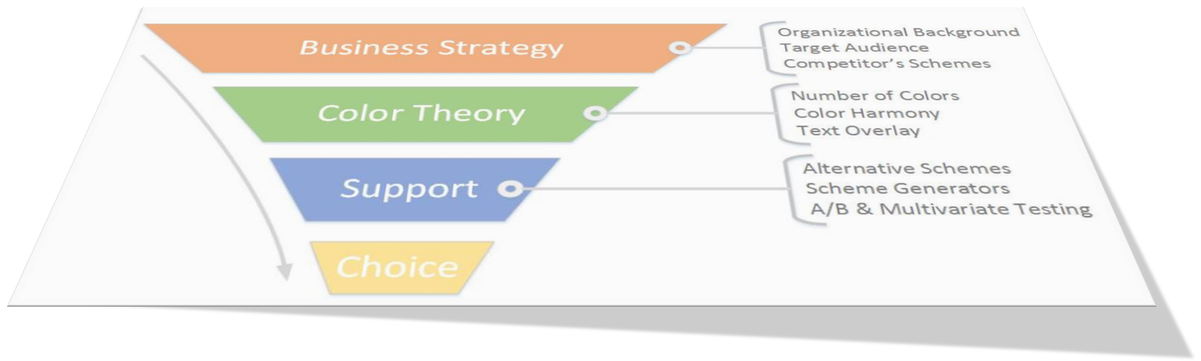
1. It calculates the sum of an absolute value of the correlation coefficient of all evaluation elements that it uses in the Kansei scale *(let A be this answer)*.
2. Correlation coefficient is divided by *A (let B be this answer)*.
3. It multiplies the evaluation element by *B*.
4. To every evaluation element that it calculates, the sum becomes a Kansei scale value.

In the case that Kansei scale value N is calculated, the evaluation elements which exerts an influence $a, b, c,$ value of an evaluation elements X_a, X_b, X_c and value of the correlation coefficient Y_a, Y_b, Y_c, N is calculated with the style that next shows it.

$$N = \frac{(X_a Y_a + X_b Y_b + X_c Y_c)}{(|Y_a| + |Y_b| + |Y_c|)}$$

Kansei scale	evaluation elements	correlation coefficient
warm ⇕ cool	hue average	−0.637
soft ⇕ hard	lightness average	0.813
	lightness chromaticness average	0.590
	lightness distributed degree	−0.791
natural ⇕ artificial	lightness average	0.620
	lightness distributed degree	−0.745
	distance distributed degree	−0.724
brightly ⇕ dark	lightness average	0.970
	lightness chromaticness average	0.916
	lightness distributed degree	−0.654
gay ⇕ quiet	chromaticness average	0.796
	lightness chromaticness average	0.909
	distance distributed degree	0.566

WEB COLOR FRAMEWORK



This is the web color framework that was developed based on the research in the left pane. It represents a funnel in the sense that as one goes through each layer of the framework, the total number of options are filtered down from infinite to just one choice that is both appropriate to the business and effective in execution. To test how well this framework helps novice students during the color scheme decision-making process, a study and its results are described below.

STUDY

In this study, students from the college of business, science, and engineering were asked to complete a Google Forms survey. Both the control and experiment group were given a company description and were asked a series of questions to assess their ability to conceptualize a color scheme for the design of the fictitious company's website. The experiment group was also given an overview of the Web Color Framework at the beginning of the survey. The goal of the study was to determine if the Web Color Framework improved students' ability to analyze relevant business information, conceptualize a color scheme, and rationalize, as well as test, their choices. The Google Forms survey was distributed via email through college email lists. 60 students were surveyed, 45 valid responses were received, among which 23 were in the control group and 22 were in the experiment group. The table to the upper right outlines the demographics of the participants in percentages for the control group, experiment group, and combined.

The survey contained 18 - 34 questions including multiple choice, fill in the blank, and short answer questions, and was estimated to take 15-30 minutes to complete. The questions contained in this survey fell under 6 categories: web framework quiz, business understanding, color scheme generation, justification, reflection, and demographics. The table to the lower right illustrates the grading rubric used when evaluating responses. Results were then aggregated and compared between the control and experiment groups.

Value	Combined	Control	Experiment
Gender			
Male	43.33%	47.00%	40.00%
Female	**56.67%**	**53.00%**	**60.00%**
Class Standing			
Freshman	11.67%	13.00%	10.00%
Sophomore	15.00%	23.00%	17.00%
Junior	**33.33%**	30.00%	**37.00%**
Senior	**33.33%**	**40.00%**	27.00%
Super	6.67%	3.00%	10.00%
Grad	0.00%	0.00%	0.00%
Major			
Business	**15.00%**	**33.33%**	**16.67%**
Marketing	5.00%	3.33%	6.67%
CS	11.67%	**13.33%**	10.00%
Accounting	5.00%	6.67%	3.33%
Ind. Engineer	1.67%	3.33%	0.00%
CIS	10.00%	6.67%	13.33%
Finance	6.67%	10.00%	3.33%
MHR	3.33%	3.33%	3.33%
TOM	1.67%	0.00%	3.33%
Science	1.67%	0.00%	3.33%
Web Design Skill Level			
Low	**38.33%**	**47.00%**	30.00%
Medium-Low	23.33%	23.00%	23.00%
Medium	28.33%	23.00%	**33.00%**
Medium-High	8.33%	7.00%	10.00%
High	1.67%	0.00%	3.00%

Group	Category	Range	Score
Quiz	Quiz Score	0 - 5	
		Total:	0
Company	Company Evaluation	0 - 5	
		Total:	0
Background	Background Base	0 - 5	
	Background Variant	0 - 3	
	Gradient	0 - 1	
		Total:	0
Brands	Number of Colors	0 - 5	
		Total:	0
Scheme Colors	1st Base	0 - 5	
	1st Variant	0 - 3	
	1st Percentage	0 - 3	
	Subtotal:		0
	2nd Base	0 - 5	
	2nd Variant	0 - 3	
	2nd Percentage	0 - 3	
	Subtotal:		0
	3rd Base	0 - 5	
	3rd Variant	0 - 3	
	3rd Percentage	0 - 3	
	Subtotal:		0
	4th Base	0 - 5	
	4th Variant	0 - 3	
	4th Percentage	0 - 3	
	Subtotal:		0
	Average Total:		0
Text	Text Base	0 - 5	
	Text Readability	0 - 3	
		Total:	0
Matching	Color Harmony	0 - 5	
		Total:	0
Total	Grand Total:		0
Other	Alternative Schemes	0 - 3	
	Scheme Testing	0 - 5	
	Scheme Reasoning	0 - 5	
	Average Total:		#DIV/0!

RESULTS

When the total scores were averaged, the experiment group outperformed the control group by 11.08%. In the rubric subcategories, the most substantial areas of improvement were in the areas of company evaluation (65.07%), number of colors to use (24.06%), and harmonious matching of colors (14.83%). There were two areas of negative improvement: text (-7.75%) and other (-4.84%). The results proved positive, but do not pass the t-test, most likely due to the small sample size.

Statistics	Rubric	Company	Background	# of colors
	Experiment Score	2.727272727	2.151515152	4.045454545
	Control Score	1.652173913	2.115942029	3.260869565
	Difference	1.07509881422925	0.0355731225296445	0.784584980237155
	Difference	**65.07%**	**1.68%**	**24.06%**

Statistics	Rubric	Scheme Colors	Text	Matching
	Experiment Score	7.564393939	3.068181818	3.045454545
	Control Score	6.992753623	3.326086957	2.652173913
	Difference	0.571640316205532	-0.257905138339921	0.393280632411067
	Difference	**8.17%**	**-7.75%**	**14.83%**

Statistics	Rubric	Other	Total
	Experiment Score	2.303030303	24.90530303
	Control Score	2.420289855	22.42028986
	Difference	-0.117259552042 16	2.485013175230 57
	Difference	**-4.84%**	**11.08%**

These results show that using the Web Color Framework allows students' to gain a better understanding of color theory and develop color schemes that are more visually attractive by about 15%. This fact alone is great support for the Web Color Framework, as improving color harmony skills is one of the most important target metrics that the framework attempts to improve. While there were two areas of negative improvement, their significance is less so as they were only a secondary focus of the framework. It is possible that students' in the experiment group only retained highlights from the core of the framework (business strategy and color theory) during their brief exposure.

REFERENCES

- Alberts, W., & van der Geest, T. (2011). *Color matters: Color as trustworthiness cue in web sites*. (University of Twente, Netherlands).
- Anthony (2010, October 11). *How color saturation affects user efficiency*. Retrieved from http://uxmovement.com/content/how-color-saturation-affects- user-efficiency/
- Barber, W., & Badre, A. (1998, June). Culturability: The merging of culture and usability. In *Proceedings of the 4th Conference on Human Factors and the Web*(pp. 1-14).
- *Basic color schemes - Introduction to Color Theory*. (n.d.). Retrieved from http://www.tigercolor.com/color-lab/color-theory/color-theory-intro.htm
- Brown, D., Burbano, E., Minski, J., & Cruz, I. (2002). *Evaluating web page color and layout adaptations*.
- Burtoff, Barbara. "Color Your World: Red is for Sexy. Blue is for Calm" Washington Post, June 2000. New York Public Library Online. 19 March 2001
- Chapman, C. (2010, January 28). *Color theory for designers, part 1: The meaning of color*. Retrieved from http://www.smashingmagazine.com/2010/01/28/color-theory-for-designers-part-1-the-meaning-of-color/
- Chapman, C. (2010, February 02). *Color theory for designers, part 2: Understanding concepts and terminology*. Retrieved from http://www.smashingmagazine.com/2010/02/02/color-theory-for-designers-part-2-understanding-concepts-and-terminology/
- Chapman, C. (2010, February 08). *Color theory for designer, part 3: Creating your own color palettes*. Retrieved from http://www.smashingmagazine.com/2010/02/08/color-theory-for-designer-part-3-creating-your-own-color-palettes/
- Chevreul, M. E. (1839). *The principles of harmony and contrast of colors*. Birren, F. (Ed.) (1987). New York: Van Nostrand Reinhold.
- Chisholm, W., Vanderheiden, G., & Jacobs, I. (1999, May 05). *Web content accessibility guidelines 1.0*. Retrieved from http://www.w3.org/TR/WAI-WEBCONTENT/
- Chopra, P. (2011, May 11). *Blue link vs. red link vs. banner: which one got 50% more clicks?*. Retrieved from http://visualwebsiteoptimizer.com/split-testing-blog/blue-link-vs-red-link/
- Gerber, S. (2013, June 09). *10 tips for company color schemes*. Retrieved from http://mashable.com/2013/06/09/color-schemes-business/
- Hall, R., & Hanna, P. (2004). The impact of web page text-background colour combinations on readability, retention, aesthetics and behavioural intention. *Behavior & Information Technology*, *23*(3), 183-195. Retrieved from http://tecfa.unige.ch/tecfa/maltt/cosys2/textes/hall04.pdf
- *How many colors should you use in your designs?*. (n.d.). Retrieved from http://www.tigercolor.com/color-lab/tips/tip-01.html
- Lowe, D., & Eklund, J. (2002). Client needs and the design process in web projects. *J. Web Eng.*, *1*(1), 23-36.
- Piirto, Rebecca, Claudia Montague. "The Wonderful World of Color" Marketing Tools Oct. 1997. New York Public Library Online
- *McArdle*, S. (2013, January 13). *Psychology of color in logo design*. Retrieved from http://thelogocompany.net/blog/infographics/psychology-color-logo-design/
- Nishiuchi, N., Yamanaka, K., & Beppu, K. (2008, July). A study of visibility evaluation for the combination of character color and background color on a web page. In *Secure System Integration and Reliability Improvement, 2008. SSIRI08. Second International Conference on* (pp. 191-192). IEEE.
- Noack, S. (2010, March 08). *A look into color theory in web design*. Retrieved from http://sixrevisions.com/web_design/a-look-into-color-theory-in-web-design/
- Ou, L. C., Luo, M. R., & Cui, G. (2009). A Colour Design Tool Based on Empirical Studies.
- Pintilie, D. (2011, June). *How to choose the right color scheme for your website*. Retrieved from http://www.designjuices.co.uk/2011/06/color-scheme/
- Porter, J. (2011, Auguest 02). *The button color a/b test: Red beats green*. Retrieved from http://blog.hubspot.com/blog/tabid/6307/bid/20566/The-Button-Color-A-B-Test-Red-Beats-Green.aspx
- Fleming, J., & Koman, R. (1998). *Web navigation: designing the user experience* (p. 166). Sebastopol, CA: O'reilly.
- Ridpath, C. & Chisholm, W. (2000). *Techniques For Accessibility Evaluation And Repair Tools*. Retrieved from http://www.w3.org/TR/AERT#color-contrast
- Rogers, Stephen B. "A Color Can Be a Trademark" San Antonio Business Journal, Apr. 1995. n. pag. New York Public Library Online.
- Saito, D., Saito, K., Notomi, K., & Saito, M. (2006). *The effect of age on web-safe color visibility for a white background*.
- Schloss, K. B., & Palmer, S. E. (2011). Aesthetic response to color combinations: preference, harmony, and similarity. *Attention, Perception, & Psychophysics*, *73*(2), 551-571.
- Singh, S. (2006). Impact of color on marketing. *Management Decision*, *44*(6), 783-789.
- Tackett, J. (2012, December 07). *Website optimization: 5 mistakes marketers and designers make with color*. Retrieved from http://www.marketingexperiments.com/blog/research-topics/landing-page-optimization-research-topics/optimization-mistakes-with-color.html
- Vukovic, P. (2012, September 25). [Web log message]. Retrieved from http://99designs.com/designer-blog/2012/09/25/8-common-mistakes-in-working-with-color-and-how-to-fix-them/
- Work, S. (2011). *True colors - breakdown of color preferences by gender*. Retrieved from http://blog.kissmetrics.com/gender-and-color/
- Yamazaki, H., & Kondo, K. (1999). A method of changing a color scheme with kansei scales.