SOUTH AFRICA 2006

# "Colour in Fashion and Colour in Culture"

Proceedings of the Interim Meeting of the International Colour Association

24 – 27 October 2006, Misty Hills, South Africa

Organised by the Colour Group of South Africa

**Hosted by**

**Sponsored and supported by**

# AIC Executive Committee Officers and Members

**President**

**Prof. José Luis Caivano**
Argentina

**Vice President**

**Mrs. Berit Bergström**
Sweden

**Secretary/Treasurer**

**Prof. Dr. Javier Romero**
Spain

**Member**

**Prof. Dr. Roy S. Berns**
USA

**Member**

**Prof. Dr. Osvaldo da Pos**
Italy

**Member**

**Mr. Nick Harkness**
Australia

**Member**

**Prof. Guanrong Ye**
Peoples' Republic of China

# AIC Regular Members

**Argentina:**
**GRUPO ARGENTINO DEL COLOR**
www.fadu.uba.ar/sitios/sicyt/color/gac.htm

**Australia:**
**COLOUR SOCIETY OF AUSTRALIA**
www.coloursociety.org.au/

**Bolivia:**
**ASOCIACIÓN BOLIVIANA DEL COLOR**
asociacionbolivianadelcolor@entelnet.bo

**Brazil:**
**ASSOCIAÇÃO BRASILEIRA DA COR**
hstruck@terra.com.br

**Bulgaria:**
**COLOUR GROUP – BULGARIA**
color_bg@hotmail.com

**China:**
**COLOR ASSOCIATION OF CHINA**
ygr@moi-lab2.zju.edu.cn

**Finland:**
**SUOMEN VÄRIYHDISTYS SVY RY**
www.svy.fi/

**France:**
**CENTRE FRANÇAIS DE LA COULEUR**
www.cf-couleur.fr/

**Germany:**
**DEUTSCHER VERBAND FARBE**
www.dfwg.de/
www.deutsches-farbenzentrum.de/

**Great Britain:**
**THE COLOUR GROUP**
www.city.ac.uk/colourgroup/

**Hungary:**
**HUNGARIAN NATIONAL COLOUR COMMITTEE**
nemcsics.antal@axelero.hu

**Italy:**
**ASSOCIAZIONE OTTICA ITALIANA**
www.associazioneotticaitaliana.info/

**Japan:**
**COLOR SCIENCE ASSOCIATION OF JAPAN**
www.soc.nii.ac.jp/color/

**Korea:**
**KOREAN SOCIETY OF COLOR STUDIES**
www.color.or.kr

**Netherlands:**
**NEDERLANDSE VERENIGING VOOR KLEURENSTUDIE**
www.kleurenstudie.nl/home.html

**Norway:**
**NORSK FARVEFORUM**

**Poland:**
**LÓWNY URZAD MIAR**
www.gum.gov.pl/pl/site/

**Portugal:**
**ASSOCIAÇÃO PORTUGESA DA COR**
apcor@fa.utl.pt

**Slovenia:**
**DRUSTVO KOLORISTOV SLOVENIJE**
www.dks-drustvo.si/

**South Africa:**
**COLOUR GROUP OF SOUTH AFRICA**
www.colourgroupsa.org.za/

**Spain:**
**COMITÉ ESPAÑOL DEL COLOR**
http://sedo.optica.csic.es/color/color.html

**Sweden:**
**STIFTELSEN SVENSKT FÄRGCENTRUM**
www.ncscolor.se/SCCF/

**Switzerland:**
**PRO COLORE**
www.procolore.ch/

**Thailand:**
**THE COLOR GROUP OF THAILAND**
aran@sc.chula.ac.th

**United States:**
**INTER-SOCIETY COLOR COUNCIL**
www.iscc.org/

## AIC Observers

**Austria:**
**Dr. Leonhard Oberascher**
ecd@leoncolor.com

**Canada:**
**Dr. Alan Robertson**
alan.robertson@nrc.ca

**Denmark:**
**Mrs. Mette Terkildsen**
info@danskfarveinstitut.dk

**Greece:**
**Prof. Dr. Theano F. Tosca**
tosca@eng.auth.gr

**India:**
**Ms. Suma Ahuja**
suma.ahuja@asianpaints.com

**India:**
**Ms. Latika Khosla**
latika@hathway.com

**New Zealand:**
**Dr. Andrew Chalmers**
chalmers@manukau.ac.nz

**República De Panamá:**
**Ing. Guillermo Marconi**

**Slovak Republic:**
**Dr. Diplo.-Ing. Andrea Urland**
a_urland@yahoo.com

**Turkey:**
**Dr. Susan Habib**
lapismaple@gmail.com

**Turkey:**
**Dr. Nilgün Camgöz-Olgunturk**
onilgun@bilkent.edu.tr

**Turkey:**
**Assoc. Prof. Rengin Ünver**
runver@yildiz.edu.tr

# President's Message

It gives me great pleasure to welcome you to the International Color Association (AIC) Interim meeting hosted by the Colour Group of South Africa. It is the first time that an AIC meeting is held on the continent of Africa and it is an honour to host this event.

This meeting is the highlight on the Colour Group's calendar of events and provides members with the opportunity to share technical knowledge and to establish or renew contacts with experts in the field in a relaxed atmosphere.

South Africa's arts and culture are as rich and varied as one might expect from such a diverse nation. Therefore the themes of this interim meeting: "Colour in Fashion" and "Colour in Culture" are especially suitable choices.

AIC 2006 is the premier technical event in South Africa this year for designers, artists, engineers and scientists working in these fields. The range of subjects presented in the technical programme includes colour in architecture and urban design, colour in cosmetics and fashion, colour preference studies, colour psychology, colours and basic emotions, colour and branding, colour forecasting, colour science education and more. It is a diverse mixture of professional interests that is characteristic of this meeting.

In addition to a stimulating technical programme, delegates will have the opportunity to experience Johannesburg, a sophisticated city at the gateway to a majestic continent. Affectionately known as Egoli, the beloved "City of Gold", the vibrant, exiting city offers visitors a large selection of recreational, cultural and historical attractions.

To all delegates and accompanying persons, my best wishes for a rewarding and enjoyable congress.

Natasha van Tonder
President: Colour Group of South Africa

# Foreword

It is with great pleasure that the AIC holds its first meeting in the African continent. Certainly, this is an occasion to celebrate, because even when we already covered the five continents with regard to membership, for the first time we can say that we have also reached the five continents with our meetings.

To date, 33 AIC congresses and meetings have been held, with the distribution for continents shown in the "Meetings" column below. If we take into account the present distribution of regular members in the AIC —that is to say, country members, or national associations—, from the total of 25 countries, the figures are as shown in the "Membership" column.

| Continent | Meetings | | Membership | |
|---|---|---|---|---|
| | Quantity | Percentage | Quantity | Percentage |
| Europe | 20 | 61% | 15 | 60% |
| America | 7 | 21% | 4 | 16% |
| Asia | 4 | 12% | 4 | 16% |
| Oceania | 1 | 3% | 1 | 4% |
| Africa | 1 | 3% | 1 | 4% |
| Total | 33 | 100% | 25 | 100% |

Thus, we can see that the relationship between meetings and membership distribution is fair enough, except for a little difference in favor of America and against Asia: having both continents 4 countries within the AIC —i.e. the same membership—, more congresses were held in America than in Asia. But a better balance will be reached next year, 2007, with the Midterm Meeting in China.

This AIC Interim Meeting in Johannesburg is also the fourth in the list of meetings and congresses held in the South hemisphere. In this regard, while 20% of the AIC membership is composed of Southern countries, only 12% of the meetings have been hosted in the South.

| Hemisphere | Meetings | | Membership | |
|---|---|---|---|---|
| | Quantity | Percentage | Quantity | Percentage |
| North | 29 | 88% | 20 | 80% |
| South | 4 | 12% | 5 | 20% |
| Total | 33 | 100% | 25 | 100% |

Again, these statistics will become slightly more balanced in 2009, with the 11th Congress being held in Australia.

I want to acknowledge the local organizing committee and the international scientific committee for their work towards making this AIC Interim Meeting in South Africa possible, and I wish the best success to it. I am sure that after the meeting, and by reading these proceedings, we will get a better understanding of the complexities of color in culture and color in fashion.

José Luis Caivano
AIC President

# Technical Programme

| Time | Wed 25 Oct 06 |
|---|---|
| 08:30 | Registration desk open |
| 09:00 | |
| 09:30 | Opening Ceremony |
| 09:45 | **SESSION CHAIR: M Reeves** |
| 10:00 | Keynote speaker:<br>Can color be an antiglobalization factor? Analysis of colors in branding<br>Prof JL Caivano & M López (Argentina) |
| 10:30 | Tea Break |
| 11:00 | **SESSION CHAIR: Ms B Bergstrom**<br>Color Science Education for Fashion Merchandising and Interior Design Students<br>Dr H Epps(USA) |
| 11:30 | An Analysis Of Basic Design Students' Intuitive And Analytic Attitudes In Colour Decisions<br>Miss S Akbay(Turkey) |
| 12:00 | Teaching color and appearance at the Laboratory of Light And Materials, Faculty of Arts, University of Granada, Spain<br>Dr F García Gil(Spain) |
| 12:30 | The Psychology of Light and Colour in Architectural Education<br>Prof B Mikellides(UK) |
| 13:00 | Lunch Break |
| 13:45 | Poster Session |
| 14:30 | **SESSION CHAIR: Dr O da Pos**<br>The preference of the male university students of Beijing in coloring of clothing and accessory<br>Mr Deng Han Yu and Prof Li Li Ting(China) |
| 15:00 | Cultural preferences for hair colour<br>Dr T Sato(Japan) |
| 15:30 | Color Cosmetic Assessment For China<br>Mrs L Khosla (India) |
| 16:00 | Tea Break |
| 16:30 | **SESSION CHAIR:J Romero**<br>Digital Rejuvenation of Artwork and its Effect on Meaning<br>Dr R Berns(USA) |
| 17:00 | Colour Meaning in Different Settings: Example from the fine arts and experimental colour studies<br>Ms B Stahre(Sweden) |
| 17:30 | |
| 18:00 | |
| 18:30 | |
| 19:00 for 19:30 | Dinner at Carnivore |

| Time | Thu 26 Oct 06 |
|---|---|
| 08:30 | |
| 09:00 | **SESSION CHAIR: Prof JL Caivano**<br>Cultural Role of Color in Architecture and Urban Environment<br>Prof S Rizzo(Italy) |
| 09:30 | Color as Idea: using color as the conceptual basis for architectural and urban design<br>Prof G Minah(USA) |
| 10:00 | An architectural understanding of colour research<br>Ms M Billger(Sweden) |
| 10:30 | Tea Break |
| 11:00 | **SESSION CHAIR: G Ye**<br>The Survival of Cengar as a Cultural Meaning<br>Dr A Yildiran(Turkey) |
| 11:30 | Interaction of colour and culture - Environmental Colour Design 1900-2010: An Anthology on Colour<br>Ms VM Schindler(France) |
| 12:00 | Colour as Cultural Indicators During Ottoman Period<br>Dr GR Kucukerdogan(Turkey) |
| 12:30 | Meaning of Colours for Ottoman Costumes<br>Prof S Gundes(Turkey) |
| 13:00 | Lunch Break |
| 13:45 | Poster Session |
| 14:30 | **SESSION CHAIR: Dr R Berns**<br>Colours and basic emotions<br>Dr O da Pos(Italy), P Green-Armytage (Australia) |
| 15:00 | A Ten-year Follow-up Study of Psychological Influences by the Disastrous Earthquake (Color Images and Earthquake Experiences)<br>Dr H Ohno, Y Nakano(Japan) |
| 15:30 | A Semiotic Approach To Colour<br>Mr L Lundgren(Sweden) |
| 16:00 | Tea Break |
| 16:30 | **SESSION CHAIR: Prof B Botha**<br>Fashion And Identity Color<br>Ms R Pompas, L Luzatto(Italy) |
| 17:00 | Exploring Personal Colour Analysis Data for the Colour Forecasting Process<br>Dr TD Cassidy(UK) |
| 17:30 | Adding other values to colors besides fashion<br>Dr AL Battaiola(Brazil) |
| 18:00 | |
| 18:30 | |
| 19:00 | Banquet |

| Time | Fri 27 Oct 06 |
|---|---|
| 08:30 | |
| 09:00 | **SESSION CHAIR: Ms M Billger**<br>Communicating colour research results: Two recent Swedish Examples<br>Dr K Fridell Anter (Sweden) |
| 09:30 | Simultaneous Contrast In Visual Culture And In Fashion<br>Ms G Olssen(Sweden) |
| 10:00 | Chromatic studies for urban space: Case Study: High School Campus, Lamentin (Guadeloupe, French West Indies)<br>MS VM Schindler, Mr M Cler (France) |
| 10:30 | Tea Break |
| 11:00 | **SESSION CHAIR: Mrs N van Tonder**<br>Colour Knowledge And Its Application As A Reflection Of One's Culture<br>Prof P Botha (South Africa) |
| 11:30 | Color Harmony Study on Object-Background Patterns<br>Miss XP Gao(Hong Kong) |
| 12:00 | Closing Ceremony and Lunch |

# Posters on Exhibition

| |
|---|
| Improvement PCA performance in recovery of spectral reflectance, considering the lightness mean of samples<br>Dr Mohammad Amani Tehran |
| Printing of colours measured in nature on fabric and field evaluation there-of<br>Mr Johannes Baumbach |
| Optical Characteristic Of Ink Jet Prints Conditioned By Substrate Ageing<br>Zdenka Bolanca |
| Perceptions, Preferences And Fashion Trends With Regard To Mobile (Cell) Phone Key Pad And LCD Backlighting In South Africa<br>Ms Elsie Coetzee |
| Color In Fashion And In The Artistic Vanguard<br>Rubén Gramón |
| The World of Colours in Hairdressing<br>Ms Charmaine Joubert |
| The Study on Development of Device Independent Color Analysis Program in the Field of Fashion<br>Yeon sook Noh |
| The Teaching Materials of Dyeing by a Green Leaf of a Natural Indigo Plant: Various Blue Learning<br>Ph. Dr Ikuko Okamoto |
| Color As A Specific Feature And Cojoint With Other Features In Experiments On The Appearance Of Complex Test Objects<br>Lucia R. Ronchi |
| Estimation of a Dyed Textile's Original Color based on Model of Discoloring Process<br>Ms Nozomi Sasaki |
| Evaluation of Colour Harmony of Thai Observers for CRT-Colour Samples<br>Suchitra Sueeprasan |
| Colour Vision in Quality Assurance<br>Ms Heleen Temple |
| Texture Effect on Visual Colour Difference Evaluation Using the Texture Pairs<br>Prof John Haozhong Xin |
| A comparison of various methods for establishing the relationship between structure and colour for fibre blends in yarn<br>Dr Geoffrey David Banyard |
| A Comparative Study on Color Scheme Preferences of Elementary School Children for Their School Environments: Two Private Schools in Ankara<br>Dr Zeynep Basoglu |
| Color, the Architectural Project and Archetypical Images<br>Dr João Carlos De Oliveira Cesar |
| Colors of nationality as chromatic intertext<br>Lic Mabel A. Lopez |

# Table of contents

# Can color be an antiglobalization factor? Analysis of colors in branding

José Luis Caivano and Mabel Amanda López
Secretaría de Investigaciones, Facultad de Arquitectura, Universidad de Buenos Aires
Ciudad Universitaria Pab. 3 piso 4, C1428BFA Buenos Aires (ARGENTINA)
E-mails: J. Caivano (caivano@fadu.uba.ar), M. López (ychodos@fadu.uba.ar)

**Abstract:** Color, in its use as identity, is symbolically codified but, in turn, it is traversed by other codifications that interfere with its interpretability. The formulation of a chromatic identity takes into account the coherence in relation to the competence in a system that assures identity and differentiation, tradition and innovation. The expansion of companies and institutions in the global market implied the transposition of their chromatic signs. The local connotations may re-signify or neutralize the values attributed to brands and identities. Being a feature of the global communication, it is interesting the study of this phenomenon from the point of view of color, because, as a sign, color seems to be more "transparent" in its meaning than written texts or even certain iconographies.

## 1. Designed identity: being at the service of the global market

Color works as a true code in the context of an institutional image. The existence of a chromatic code presupposes an intention in its aspects of production and the possibility of being recognized by the readers or users, i.e., it shows some degree of standardization. The use of color for identity purposes is symbolically codified but, in turn, is also traversed and interpenetrated by other codifications that interfere in its interpretation. The formulation of a chromatic identity takes into account the coherence in relation to its competence in a system that assures identity and differentiation, traditional values and innovation. The expansion of companies and institutions in the global market resulted in the transposition of their chromatic signs. Local connotations may re-signify or neutralize the values attributed to the brands and identities that the companies intend to communicate. While this phenomenon is a consequence of the global communication, it is interesting to study its chromatic aspects because, as a sign, color seems to be more "transparent" in its meaning than written texts or even certain iconographies.

The formation of the very concept of corporative identity is a product of market. At the beginnings of the 20th century, and in the frame of the so-called second industrial revolution, production and design appear interwoven, inaugurating a new way of series production that adds a symbolic value to objects. This tradition is inaugurated with emblematic works such as those produced between 1907 and 1914 by Peter Behrens (a German architect and graphic artist) and Otto Neurath (an Austrian sociologist) for the German company AEG.

However, only some decades after, with the creation of the Ulm School of Design (Hochschule für Gestaltung), the application of the principles of design at the service of a company becomes evident and systematic. One of its precursors, Otl Aicher —to whom the creation of the concept of *corporative image* is attributed— asserts that when speaking of corporative image we should speak of its representative image, the intended appearance. Everything that exists has a form, a shape, a face. The form is not only image and edge; it is gesture, presence and behavior. The image is a philosophical and moral phenomenon. Corporative identity is not the visible aspect but the complete personality of the company; the figure should not be understood as an external appearance but as a manifestation of the whole: the company seems what it is, and represents what it is.[1]

Identity is unity, concordance, synthesis of different elements; it should never be mere cosmetics that simply cover the objects or services as a make-up. Concerning activities of companies or organizations, this posture would imply that the inner profile of the services of a company —i.e., its know-how, its competence, its attitude— must coincide with the external profile of its services —for instance, the configuration of the product, the communication or image of the brand.[2]

The communicational study of corporative identity —understood as the representations or play of images of the subjects interacting in the interchanges— demonstrates that there is no univocal image but a set of ideas more or less diverse, coexistent and, however, "true".[3] The identity involves at least

four complementary faces: two subjective aspects, what the subjects intimately *believe to be* (Identity), and what *the others think they are* (Image); and two objective aspects, what *they say they are* (Communication), and the so-called objective indicators (Reality), what the data —relatively true and not always known— reveal.

The work on the company or institution can only operate on the subjective aspects, but it is necessary to establish the correspondences with the "phantom" created, between the interpretants addressed by the symbols and the objective aspects of the company (objective world or reality).

The identity becomes visible and communicable by means of different objects of design (architectural, graphic, industrial, textile, and multimedia design) that integrate a system of signs. The global character of the identity —pointed out by the designer Joan Costa[4]— and its interdisciplinarity —emphasized by Otl Aicher[1]— are two dimensions which can never be disengaged from the designer of the institutional image. The identity is a complex system of signs that calls for the sensorial and cognitive domains: it is visible, audible, and communicable. This system of signs was organized by Costa by means of seven vectors that constitute the support of the global identity (Table 1).[5]

The communicational strategies outlined coincide temporally and ideologically with the materialization of the globalization of markets. In fact, it can be asserted that both are two faces of the same coin, and that both, global identity and global market, permanently feed back each other.

*Table 1. Vectors that support the corporative global identity according to Joan Costa (left), and our interpretation in terms of a semiotic system (right).*

| | | |
|---|---|---|
| 1. | Name (brand name) or verbal identity | Linguistic symbol |
| 2. | Logo | Verbal symbol visualized typographically |
| 3. | Graphic mark | Graphic symbol |
| 4. | Chromatic identity | Color as a symbol |
| 5. | Cultural identity | Behavioral indexes: behaviors, actions, modes of doing, gestures |
| 6. | Corporative architecture | Spatial signs |
| 7. | Objective indicators of the identity | Economical indexes |

## 2. Color: a global sign?

Is color a global sign? One of the factors that render the identity of an institution visible is color. As a factor of identification of a company and, in turn, as a factor of differentiation from its competitors, color is widely acknowledged in institutional design. As Joan Costa says, it is one of the vectors of corporative identity.[5]

By mentioning cases such as *The Big Blue* (IBM), we must agree that, inside the global semiotic system, color is one of the key elements in the conformation of corporative identity. Its visual impact, pregnancy, memorability, as well as its possibilities of reproduction in different applications and media are key factors in design. The perception of color is faster than the perception of a symbol; inasmuch as it works as a "signal" and not as "information", the corporative color becomes a language.[5]

Color has a high impact on institutional communication because it is perceived faster than other institutional symbols such as iconographies or verbal texts. In addition, color requires less time of "lecture" than a logo.[6] When shape and color are adequately associated, color (the more primary element) facilitates the memorability of shape. Chromatic logos are more easily remembered than achromatic ones. In this way, color works as a factor for remembering the brand (for instance: *Kodak* yellow, *Nestle* red, *Coca-Cola* red, etc.).

But in addition to the perceptual aspects and the production and reproduction matters, the right choice of an institutional color is based on the values attributed by the addressees. Positive or negative associations are metonymically transferred from signs to objects, whether they are products or services.

The color of an institution is never apart from the more or less conscious associations that a community historically endorses to that color by tradition. For example, the color of the packaging of a product may connote cheapness or expensiveness. In the global economy it is necessary to pay attention to the values culturally attributed to colors by different people, because they can present local variations that downgrade the idea of a brand and are associated with negative connotations.

Color works as a sign that transmits symbolic values; for instance, the choice made by IBM is appropriate for the universe of technology and the vanguard: The future is blue.

### 3. The identity in metamorphosis: an imperial rainbow?

The local identity of a population, of a nation, is a constant whose axis is the spatial variable. The modern urban project defines the city as a spatial unit. The urban identity is displayed in an infinite space that promotes difference, with its history, its people, its economic and symbolic patrimony. This urban space reproduces a sensory and affective world identified by smells, sounds, colors, which are basically referred to a territoriality.

Globalization, instead, proposes a de-territorialized identity. Marshall McLuhan's *global village* was an infinite space without frontiers or boundaries. The Internet recreates this paradigm: virtualization, dematerialization of space, and the illusion of belonging to a global fraternity. The dissolution of barriers (communicational, economic, cultural and ideological ones), whose emblem could be incarnated in the fall of the Berlin Wall, seems to be a sign of the age. In parallel, the creation of supranational entities with diverse aims was fostered (such as the European Economic Community, the Mercosur in South America, the ALCA). In this new paradigm of infinite spaces, time is the measure, and movement or dynamism is, paradoxically, the only constant.

With all these warnings it becomes evident that management, institutional or corporative identity does not mean the same thing than at their origins. Given that one of the essential conditions for identity is unity in differentiation, the very concept of *global identity* becomes dubious. In the first place, its characteristics require the acknowledgment and identification on the part of the public —not just a massive public, as before, but a global public— and, in addition, it could not anchor its communication in rigid schemes that rapidly become obsolete but, instead, it must undergo a unity in perpetual movement.

Globalization has not produced the utopia that McLuhan envisioned; nobody ignores that today the world is not a village but a gigantic market without barriers and with deep asymmetries between producers and consumers, between those who have access to consumption and those who are directly excluded from it. And communication in a globally interconnected community has created necessities instead of satisfying them.

In this scenario, as Michael Hardt and Antonio Negri point out, the sovereignty has acquired a new shape, composed of a series of national and supranational organisms joined by the logic of domination.[7] This new form of sovereignty responds to the concept of "empire". In spite that this word immediately recalls the concept of "imperialism", these theoreticians differentiate them. The national sovereignty was a condition of the imperialism, whose boundaries guaranteed the purity of the own identity and, at the same time, excluded what was different.

Imperialism was actually an extension of the sovereignty of the European state-nations beyond their own boundaries. Eventually, almost all territories in the world could be divided in pieces of land, and the entire map of the world would appear encoded with the European colors: red for the British territories, blue for the French ones, green for the Portuguese ones, etc.[7]

The empire does not establish a center of power —but it could be argued that the United States occupy a place of privilege in it— but is constituted in a decentralized and de-territorialized apparatus that includes the whole planet with open boundaries in permanent expansion. Within the empire there are no pure identities, but hybrid ones. This is a world governed by new ways of differentiation and homogenization. The national colors, distinctive of the imperialist map of the world, have been fused and melted together in a global imperial rainbow.[7]

### 4. Chromatic identity

How were some companies able to establish a universal chromatic code? Among other factors, leadership in their markets, diffusion, and permanence are decisive. For instance, the election of red for *Coca-Cola*, when no equivalent beverage was present in the market, created a generic code for all cola beverages. In spite that what is remembered is *"Coca-Cola"*, the use of red in the competitor brands allows for the identification of the kind of beverage and for certain mimicry which would associate them to the prestige of the leader brand. Red conveys "calories", and in this sense may be appropriate for this kind of energizing beverages with sugar and caffeine; however, the association

seems to be more of a symbolic kind. In addition, red is the preferred color for products of massive consumption, because it is regarded as a "declassifier", i.e., a color that does not contain markers of class. Another similar phenomenon is the case of McDonald's.

In general, once a generic chromatic code has been installed the different brands tend to reproduce it; for instance: normal cigarettes (reddish, brownish, blackish) versus light cigarettes (bluish) and menthol cigarettes (greenish). This kind of metonymic-indexical association is repeated in liquids for cleaning, mineral water (cold colors plus white), coffee or tea (warm colors plus black). The green hue, selected as an index of naturalness, has become a symbol of "ecological".

However, these connotations only reach certain regularity in their interpretations within the frame of the class of product or service alluded. For instance, green can be selected for a bank, a health service or a university because of being a "serious" or institutional color (such as bordeaux and blue), which metaphorically and symbolically transmits "security" and "reliability" and pretends to generate trustworthiness on the part of the public.

To design a chromatic identity, then, more than "creating" the color seems to be a matter of a delicate play of insertion in a complex grammar of codes (generic, stylistic, cultural codes) which, in spite of not being determinant of the election of color, certainly imposes limits to this election. There are senses that must be "silenced", sealed off, making then invisible; then, there are inappropriate or unacceptable colors. For instance, pink is not acceptable for male products, while is the preferred color in brands of products for girls, like *Barbie*.

However, when a brand succeeds in breaking those stereotypes, it may impose its chromatic identity as a powerful symbol. For instance, the lilac color of *Milka* chocolates is a transgression with regard to the traditional iconic associations of the product with brown, the indexical-metonymic associations (energy, calories = warm colors), or the metaphorical-symbolic values (sumptuousness, premium = gold). In this way, the lilac color creates a plus (softness), re-inventing and re-updating an old product such as chocolate.

From what has been said, we can conclude that very few brands have succeeded in fixing their chromatic identities to the public. Only the pioneers and leader brands are memorable and have established true codes that regulate the use of color.

## 5. Chromatic identity: a factor of resistance?

The opacity of the chromatic sign is based upon its great sensibility to the context and on the fact that every color simultaneously participates of different subcodes. Then, when one of these subcodes enters in competence with another, the user decides the sense by paying attention to the criteria of relevance (in that context). This would explain how some chromatic codes that are positively interpreted in the majority of contexts could be rejected in certain local contexts.

The conscious rejection that global phobic people could make by not consuming certain brands is an isolated gesture; its action is weak in comparison with the organized project of creating a global market. However, there are zones —not of the order of what is rational but of the order of what is emotional, and for this reason more resilient— which still operate as a factor of continuity and resistance: the patriotic colors (national identity), and, associated to them, the sports identity (for instance, the colors of the national football team), and the identity of political parties.

This hypothesis would explain anomalous cases in which the local market fights against the multinational brands and even succeeds in defeating them.

One of the few countries in Latin America in which *Coca-Cola* is not the most selling cola beverage is Peru. *Inca Kola*, with "a national flavor", is the leader. Its success is based on the exaltation of the local and autochthonous values that it represents (Figure 1).


*Figure 1.* Inca Kola *case in Peru (blue and yellow): a transgression of the chromatic generic code for cola beverages.*

Argentina —a country with no prestige as a producer of beer— has generated, however, a leader brand, *Quilmes*, whose success relies on the use of the national colors. In addition, light blue and white are colors very seldom used for beers, and for this reason become transgressors and "different". *Quilmes* cannot make a good competition with the leader brands from common or traditional positions, but it is effective from the evocation of values of the local idiosyncrasy (Figure 2).


*Figure 2. The case of* Quilmes *in Argentina (light blue) compared with other brands of beer (red, yellow): transgression of the generic chromatic code.*

These kinds of associations are not unknown by the creators of a global image —for instance, they know that it would be impossible to introduce a brand with the colors of the US flag in adverse contexts.

An interesting case, where an identity was created by paying attention to the state-national axis versus the private-foreign one, was the process of privatization of national companies (state companies) in the decade of 1990 in Argentina. Something had changed, and it was necessary to show that change in the design, but some aspects were best to be hidden. In this sense, the two companies of telecommunications that divided the business of fixed telephonic services —the French *Telecom* and the Spanish *Telefónica*— selected different ways. It is necessary to make clear that the companies required a differentiation in the market, though there is no competition between them because each one was assigned a different part of the country, with "captive" customers whom they do not need to seduce. The old national company, *ENTEL*, lacked a chromatic identity. *Telecom* aimed at a national identity, its logo was an Argentine flag-telephone. In reality, it is not a continuity with respect to the past, but an overacting on the quality of being multinational, oriented to this specific market. On the contrary, in that initial moment, *Telefónica* aimed at the concept of modernization and universality, at the idea of a positive change. In a second moment, *Telecom* detached its identity from the icon of the telephone to correlate it with the new services offered. The new symbol can be seen as a metaphor of fiber optics circumvallating the globe: the promise is the future of technology as an inevitable destiny. The chromatic continuity lays down a bridge between past and future, masking the global aspects. On its side, *Telefónica* also maintains its own profile by introducing its global corporative image (the typographic mark) with a chromatic election that connotes modernity, innovation, and technology. All these attributes are desirable and are expected from a company that offers this kind of services, a reason why both companies empowered their positive images (Figure 3).


*Figure 3. Privatized telephonic companies in Argentina:* Telefónica *and* Telecom, *1st and 2nd stages.*

At the same period, the state oil company *YPF* was privatized. Its image was not depreciated in the mind of the public, as it was the image of the old telephonic state company *ENTEL*. Instead, *YPF* was regarded as an emblem of sovereignty and national richness. Its position was excellent, even when, before being privatized, the government said that it overloaded its budget in order to be able to afford its bad administration. Its identity was based upon the national colors. The privatized company kept the name and also the chromatic spirit. The modifications were almost imperceptible, and seemed just a modernization of the same company. Yellow was incorporated, which may represent the sun that appears in the Argentina flag of war. The design emphasized the continuity and dissimulated the change of owners. In the last stage of this story, the company was fused with the Spanish *Repsol*, integrating both names in the same logo. However, the gas stations —of a high technology and quality— have not been modified. The commercial strategy was not to make the change evident. The

value of the local-national features makes *Repsol-YPF* different from their competitors, *Esso* and *Shell* (red and yellow), which historically represented the multinational companies (Figure 4).


*Figure 4. The changes after the privatization of* YPF *oil company in Argentina.*

When the Brazilian company *Petrobras*, with its green and yellow colors (making a clear reference to the flag of Brazil), was introduced in the Argentine context, their owners decided to make a small chromatic change. The inclusion of blue had the intention of making the identity closer to the company that holds the best position in Argentina *(YPF)*, and attenuating its Brazilianness, which is an attribute not at all positive in the mind of some users (mainly because of the historical rivalry between Brazil and Argentina in football —soccer). The strategy is clearly to mimic the old national company *YPF*, still present in the mind of the consumers (Figure 5).


*Figure 5. Insertion of the Brazilian* Petrobras *oil company in Argentina. Left: original colors (green and yellow). Center and right: chromatic adaptation to Argentina (blue, green, and yellow).*

Extreme cases of this strategy are produced in the publicity applied to sport clothes, where the corporative color give up in front of the colors of the team (Figure 6). The patriotic colors, the national identity, the sports identity and the political identity seem to be colors engraved in our affective memory in such a positive way that work as unconscious barriers or "chromatic vaccines" in front of the dominant and hegemonic colors of the global market. Perhaps these are the colors from which small but fruitful redoubts of local resistance can be built.


*Figure 6. Lose of the identity colors of a trademark when it is a sponsor of a sports team:* Petrobras *(in blue) in the Racing club, and* Pepsi *(in blue on a yellow background) in Boca Juniors club, Argentina.*

**References**


1. O. Aicher, "La imagen", in *El mundo como proyecto* (Gustavo Gili, Barcelona, 1991).
2. B. Bürdek, *Design*. Spanish translation by F. Vegas López-Manzanares, *Diseño* (Gustavo Gili, Barcelona, 1994), p. 279.
3. N. Chaves, *La imagen corporativa* (Gustavo Gili, Barcelona, 1988).
4. J. Costa, "Imagen global", in *Enciclopedia del diseño* (CEAC, Barcelona, 1989).
5. J. Costa, *Identidad corporativa y estrategia de empresa* (CEAC, Barcelona, 1992).
6. M. Chague, M. Mattiello, and S. Pescio, "Reconocimiento formal de isotipos cromáticos", in *ArgenColor 1998, Actas del IV Congreso Argentino del Color* (Grupo Argentino del Color, Buenos Aires, 2000), pp. 153-158.
7. M. Hardt and A. Negri, *Imperio* (Paidós, Buenos Aires, 2002).

# Color Science Education for Fashion Merchandising and Interior Design Students

H. H. Epps
Department of Textiles, Merchandising and Interiors, The University of Georgia
Athens, Georgia 30602 (USA)

## ABSTRACT

Effective color communication is a necessary tool for Fashion Merchandising and Interior Design students. Undergraduate students at the University of Georgia who enroll in a Color Science course explore seven different levels of color communication through numerous individual and group assignments on topics ranging from fashionable to common color names, to color order systems, and instrumental color measurement. Group projects and individual student projects are designed to facilitate effective communication of color information between designers, product development specialists, colorists, marketers, and consumers.

## BACKGROUND OF THE COURSE

Students who major in either Fashion Merchandising or Interiors and Furnishings (Interior Design) at the University of Georgia enroll in a Bachelor of Science degree that is designed to prepare them to assume professional positions in a wide range of marketing, merchandising, product development, consumer relations, or design establishments. There are two commons factors among these career possibilities. First, each involves communication with other individuals or groups within the design-product development-sourcing-production-evaluation-marketing-sales-consumption chain. Secondly, each involves products for which color is an important consideration for consumers, affecting not only the consumer's selection of the product or service, but also long-term satisfaction with the product or service.

In the textiles, apparel, and interior design fields, communication and specification of color between and among designers, manufacturers, suppliers, marketers and consumers has always been challenging, because color is a highly visible phenomenon of significant importance to consumers. In the increasingly global textiles and apparel market, linguistic, cultural, and technological differences provide further challenges to effective communication of color information and color specification. In order to prepare students of interior design and fashion merchandising at the University of Georgia to address the challenges of effective color communication, an undergraduate color science course was developed. The overall goal of the course is to enable students to effectively communicate color information.

## LEVELS OF COLOR COMMUNICATION

Kelly and Judd [1] identified six levels of universal color language based on their level of precision in communicating color, also indicating the number of divisions of color within each level, and possible applications for the use of each level. In the Kelly and Judd classification, level one, the least precise, consists of generic hue names and neutrals, using terms such as "red" or "grey". Level two includes all hue names and neutrals with color names used as modifiers, such as "greenish", for example, as in "greenish-brown". This combination of color names and modifiers results in terms that are slightly more precise than level one, but still quite ambiguous. Level three in the Kelly-Judd hierarchy refers to a specific set of hue names, neuturals and modifiers specified in the ISCC-NBS system, to correspond with the Munsell color model. The ISCC-NBS system is rarely used today, but it represents a well-intended attempt to merge common color language with a more specific approach to color communication, with the goal being that the lay person and the scientist use the same system to describe color. Level four refers to color order systems, specifically systems in which colors are arranged and designated in some logical order that is usually based either on color perception or color

mixing. Level five consists of visually interpolated notation from color order systems. This involves estimation of a color notation of a specimen whose color appears to fall somewhere between the colors of two standard specimens within the designated color order system. Level six, the most precise, is instrumental color measurement.

The levels described by Kelly served as a theoretical framework for initiating and developing the color science course, but as the course evolved, another level, that of "fashionable color names" was included, which, for purposes of this particular course, is now designated as level one, since it is less precise than Kelly's level one. Fashionable color names are color terms that typically endure for a short period of time, often no longer than one season. They may consist of words that in normal usage are not related to color. Examples might include such terms as "mist", or "forest", or, fashionable color names may be as obscure as "Finish Line" (a Cotton Incorporated color name from a recent season). Another adaptation of Kelly's model was the addition of descriptors such as "light", "dark", etc. into the level which corresponds with Kelly's level two. Including these modifications, the levels of color language that are addressed in the course, ranging from least precise to most precise are:

1. Fashionable Color Names
2. Common color names (hue names and neutrals)
3. Hue names and neutrals with modifiers
4. Specific hue names and neutrals with modifiers (as in ISCC-NBS system)
5. Color Order Systems
6. Visually Interpolated Color Order Systems
7. Instrumental Color Measurement

**COURSE OBJECTIVES AND FORMAT**

Developing an appreciation of each of these levels of color language aids in the development of effective color communication skills. Using class assignments which require students to describe a color as they would in communicating to a friend, to a potential client or customer, and to a dyer or colorist who must re-create the color, each of the levels of color language is explored. Each of the seven levels is introduced in the course, but the primary focus is on exploring different color order systems and learning instrumental color measurement.

While the overall goal of the course is to facilitate effective color communication and specification, there are five specific objectives for students who enroll in the course:

1. To understand basic color theory, measurement and evaluation;
2. To observe and evaluate the interaction of color and other elements of design (in particular, light and texture);
3. To understand basic principles of color vision;
4. To address problems related to coloration and/or color assessment of consumer products;
5. To become aware of color-related problems in presentation and marketing of consumer products.

The undergraduate color science course meets three hours per week for a 16-week semester. Enrollment is limited to 30 students. It is taught primarily as a lecture-discussion course with numerous in-class laboratory assignments. The course begins with an adaptation of the "desert island experiment" described by various authors, including Berns[2]. During this class exercise, students are divided into groups and given the task of arranging a set of approximately 100 color chips "in order". Attention is drawn to the different approaches to solving this problem and the specific words used among the students as they discuss how to approach the task. Throughout the course, readings and other assignments address the history, art, and science of the development and application of color theory. Various color-order and color designation systems are studied and compared, including primarily Munsell and NCS, but also systems as diverse as Ostwald, Chevreul, Kuppers, and Pantone. Color vision and color discrimination are evaluated. Effects of light are explored in laboratory exercises on color rendering and metamerism. Study of human color vision leads into examination of

tristimulus and opponent theories and development of color measurement systems. Color measurement projects include limited use of bench-top and hand-held spectrophotometers, supplemented with related computer assignments. Students also complete a project on the topic of their choice. Project topics have included various color theorists not otherwise included in the course, color memory, color preference studies, color and lighting, as well as reviews of literature related to color psychology, or color in historical textiles or design.

**REFERENCES**

1. K. L. Kelly and D. B. Judd. Color: Universal Language and Dictionary of Names, NBS Special Publication 440, US Government Printing Office, Washington, DC (1976).

2. R. S. Berns. Billmeyer and Saltzman's Principles of Color Technology, 3rd Edition. (Wiley, New York, 2000).

# An Analysis Of Basic Design Students' Intuitive And Analytic Attitudes In Colour Decisions

Saadet Akbay
Department of Interior Architecture, Faculty of Engineering and Architecture, Çankaya University,
Öğretmenler Cad. No: 14 06530 Balgat-Ankara (TURKEY)
Corresponding author: S. Akbay (akbay@cankaya.edu.tr)

**ABSTRACT**

The study aims at searching for the progression of the design students' intuitive and analytical attitudes in colour decisions by means of aesthetic values in basic design education. Thus, the study has been conducted to search for these approaches with an empirical study with the basic design students of Bilkent University, Department of Interior Architecture and Environmental Design. The results of the study show that during the progression of colour education in basic design, the students' colour decision tendencies towards subjective and intuitive attitudes have a decrease and their tendencies towards knowledge-based and analytical attitudes have an increase.

## 1. INTRODUCTION

Colour can be defined as a subjective preference, an experience and an intuitive sense, or as a theory and a science. Design education regards colour as a scientific theory by means of reasoning. Design students learn colour in a way of traditional and objective methods in colour education. Colour education aims at providing design students to be able to understand colour theory and features to use colour harmony arrangements in visual composition [1].

People have –more or less – an acquaintance with colour, so do the design students, which depend on their personal preferences, subjective experiences, and socio-cultural attributions. Design education does not ignore or rejects students' subjective experiences and accumulation; however they can be enriched and honed with knowledge. Basic design education is the first step to cultivate design students' subjective attitudes towards colour. Consequently, colour education in basic design is one of the important stages in order to improve students' visual thinking and reasoning needed for further colour designs.

## 2. EMPIRICAL STUDY

### 2.1. Aim of the Study

Students of basic design have personal, subjective and intuitive sets of values, preferences and attitudes. Light states that students of design have more or less developed intuitions and these subjective responses can be enriched and cultivated [2]. When these preferences and values are cultivated, it is expected that their intuitive attitudes transform into and supported by objective and analytical sets of approaches. Before going into further discussions asking the following questions are necessary. How these intuitions and subjective responses appear and/or disappear during the basic design education? What kind of relations exists and/or can be observed between the appearance and/or disappearance of intuitive and subjective responses and theoretical and analytical acquirements during the progression of the basic design education?

If these claims are inferred for this case, the major concern of the study is to analyze the progression and cultivation of basic design students' intuitive and analytical attitudes in colour decisions by means of aesthetic values on two-dimensional projects. Consequently, in order to analyze the validity and the accuracy of these statements, it has been studied by means of an empirical study involving the basic design students of Interior Architecture and Environmental Design (IAED) department of Bilkent University.

### 2.2. Methodology of the Study

Basic design education in IAED depends upon the basic design studio courses which comprises of two semesters, two days/ nine hours per week. In the first semester of basic design education, design elements as tools, and design principles as themes which are taken from the Gestalt Theory of

Perception for the supportive formulations of the visual language are brought together in two-dimensional plane and followed by three-dimensional organizations[3]. The second semester of the basic design studio has been programmed as an introduction to architectural design by including human dimensions and informal distances, openings, natural lighting, and functional organizations [4]. As the study focuses on the 2D colour compositions, only the period in which 2D design projects of the 2002-2003 first (fall) semester of the basic design studio in IAED was investigated.

There were three critical stages of 2D projects that the basic design students faced with during the colour applications in basic design studio course which were; a. Name-Poster project (sketch problem), b. 2D-Pattern project, and c. 2D-Organization project.

**a. Name-Poster** project was the first day basic design studio work of the fall semester, which required students to collage their names by the technique of cut and paste with the media of coloured papers, magazines and newspapers onto the 40*70 cm. grey card boards. They were free to use colour, texture, and material. This project was important to introduce students to design education, to understand the level of their visual thinking, and to unfold the ability to design because the students' colour, colour composition and design decisions were based on their intuitive attitudes and their background experiences.

**b**. At the second project of **2D-Pattern**, the basic design students were demanded to use the primary colours, black and white and their mixtures on A4 drawing paper by the technique of cut and paste with the media of gauge colours at third week of the semester. Although the students had not studied colour analytically, its theory and compositional principles, this process was significant for colour education in basic design. This led them to subjective experimentation [2].

**c.** In the **2D-Organization** project, the basic design students employed a knowledge based and analytical approach. The approach of ranges was from achromatic or monochromatic scales to full spectral harmonies. In this project, the students learned fundamentals and basics of colour theory and its compositional harmony, and inter-relation between visual organizational principles. It was required to use the basic principles of organizations and colour theory principles by the cut and paste technique with the media of gauge colours on 35*50 cm. thick paper at the seventh week of the semester. The 2D-Organization was the last project of the two-dimensional designs of the fall semester.

### 2.3. Participants

The participants were the first year basic design students of Interior Architecture and Environmental Design Department of Bilkent University. The total population of basic design comprised of 81 students, however the repeating students of basic design course were omitted in order to prevent the bias that would occur. The students who did not submit any of the three projects were excluded as well. Finally, the study eventuated 30 from 50 basic design students who attended to the interview. Consequently, each 30 student had three projects.

### 2.4. Procedure

All of the participants were required to fill an open-ended questionnaire at the end of each project they submitted. The questionnaire was based on one important question, which questioned the basic design students' colour decision criteria. In addition, the questionnaire was supported by other questions in order to expand the main question. Consequently, the questionnaire comprised of four questions which aimed at clarifying the reasons and decisions of the students about the colours on their projects and the same questions were asked for each project.

### 2.5. Data Analysis of the Projects

The data were collected from the answers of the interview of the three 2D projects and the generalizations were made under the headings of a certain criteria. The answers of students' colour decisions were analysed in relation to the existence or not existence of the criteria. The analysis and comparisons were generated by the frequency and relative frequency distributions, and bar graphs were used to display the dispersion of basic design students' colour decisions of the two-dimensional projects. The criteria derived from the development of an aesthetic experience in human nature are as follows.

**Subjective/ Intuitive/ Heuristic** **Objective/ Knowledge-base/ Analytic**

- Preference
- Symbolic
- Formal
- Thematic
- Systematic

Preferences dealt with likes, pleasantness and arousal; symbolic values referred to connotative and associational meanings and attributions, which might be justified in socio-cultural environment. Formal attitudes depended upon Gestalt theory of principles and reasoning in design. In accordance with the theme or the concept of the projects of the organizational principles, thematic attitudes of colour decisions were considered as analytical decisions. Systematic attitudes carried on visual thinking and reasoning in colour design by colour theories and colour harmony principles. Consequently, formal, thematic, and systematic attitudes depended upon theoretical and analytical levels of design. Even though, colour preferences and symbolic values based upon subjective and intuitive approaches; formal, thematic, and systematic attitudes relied upon analytical and knowledge-based colour decisions.

**2.6. Results of the Analysis**

All the three projects were analyzed and the proper progression among the projects of the Name-Poster, the 2D-Pattern, and the 2D-Organization was observed. The Figure 1 displays the frequency distribution of basic design students' colour decisions on three projects.

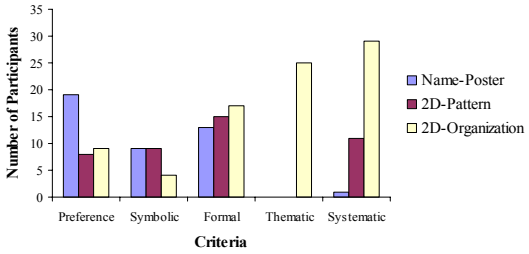



*Figure 1. Bar Graph for the Distributions of the Projects*

In Name-Poster project, the basic design students' colour preferences (r*f*= 0.452) were observed preliminarily. These preferences were composed of their favourite colours. Following, although the students had not had theoretical knowledge about colour besides their past and background accumulations, their colour decisions depended upon formal attitudes such as harmony, contrast of colours and legibility of their names on the poster (r*f*= 0.309). Moreover, it was examined that the students had conscious associational and symbolic attitudes towards colour decisions on this project (r*f*= 0.214). Hence, the students' colour decisions have the common distribution on the intuitive attitudes. In 2D-Pattern project, formal attitude in colour decisions was more dominant than any of the parameters that sum up the set of criteria (r*f*= 0.348). Although the colour preferences (r*f*= 0.186) and the symbolic values (r*f*= 0.209) of the students' decisions were not abandoned, the frequency distribution of the 2D-Pattern project was not as high as it was in the Name-Poster. Also, the tendency towards systematic approach was observed (r*f*= 0.255). In this project, it was examined that basic design students' colour decisions both depend upon their intuitive and analytical attitudes. Although basic design students do not have proper theoretical knowledge about colour, they were conscious about reasoning while designing in this process. Hence, the evaluations showed that there was an increase of the analytical attitudes of the students. In 2D-Organization project, the analysis pointed out that in the dispersion of the colour decisions had a decrease in the intuitive attitudes– preferences (r*f*= 0.107) and symbolic (r*f*= 0.047) – of the students. However, there seemed to be an increase in systematic (r*f*= 0.345) and thematic (r*f*= 0.297) approaches. Also, formal attitudes of the students' were the highest frequency than any other projects (r*f*= 0.202). Students have learned the basics and objective approaches of colour theory and colour harmony, and the basic elements and the principles of visual organization. The students' colour decisions have the common distribution and progressive development to the analytical attitudes.

## 3. DISCUSSIONS and CONCLUSIONS

During the progression of colour education, the tendency towards referring subjective and intuitive attitudes had a decrease and an increase was observed towards knowledge-based and analytical attitudes in colour decisions. This dual process framework in decision theory is explained by two systems, which are heuristic (intuitive) system processing, and analytic system processing in decision making[5]. Thus, the intuitive attitudes of the basic design students were the result of the heuristic system processing, and knowledge-based approaches were the outcome of the analytic system processing.

Considering the discussed progressing of decision-making, Parsons states that development of aesthetic experience in human nature is divided as heuristic and analytic, as well. Researches analyzing the development of aesthetic experience come to the conclusion that this development constitutes of four stages; a. Preferences and symbolic meanings, b. Formal aesthetics: questions of balance, harmony, contrast, etc., c. Thematic and expressive qualities of an object, and d. Aesthetic qualities of an object itself[6]. Consequently, this development showed a similarity with development in aesthetic experience in human nature and that of in the progression of the basic design students' colour decisions towards their three two-dimensional projects in basic design education.

With the analysis, it has been concluded that, there has *been* a progression and cultivation in the attitudes of the basic design students' colour decisions in basic design education. At this stage, the initial interest for research findings should be most easily developed by not only increasing the total population of the empirical study but also analyzing the cultivation processes of the second, third and the last year students' intuitive and analytical attitudes in colour decisions of design education. The research should be expanded with the other design disciplines and universities as well. The relationship between the progression of the students' colour decisions and their successes on the projects should also be investigated for the further studies.

## REFERENCES


1. R. Ünver, "Colour Education in Architecture," in Proceedings of the 9th Congress of the International Colour Association (Rochester, New York, 2002), pp. 1000-1003.
2. W. Light, "Uncoloured Colour: The subjective Syndrome and the Objective Objective in Teaching Architectural Colour Design," in Proceedings of AIC Symposium (Winterthur Polytechnic, Switzerland, 1988) pp. 24.1-24.6.
3. N. Kural, "Temel Tasarımda Bir Program, in Temel Tasarım/ Temel Eğitim, N. Teymur and T.Aytaç-Dural, eds. (Ankara: ODTÜ Mimarlık Fakültesi Yayınları, 1998).
4. ---, "An Introduction to the Objectives of the Basic Design Studio in the Department of Interior Architecture and Environmental Design," in the Basic Design Studio Group of Bilkent Interior Architecture and Environmental Design (December 6, 1999).
5. P. A. Klaczyniski, "Framing Effects on Adolescent Task Representations, Analytic and Heuristic Processing and Decision Making Implications for the Normative/Descriptive Gap," Applied Development Psychology 22, 289-309 (2001).
6. M. J. Parsons, "A Suggestion Concerning of the Development of Aesthetic in Children," Journal of Aesthetics and Art Criticism 34.3, 305-314 (1976).

# Laboratory of light and materials: Faculty of Fine Arts, University of Granada, Spain.

Authors: F. García Gil, A. García López, I. Soler Ruiz, A. Lozano Salmerón, M. Garrido Román, J. Romero Torres, M.E. Úbeda Fernández, G. Román Jiménez S. Teva Almendros, T. Vida Sánchez.
Corresponding author: F. García Gil (tfgarcia@ugr.es)

Research Group: *Constitution and interpretation of the artistic image*. HUM480
Collaborating groups: *For another public sculpture* HUM 425, *Tradition and modernity in contemporary art culture HUM* 736 and *New materials for contemporary art* HUM 611.

The Laboratory of Light and Materials was created to meet the needs that arose in the study of the language of images which revises the constituent elements of the image in contemporary art and its teaching implications. The research focuses mainly on a revision of LANGUAGES by analysing their generating elements: THE GENETIC ELEMENTS OF THE PLASTIC AND VISUAL IMAGE.

Plastic and visual language is configured as a system of systems, a complex system which includes the traditional systems of perception, colour study, etc., whilst synthesising elements of physics, psychophysics and cultural studies as one inter-related whole. The confluence of these studies comprises a useful tool in the creation of new strategies and a fresh approach to the analysis of images:

- BASIC PRINCIPLES OF THE PHYSICAL SCIENCES: perception, physiology, elemental physics, technology of materials, optics and psychology.
- PSYCHOLOGY, PSYCHO-PHYSICS, COGNITION, CULTURAL STUDIES. System of capturing and producing images of the world in all its cultural diversity and possible referents.
- The reality of the analogies and correspondences in the naturally interdependent systems of capturing and producing images is present in the SYSTEM OF SYSTEMS.

In this context, the subject of study is the Microsystem of Appearance which agglutinates and is the essence of the interaction of other systems such as colour, form and those related to the nature of matter. The study demonstrates that Light, Matter, Space and Time are "Generating Elements", and it takes into account the processes of interaction, giving equal importance to both elements and processes, in constant expansion as a defining feature of contemporary art works.

The objectives of the work and projects carried out within the framework of the Laboratory of Light and Materials develop a number of applications, uses and expressions of the five primary sensations which make up the System of Appearance: transparency, translucence, matt opacity, specular opacity and darkness. Along with their three pairs of variation types in relation to space, matter and the situation of the receptor (the geometry which is generated by all of them): permeability/opacity, absorption/luminosity, and regularity/diffusion, all are included in current and twentieth century plastic and visual work and architectonics.

Teaching related to the spatial distribution of light is based on the System of Appearance. This refers to the physical phenomena which produce specific sensations revealing both the complexity of perception and the referents in the physical world which make perception possible. It is thus concerned with the visual relations through which we get to know the world. The System of Appearance also manifests as a constitutive strategy in the creation of an artistic image. Thus the Laboratory of Light and Materials has been created as a teacher training area where art students

experiment using the results of the project for two purposes: 1) to create a typological system of strategies used by artists 2) to further research into new developments.

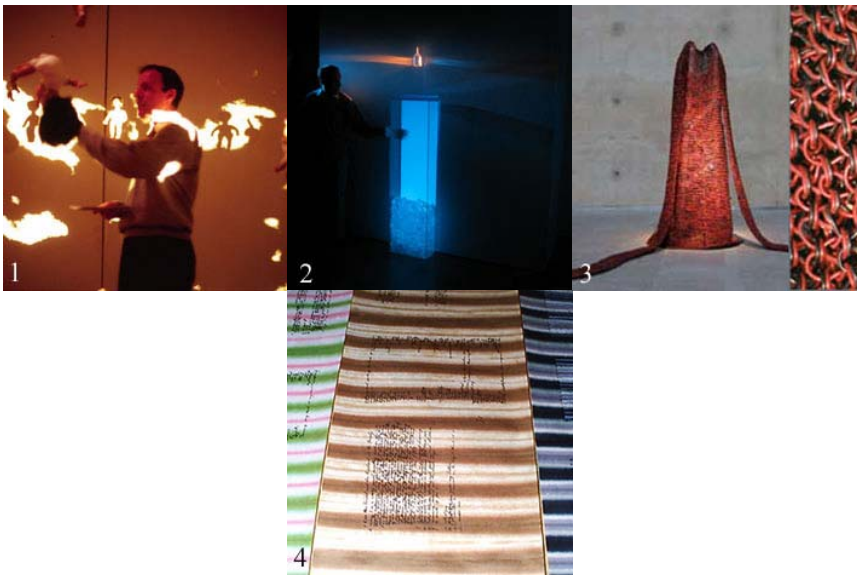
Developments in the plastic and visual arts and open systems of interpretation based on hermeneutics include:

- Construction and posterior reading of the image. Light, spatial and material referents and their inter-relations.
- Links between genetic elements and traditional constituent elements.
- Comprehension of each element activated by a synthesising inter-relation between all of them.
- Materializations and their referential images, virtual images, etc.
- Real sense and interpretation.
- Contextual sense and interpretation.
- Strategies based on alteration, transgression and shifts in new forms of language.
- Redefinition of the mute language of nature in the language of the plastic and visual language.
- Detection of new strategies to widen the developments of these languages.

Analysing and interpreting works from the angle of their physical existence has frequently been overlooked in the study of plastic languages, and really constitutes nothing more than the semantic study of the constituent physical elements, beginning with an analysis of the superior syntactic level itself of that which can be sensed and leading to an analysis on a pragmatic or morphological level. The absence of study regarding the first level or signifying substratum results in a loss of sense when analysing a work of art.

New ways of working which are emerging have led to an enrichment of the creative process bringing about an extension of languages and a call for a redefinition of the interpretive projection, the constructive projection and the pedagogical projection.

Research is related to the System of Appearance in plastic and visual works. The Laboratory of Light and Materials has run the following activities, courses, lectures and workshops:



1. Course and workshop: *Technology of illumination for Fine Art,* directed by Prof. Mauricio Rinaldi (Argentina) for the teaching staff at the University of Granada Fine Arts Faculty and for the scientific update of the research groups, March 2002.
2. Prof. Rinaldi is a visiting professor who has come to the University of Granada Fine Arts Faculty to review the illumination material necessary for research in the Laboratory. 2001-2003.
3. Course and workshop 2005 Maribel Domenech *Look at me, listen to me.*
4. Course and workshop 2004: *Reflection on and experience of space: art and philosophy,* given by the Australian artist Narelle Jubelin and Prof. Luis Sáez Rueda of the Department of Philosophy of the University of Granada.


5. Site-Specific Project 2005: *Universe extracted from a dream: Hamman. Cultural approximation and plastic recreation.* Fernanda García Gil, Gertrudis Román y Sara Teva Almendros.



6. Course and workshop 2006: *Projects and Identity: transformation and technology and conscience,* with philosopher Marcus Weiglt and plastic artist Susana Vidal.
7. *Changing your Perception* by Teresa Vida Sánchez. An installation comprising translucent colour fields set on Asbach Street in Weimar and provoking perceptual transformations in passers-by. The natural views which they had been accustomed to seeing on a daily basis were now being altered. The installation opened up new perspectives in a playful way. Weimar, Germany 2004.
8. Course and workshop 2005 Daniel Canogar *Zero Gravity.*
9. Workshop: *Image/Imaginary: interdisciplinary nature of the artistic image*, consisting of two blocks: a series of lectures given by writer and lecturer Román Gubert in March 2002; a practical workshop given by plastic artist María Zárraga, who researches into transparency and light in the digital image, 2002-2005.

BENEFITS OF THE RESEARCH:

We have experienced the synergy resulting from plastic artists, architects and professionals from other areas working together and sharing complementary and confluent knowledge bases, an approach favoured by the university, whose objective is teaching and research. The results of such interaction leading to a continuous process of interchange benefiting society at large can, in our view, be summarised in the following way:

1 Providing a contribution to the general theory of knowledge in terms of the interaction of Light and Matter, allowing us to know, and thus predict, how these elements behave when creating varied plastic spaces, scenographic, architectonic, etc.

2 Making explicit all the possible light variables and their applications, according to the specific materials which allow the illumination of plastic, architectonic, scenographic and urban spheres. By being familiar with the inter-relation of all the elements involved and by using established variables and standardised models – types of light, light sources, projectors, materials and spaces with their textures and colours – the referents of the images sought can be reassessed or created.

3 As a result, a body of systemised knowledge can be obtained which includes the latest strategies in scientific philosophy, such as chromatology, optical and psychological aspects of perception, and above all, the interaction of systems traditionally studied in isolation, in an open microsystem. The benefit of combining Art + Science + Technology enriches the languages of art, creating new iconographies, new ways of teaching and researching into art. Throughout history the latest, most up-to-date technology has always been incorporated into the imaginary of art and culture.

4 By means of the proposed experimentation, the Laboratory of Light and Materials also allows the materialisation of images that are technologically virtual in terms of their presentation and representation. It can be said that the totality of the technology potentially used in the creation of an image is contained within its materialisation and dematerialisation. The Laboratory creates a bridge between the comprehension of the work observed and other technologies related to the image.

5 The research aims to contribute to the development of new didactic material providing greater knowledge of the elements constituting art and related areas. Main beneficiaries are students and researchers in all fields of art or architecture and other research areas in the arts, sciences or technology, as well as society in general.

BIBLIOGRAPHY:


- Caivano, J.L., ***CESIA: A SYSTEM OF VISUAL SIHG COMPLEMENTARING COLOR,*** *Color Research application* 16 (4) 1991, 258-268
- Canogar, D.; García Gil, T. F.; Cano Turrión S. J.; Peña Méndez A. M.;Casado de Amezua, J.; Romero Torres, J.; Lerma Peláez, J. Garrido Román, M: ***IMPRESIONES LUMINICAS*** *(Light Impressions)*, ISBN: 84-607-0477-7. Granada 2000.
- Domenech, M.; Sawyer, M.; García Gil, T. F.; Peña Méndez M.; Úbeda Fernández, M. E. Garrido Román, M: ***TRATO DE LA LUZ CON LA MATERIA*** *(Study of Light with Matter)*. ISBN: 84-8453-079-5. Granada 2002.
- Rinaldi, M.; García Gil T. F.; Peña Méndez, M.; Rodríguez López, J. A.; Román Jiménez, G.; Úbeda Fernández M. E.; Teva Almendros, S.: ***ESCENOGRAFÍA Y ARTES PLÁSTICAS*** *(Scenography and the Plastic Arts)*. ISBN: 84-600-9896-6, Granada, 2003.
- Zárraga Llorens, M.; Gubern, R.; García Gil, T. F.; Úbeda Fernández M. E.; Teva Almendros, S.; Peña Méndez, M.; Romero Torres, J.; Román Jiménez, G.; Casado de Amezua, J.; Soler

Ruiz, M. I.; Garrido Román, M. ***IMAGEN/IMAGINARIO: INTERDISCIPLINAREIDAD DE LA IMAGEN ARTÍSTICA*** *(Image/Imaginary: interdisciplinarity of the artistic image).* ISBN 84-338-3826-1. Granada 2006.

- Sáez Rueda, L**.,** ***MOVIMIENTOS FILOSÓFICOS ACTUALES*** *(Current movements philosóphical)*. E. Trotta. Madrid 2001.
- Wittgenstein, L., ***OBSERVACIÓN COLORES*** (*Remarks on colour)*. Paidós estética. Barcelona, 1997.

Translated: Corinne Stewart

# The Psychology of light and Colour in Architectural Education

Prof Byron Mikellides,
Department of Architecture
School of the Built Environment
Oxford Brookes University
Oxford 0X3 0BP (England)
Corresponding Author: B Mikellides (bmikellides@brookes.ac.uk)

**Abstract**

The aim of this paper is to look critically at those aspects of the psychology of light and colour that designers find interesting and relevant in their education and practice of architecture from year 1 to year 5. Over the past few years we have been running a module specifically on the subject attended by architects, psychologists and artists; this paper focuses on the experience of teaching this module. This is done by providing a clear course description, rationale, indicative reading lists and the listing of the various lectures. The outline below, together with the numerous slides presented at the conference, will identify conflicting guidelines of the different approaches in relation to colour and arousal, time estimation, longitudinal colour preference studies and SAD in different climatic zones.

**Module Number and Title:**
U30042
Psychology of Light and Colour
Semester 2
**Module Leader:** Prof Byron Mikellides
**Course Description:**
This module provides an introduction to the complex psycho-physiological effects of light and colour in humans and animals. The aim is also to look critically at the extravagant claims by colour consultants in modern day environments. Seasonal Affective Disorder in the workplace environment in countries of different climatic zones will also be discussed.

---

**Relationships with other modules:** Extends ideas introduced in Module MO9906.
**Prerequisites:** Module MO9906 Architecture In Context
**Restrictions special conditions etc:**
This module is also available to students on the Diploma Course in Architecture.
**Level and Status:** Advanced single module acceptable for Architecture and Interior Architecture.

---

**Assessment:** 100% coursework
**Context:** Designed to complement modules U30006, U30024 and U30034.
**Content:** A series of lectures and seminars will discuss the biological, psycho-physiological and anthropological interpretations of the effects of colour and light.
Subjects to be discussed include:
Theories of colour vision and colour interaction; colour and personality; non-visual effects of light and colour; colour symbolism and cognition.Colour and arousal; the hue-heat hypothesis; colour and subjective time estimation. SAD (Seasonal Affective Disorder) and the influence of light on the pineal gland.

---

**Learning and Teaching Experience:** Lectures, group seminars and workshops.
**Learning Outcomes:**

**Knowledge and Understanding:**
The student will be expected to demonstrate:
- an understanding of the complex factors that influence our reactions to colour.
- a knowledge and understanding of the importance of the content and context of colour stimulation.
- an understanding of the relationship between affective and physiological responses.

**Disciplinary/Professional Skills:**
The student will be expected to demonstrate:
- an ability to carry out independent library based research.
- an ability to carry out independent observation and use a system of colour notation.
- an ability to plan and execute a piece of analytical research, and to test a hypothesis.

**Transferable skills:**
The student will have the opportunity to practise the following skills: Verbal,Written and Critical reading

---

**Indicative Reading:**

J. Davidoff, Cognition through colour, (MIT, London ,1993).
J.L.Caivano, et al, ArgenColor 2002/Actas, (Groupo Argentino del Color,Buenos Aires, 2004) pp551-559.
A. Hard, The NCS Colour Atlas (Swedish Colour Centre, 2006).
R. Küller, Non visual effects of light and colour, (SCBR,1981).
R, Küller, L. Wetterberg, "Melatonin, cortisol, EEG, ECG, and subjective comfort in healthy humans", L R. T, 25 (2), (1993)
M.Lancaster, Colourscape,(academy Editions, 1996)
M,Major,J,Speirs,A.Tischauser, Made in Light : The Art of Light and Architecture, (Birkhauser, 2005).
B, Mikellides, R,Küller, "Colour Arousal and Comfort, in Environmental Simulaton", Ed R. Marans & Stokols,Eds Plenum Publishing Corporation,New York (1993).
B. Mikellides, "Colour and Physiological Arousal", JAPRVol 7, No1(1990).
R. Osborne, Books on Colour 1500-2000, 2500 titles inEnglishandotherEuropean languages, (UniversalPublishers.comUSA, 2004).
T, Porter,B. Mikellides, Colour for Architecture, (Studio Vista, London.1976)
L. Swirnoff, Dimensional Colour (Birkhäser, Basle, 1988).
L. Swirnoff, The colour of Cities, (McGraw- Hill, 2000)

---

**Module: Psychology of Light and Colour**

1. **Module Leader:** Byron Mikellides
   **Visiting Lectures**: Roy Osborne, Peter Goodliffe, Mary Hancock, Mark Major, Peter Jones, Jane Duncan. Other visitors include: Rikard Kuller, Paul Green Armytage, Nightingale Associates

---

**2. Rationale:**

The aim of this module is to increase the knowledge and understanding of colour and light psychology research. This is a very large area of study ranging from popular myths perpetuated by 'colour consultants' and scientific research on the subject. Understanding the different psycho physiological methods by which research is being carried out is the first step of critically evaluating this work whilst at the same time looking at current artistic and architectural attempts to create special moods and emotions.

This knowledge through experience should lead to a better understanding of theories of

architecture and the related arts and human sciences and should partly meet Paragraph 2, Article 3 of the EEC Directive of 10 June 1985.

---

**3. Timetable : Module Slot: Friday, 1-4 pm in A106 Semester 2**

| | |
|---|---|
| **Week 1** | **3 February** |
| 1.00 - 3.00 pm | General introduction to Colour Psychology in Theory and Practice (workshop) - *Byron Mikellides* |
| 3.00 - 4.00pm | Discussion |
| **Week 2** | **10 February** |
| 1.00 - 3.00 pm | Colour and Symbolism- Roy Osborne |
| 3.00 - 4.00pm | General discussion – Roy Osborne and Byron Mikellides |
| **Week 3** | **17 February** |
| | Colour naming, colour connotation and denotation |
| | NCS Notation- Byron Mikellides |
| | **www.ncscolour.co.uk** |
| **Week 4** | **24 February** |
| 1.00 – 2.00 pm | Experiencing colour inside – Peter Jones |
| | http:// www.colordome.com |
| 2.00 - 3.00pm | Discussion- Choice of Projects-Byron Mikellides and Peter Jones |
| **Week 5** | **3 March** |
| 1.00 – 2.00 pm | Light in Photography- Peter Goodliffe |
| 2.00 - 3.00 pm | Discussion |
| **Week 6** | **10 March** |
| 1.00 - 2.00 pm | Source Surface Sight |
| 3.00 - 4.00 pm | Colour comparison – Roy Osborne |
| **Week 7** | **17 March** |
| 1.00 - 2.00 am | Colour in Fashion and Dress |
| 3.00 - 4.00 pm | Colour in 2D Design – Roy Osborne |
| | http:// www.colordome.com |
| **Week 8** | **24 March** |
| 1.00 - 2.00 am | SAD- Byron Mikellides |
| 2.00 - 3.00 pm | Colour and Light- Mary Hancock |
| **Week 9** | **31 March** |
| 1.00 - 4.00 | students projects presented to the class |
| **Week 10** | **7 April** |
| 1.00-2.00 | Colour in Therapeutic environments- Jane Duncan |
| 2.00- 3.00 | Mark Major and J Spears –Lighting Architects |
| **Week 11** | **25 April** |
| 1.00- 3.00 | Tutorials – Byron Mikellides |
| **Week 12** | **4 May** |
| | Submission of individual project to school Office by 3pm |

---

**4. Reading Lists**

See indicative list in the modular handbook.
Extensive reading lists will be given in each lecture and workshop.
See Roy Osbourne's 2500 list of books on colour, 1500-2000

---

**5.** (i) **1 March, Newton Lecture: Prof Richard Gregory FRS**
**Colours through a Bays Window**
(see summary of the paper at http://www.colour.org.uk)
Birley Lecture Theatre, Centenary Building, City University , Spencer St , London

**NOTE**: This is a very special annual event of the Colour Group of Great Britain. Students taking this module are welcome to attend. The lecture will be followed by "Granville tea" and then you might like to combine this occasion with going to an exhibition in London. In the Hayward Gallery for example,

there is a Light installation exhibition. Watch this space.

---

**6. Psychology of Colour and Light Project Brief**

> Assessment arrangements will be discussed in week 2. 100% Coursework in the form of a Colour Psychology Experiment or Report or Essay agreed with the Module Leader. Submission in week 12. Tuesday 4th May 2006, at the School Office by 3.00 pm for all undergraduate students. . Any Postgraduate or Diploma student who does not need a modular mark and intends to use the knowledge acquired in another term should discuss this with me in advance.

---

**Discussion:**

The main aim of this paper is to stimulate the exchange of the "latest information on the trends, colour science technology, art and design" – one of the stated objectives of AIC South Africa 2006.

By providing a detailed description of what is taught, how it is taught, the time given to the various topics and how it is examined, it will direct the discussion to specific good practices as well as failures. It will also be interesting to identify what aspects of this multidisciplinary area are covered by various countries. What aspects of colour research and practice should be taught in year 1 and what aspects in year 6?

The results of teaching this specific module will be discussed in relation to the cross-cultural study on colour research and education by Janssens and Mikellides reported in Colour-Research and Application in 1998 and in J.L. Calvano's ArgenColor 2002.

Several visual examples will be presented at the conference in the areas of psycho-physiological arousal, the hue-heat hypothesis and problems related to conflicting guidelines of using this research. There will also be an overview of designers' colour preferences over the 35 year period, 1970-2005, and the various theories to the various attempting to explain the results. Roy Osborne's 2500 books on Colour from 1500-2000 AD will be discussed in relation to students' interests doing this module. Finally there will be some feedback on students' personal projects and interests and how they perceive the benefits of studying the colour and light module.

# The preference of the male university students of Beijing in coloring of clothing and accessories

DENG Han Yu □ LI Li Ting
Textile & Fashion Design Department, Tsinghua Academy of Fine Arts
Tsinghua University, Haidian District, Beijing, 100084, CHINA
Corresponding author: Deng HanYu(deng.hanyu@gmail.com)

**Abstract:** The fads of decoration and unisex-style are sweeping on the international dressing industry with plural styles with soft color and delicate details. However, the campus in Beijing seems a bleach land of the dressing fad. Why are man students in Beijing so indifferent to the fashionable colors and fad? The author prepared a questionnaire on "the color preference on dressing of man students in Beijing's universities". In consideration of their family, living status, surrounding and Chinese culture, color education, this essay tries to analyze these students' preference on colors and dressing, and their conception on the fad of dressing.

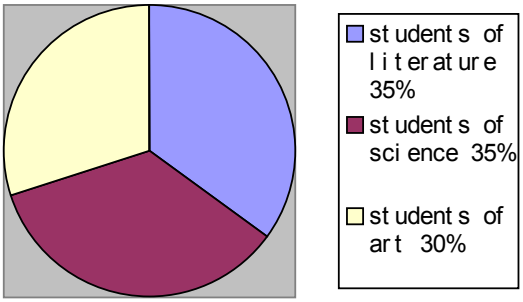
Beijing is a charming metropolis, mixing long-history cultural traditions, progressive artistic activities and multiple fads. In the period crossing Spring and Summer, the fad of men's dress is filled with a variety of colors. Soft pink is striped with grey; the keynote of black and gray is delighted among the charming colors. What's more, lots of elements doomed to women's dress, say, flouncing, embroidery of national customers and pearl-shaped pins, are incorporated in men's dress, displaying a kind of tender but unisex beautify. However, the man student's clothes look so different to the extent that youngster' clothes are simple and traditional against the fad in Beijing. In order to seek for the reasons behind such myth of difference, the author took a sampling with a questionnaire on "Youngster Students' Color Preference on Dressing in Beijing's Universities " and induced and analyzed their perception and preference on the colors of clothes. This essay is going to analysis in details about the reasons embedded on young students and other factors, psychologically and sociologically. In addition, I will present my own opinion on the relation of color perception, the presentation of dressing' color with economic development, traditional culture and color education. .

## 1. Questionnaire and the object's information.

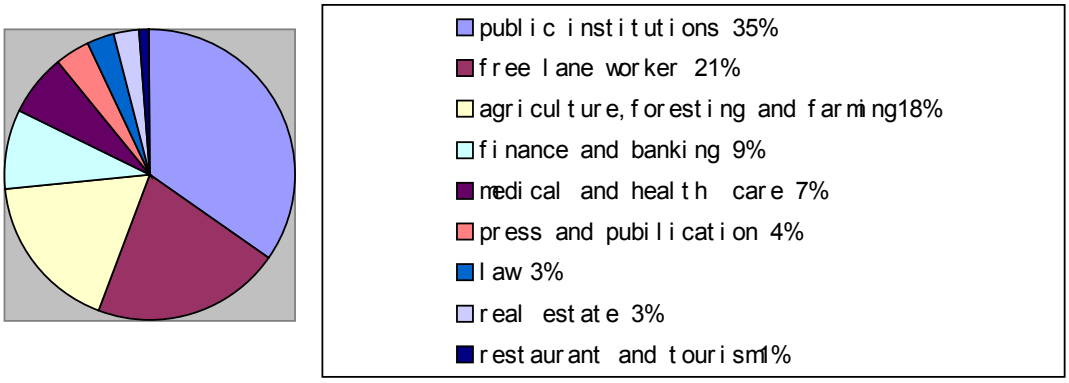
For better communication with the objects, the questionnaire is pertinent, brief and concise. Questionnaire includes the native place, specialty and parent's professions. The theme is on dressing' color, for example, the favorite color, the color of clothes frequently dressed, the favorite spring-summer dresses and autumn-winter dresses. The visual items are presented with color cards or pictures of men's dresses.

Beijing is a city with special characteristic and strong compatibility, full of colorful fashionable elements. University campus in Haidian District, located in the northwestern Beijing, appears in a different spectacle in the author's eyes from the metropolis' fad. This objects of investigation targeted on the man undergraduates and postgraduates respectively in Tsinghua University, Peking University and Ren Ming University, in a total number of 100, where there are 68 undergraduates and 32 postgraduates. By discipline, the objects are classified into literature, science and art, 35 from literature and art separately and 30 from the art (see graph 1). Since there three universities are the most famous in China and thus their students are almost the top students from various regions in China, 35 % objects are from the large cities like Beijing, Shanghai, Guangzhou, Wuhan, and Qingdao; the rest, 65%, are from mid-and small cities or countries. In this sense, their family background is greatly differentiated (see graph 2).

Graph 1 Classification of Disciplines




Graph 2 Classification of Professions of Students' Parents




**2. Data Analysis**

The investigation collects 1,400 basic data and gain over 150 comprehensive data through statistic and analysis. All these data clearly reveal the preference of interest in dressing' colors, embraced to these man students in the universities.

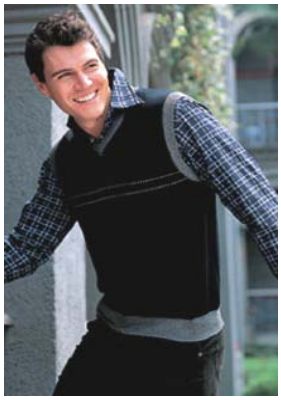
**2.1 Simple dressing**

In general, in these three universities, man students' dressing has nothing fashionable in a few percent of fashionable color and dress style. They does not rebel against the fad for demonstrate their personality. Simple dressing looks natural and practical and is very much matched with their social role. In their day-to-day clothes, most of students wear in purplish blue, white or grey, and the brightness and transparency is little low.

Table 1 man students' color preference on dressing (Unit: person)

| Disciplines / Favorite Colors | Literature | Science | Art | Total | Percentage |
|---|---|---|---|---|---|
| Purplish blue | 11 | 14 | 4 | 29 | 29□ |
| White | 12 | 6 | 8 | 26 | 26□ |
| Grey | 5 | 3 | 10 | 18 | 18□ |
| Grey green and dark green | 2 | 2 | 2 | 6 | 6□ |

In the part on the favorite spring-summer dress, the data displays that both the students of literature and science are more constant and simple than the students of art. There are 34% students like wearing shirt with sweater (graph.3), more students of literature and science that those of art; 36.7% students of art like T-shirt with leisure trousers (graph. 4). Only one student of art selects to wear professional short-sleeved sweater (graph.5); by contrast, 20% student of literature and science respectively prefer to wear. The least number of students, by 6%, like to be dressed with transparently pinky embroider knitting gown and white leisure trousers (graph 6).



Graph 3 shirt and knitting sweater

Graph 4 T-shirt and leisure trousers

Graph 5

short-sleeve sweater and leisure trousers

Graph 6

embroidered knitting gown and leisure trousers

**2.2 Preference to High Brightness and Transparency of the Colors**

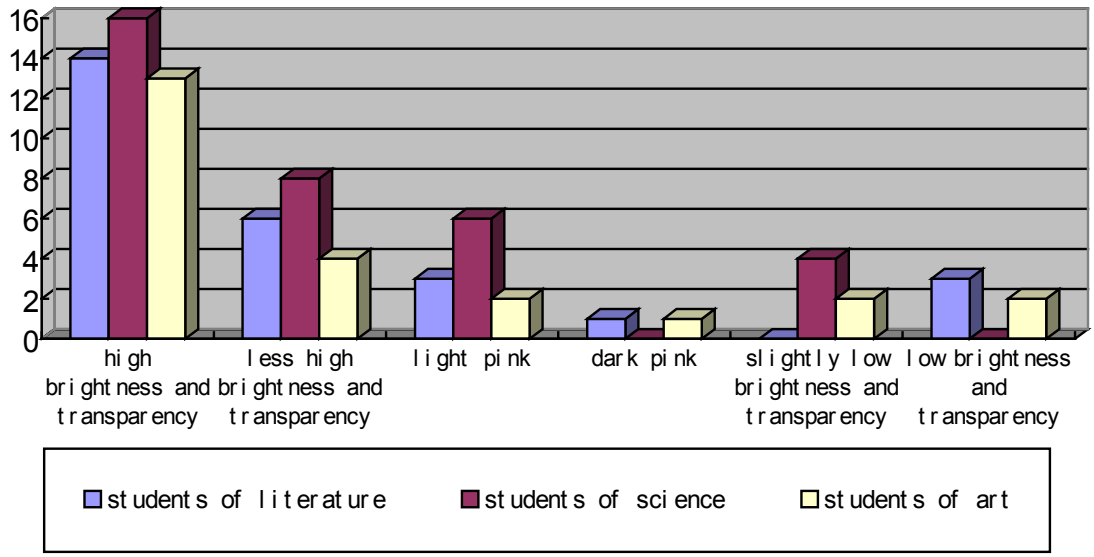
Apart from the dress, in concern with the color preference, those liking blue, say, acid blue and sky blue, are in the majority of the students under the investigation, by 31%; the second majority of students prefers to the color of green, i.e. jade green and grass green, is by 26%. Another three colors, bright red, pansy and lemon yellow, are in the favor of the students by 10%, 8% and 7% respectively. Neither golden nor silver, two fashionable colors recently, is selected by the students but 2 students of art (Table 2).

According to the items of color lump in the university students, high bright hue and high transparent color are their favor, for example, acid blue, sky blue, emerald green and bright red. The favored colors do not include pink or grey in fashion. Further, few students like black, white and grey. As the data show, the majority of 43% students prefer bright hue and color. The percentage of those like pink or grey is just 11% and 8% separately.

Table 2 Color Lump Preference of University Students

| Disciplines / Colors | Literature | Science | Art | Total | Percentage |
|---|---|---|---|---|---|
| Blue□acid blue, sky blue□ | 12 | 9 | 10 | 31 | 31□ |
| Green□emerald green, grass green□ | 10 | 11 | 5 | 26 | 26□ |
| Bright Red | 2 | 3 | 5 | 10 | 10□ |
| Pansy | 2 | 4 | 2 | 8 | 8□ |
| Lemon Yellow | 1 | 5 | 1 | 7 | 7□ |
| Silver | 0 | 0 | 1 | 1 | 1□ |
| Gold | 0 | 0 | 1 | 1 | 1□ |

Graph 7 The comparison of the brightness and transparency of color lump in favor of the man students




**2.3 In Love of Blue.**

In respect to the color of day-to-day clothes or the preference to color lump, the color of blue is the first choice of the man students. The difference lies in the distinct of hue. For example, the students like to wear in purplish blue or Russian blue, both of which are of low hue, in their daily lives. However, in the selection of color lump, most students choose acid blue in high hue and sky blue in high transparency.

**2.4. Distinctive Sex orientation Represented in Dressing**

University students seem not so interested in unisex dressing in the fad. The costumes of most man students display their sex orientation. In the questionnaire, in the time of fashionable pink man dress, 35% students conceive this color so womanly and strongly do not like such style of dress. 30% students are not interested in this color. Only 11% students select this color anddress in it.

Table 3 Man students' preference to the pinky dress

**2.5 Not much interested in color and the fad of dress.**

In the items of the interest in colors and fad, 64% of students show a usual interest to color and 78% of students hold the same attitude towards the fad. But the percentage of students of art is higher than those of literature and science in regard of the interest in color.

| Disciplines / Attitude | Literature | Science | Art | Total | Percentage |
|---|---|---|---|---|---|
| Liking and Dressing | 4 | 3 | 4 | 11 | 11□ |
| Liking but not dressed | 8 | 7 | 9 | 24 | 24□ |
| uninterested | 7 | 12 | 11 | 30 | 30% |
| Not liking | 16 | 13 | 6 | 35 | 35% |

**3. Analysis on the Result of the Investigation**

**3.1 The Influence of Gender Culture**

Generally, costume is inscribed to gender. In various ways distinguishing woman-like and manly-like styles, costume is the most direct and effective one. Biological basis decides male and female, and the man-like and woman-like personalities are culturally formed. In term of cultural attribution, the male promote their male characteristics through costume and presents their manly power. It is a common social phenomenon. As shown in the result of the investigation, the dresses of man students in Beijing are commonly neat and decent as acceptable as social morale. The majority of students does not care of fad or sedulously dress up in their day-to-day lives. Such conception results from the social and cultural attribution of man. It has been believed that the male shall be strong and firm, erudite and versatile. Therefore, the male is usually connected with some "serious" events, e.g. politics, business and war. Even in the contemporary society with plural cultures, the mainstream concept of man lies in that man should behold manly personality and man shall struggle for their career achievement. In this sense, man students don't take time and efforts on the care and pursuit of the fads. As they conceive, the most significance for a man is academic study and personal career and thus the look is nothing important. The investigation results demonstrate this conception. The interest of 74% man students in fads is not much interest to the extent that they are reluctant to spend time in noticing the fashionable colors. Subsequently, a large number of students have their dressing comfortable and convenient, adapted to their identity and traditional aesthetic taste, rather than to cater to the fad. Alternatively, the simple and practical dressing symbolizes a nature of Chinese students in their lives, essentially different from the elements of simplicity in the fad.

**3.2 The Influence of Traditional Chinese Culture and Collective Value**

In the rapid economic growth, various cultures pop up in China. The emerge of consuming culture produces charming men for common people and subsequently brings on man dress with

unisex gender on streets of metropolis and the media. On the contrast, the university students keep sharp gender differentiation: 65% of students are reluctant to pinky clothes appearing unisex gender. The most of questioned students belong to the groups greatly affected by traditional Chinese culture and collective value. In traditional culture, a means is given to identify organizational gender. It is believed that a strong link is remained between woman and beautiful appearance yet. The man-like personality is defined apart from anything related to woman, including the pursuit to the fad and personal dressing or makeup. Though the concept of gender may change in the development of a society, the power of traditional collective value still reinforces such a recognition that the man's dress must enhance to be more manly. In regard of the costume, the traditional culture and value demand man's dress to be austerity, avoiding any sense of decoration; by contrast, lady's dresses are opt to be romantic and diversified with decorations. In term of color, men like their clothes in black, grey, blue and other color signifying calming; ladies are fond of pinky-based colors on their dresses. A good example proves the importance of blue in the recognition of color in traditional Chinese culture. Blue is the favorite color of Chinese man because it is identified with the core of Confucian culture: the reserved and mean. This color is so formal that "55.9% men are usually dressed in purplish blue and black in the formal occasion, as purplish blue is an oriental style and, by comparison with the skin of Chinese people, it appears solemn and reflects the color of skin". Li Ting LI, "Rank of Dressing Colour," Art & Design-4 1995 Growing up in of such culture, Chinese men do not have their emotion exposed on their appearance. Also, they are usually conformed to the public. Even though the unisex color appears on the men's dress in the trend of fad, most of students instinctively treat such trend with traditional value and then keep themselves along with the ideology of the mainstream – their preference is still to the dresses signifying the gender of man.

### 3.3 Influence of Environment

#### 3.3.1 Influence of Region and Family

The objects of the investigation come from various places: 35% of them from large cities like Beijing, Shanghai and Guangzhou; 65% from mid-or small-sized cities or countries. The economically developed area enriches people's recreation with a variety of entertainments and significant sources for popular culture. However, in the area with less economic development, people are reserved in thought and concept. They are not eligible to accept any new issues against tradition. The difference between the families in urban city and village tailors the diversity of aesthetics and penchant to the university students. The students from urban family own an open mind to dressing and more easily accept diversified value. By comparison, those from village are conservative. According to the questionnaire, 9% of students from village by no means accept pinky dress, though 50% of students from urban family can accept it. Upon the interest in color, the percentage of students from urban family is higher than those from village. If university students are asked to select the type of spring-summer clothes, 86% of them like free style and sport costumes. Only students living in the big cities choose gold and silver popular in the fad. As a result, the fad can be understood a special system with economic restriction and regional character in aspects of production and organization.

Family is other kind of influence on the student's dressing. The living experience, working conventions and values embedded in the parents are imposed to the establishment of the cultural pattern for this unit. All of them are inherited to their children. Initially from simulating the speeches, behaviors and social skills of their parents, children are saturated in the ethics of family. The cultural pattern extends itself to the dressing. Children learn how to tie the button, recognize the colors, the quality of clothes at their childhood and then consciously combine all the knowledge learned together. The recognition of colors on the dress is deeply shaped in the family.

The cultures of family rise from the different classes. In term of dressing, the preference displays variously among the students from the families in background of public institutes, of self-employment and of finance. For example, 32.2 % of boys choose to wear blue stripe shirt and large knitting sweater, a formal style deeply affected by their parent working in public institutes, because this dressing is much matched to the serious atmosphere in the surrounding of office.

44% of the students growing up in the family of finance choose outer garment and trousers for their winter clothes, which, apparently, is the dressing convention of banking and financial sectors. To the students from the family where the parents are free-laners, colorful and bright leisure clothes and jean are chosen by 33.3% of them, exposing the free-mind and comfortable style.

### 3.3.2 The Influence of University

Tsinghua University, Peking University and Ren Ming University are located in Haidian District where dozens of universities are congregated here and there. Even Tsinghua and Ren Min are both in the hi-tech development zone—Zhong Guan Cun. The wall of the campus turns to be a screen departing the novice lives in the metropolis. Profound atmosphere of academy on the campus encounter the exuberant temporal lives outside the wall. The flourishing fad runs through the quick pace of live, dressing diversified and constantly changed; the students are congested in their studies, living regular and peaceful.

Environment may bring about the statue of living. Academic research and technological development demand ration, logic and prudence. In a consequence, the students on the campus are much affected in their dressing habits, standards on events and attitudes towards lives. While boy students pay attention to their study and care of the research of science, they, naturally, know little about the fad. Simple and appropriate dresses are in favor of these students and blue, purplish blue and blue grey are the mostly chosen colors. The color of blue represented with the reserved and rational is completely saturated with the students' tastes and academic atmosphere on the campus. In this sense, the colors of gold and silver seem so much improper against the campus. Therefore, the fashionable dressing and colors on the street of Beijing are afar and vague to the students on the campus. Provided that they may love to see the nice dress, the relatively isolated situation hinders the popular culture prevailing quickly throughout on the body's conception of dressing. At least, the proceeding of the popular elements in the fad is much tardier on the campus that that outside.

In the investigation, a particular issue shall be taken into consideration. All man students love blue so much that it on the top of the favorite color and of the color for their clothes. The case is that the dresses are in purplish blue and blue grey in daily life though the acid blue with high brightness and sky blue with high transparency are the best for the students. In addition, emerald green, bright red and ultramarine are also on the first options in the favorite of color. However, these colors are scarce in day-to-day dressing. It is believed that the contrast between the conception of color and the daily dressing is due to the heavy pressure of study as well as the job prospected. As it is mentioned that the students in the universities in Beijing are top students in their local high school, they have to carry on the pressure from the taxing study in the universities, the sincere expectation of family and the fierce social competitions. Physically and mentally, they feel so tired. The colors with high transparence and brightness will be in priority once they meet with, and the color of grey will have them much more depressed. In everyday lives, the color of gray commonly dressed is mostly imposed by traditional culture, values, family environment and dressing conception. In this sense, they are usually dressed in casual way for simplicity and comfort rather than explicit color overlapping.

## 3.4 Problems of Color Education in China

Johannes Itten, a painter, once contended that the original essence of colors is constantly changed and intangible. ( Johannes Itten, The Art of Color, Trans Du Ding Yu, ,Shanghai People's Art Press, 1985: Shanghai )The significance of colors demands deep conception and experience. To grasp the myth of colors and the pleasure on colors, it is necessary to learn the basic theory of color and understand the basic attribution and the visual, sentimental and symbolic meanings of colors, in addition to the gift on the colors. In this sense, the investigation reflects that university man students know little about the knowledge of colors and even are not much interested in color. Only 32% of the students are interested in color, but 21 students are majored in art and have received academic training in colors. 64% and 4% of the students are interested in

color in common sense and not interested in color at all. As a result, the choice of color in favor is completely different from those fashionable. It is understandable that the students turn their back to the pinky and gray which are so popular in the fad. As far as I'm concerned, besides the psychological cause, the real reason falls on the lack of qualified color education in the childhood. The limited population and the qualification requiring improvement of color education lead to the defective aesthetics and weak consciousness of the colors in the surrounding. All of these result in the mess of dressing in the daily life.

**4. Conclusion**

Man students in the universities in Beijing love to wear simple and comfortable clothe in purplish blue, white, grey and gray blue in order. Their favorite colors are acid blue, sky blue, emerald blue and bright red in sequence. In these two perspectives, apart from the common color of blue, there is a great difference against each other in other colors in terms of hue, brightness and transparency. In their dressing are usually low transparent but they prefer to the colors with high hue and transparency. A major number of the students are not interested in pinky unisex clothes, and few students like fashionable issues or popular colors. As well, a few students are interested in colors.

General speaking, the man students in the famous universities are much far away from the fad in dressing. Specifically, the difference of favor of dressing colors is not much between the students of science, literature and of art; the students of art may choose popular color, gold and silver. In dressing spring-summer clothes, many students of art like to wear free-style clothes but the students of science and literature may wear knitting sweater and shirt. Out of these distinctions between the students from different disciplines, the students of art are dressed more casual and closer to the fashion that those of literature and science. The favor of color is not distinguished among the students with different academic degree, say, the undergraduate student and the master candidates.

According to the data out of the investigation, here are the major reasons for the favor of dressing color. At first, it is because of the gender of man inherited in traditional Chinese culture. Men are required to maintain their manly personality and thus they are kept away from the contact with the fad. Secondly, the students are affected by the different backgrounds in concern of local culture, grow-up experience and family. As well, they all grow up in Confucian culture: they are educated to be qualified with mean. They are apparently reserved and opt to be introversive and modesty. Such personality does not allow them to be attracted by unisex man dresses. Thirdly, the enclosed campus and imposing force of academic surrounding retards the sensitivity of these students away from the fad. The progress of the fad on the campus is much slow than it in the other field of metropolis. The pressure of study and society presses these students to survive in their heavy study. Conversely, the physical and mental force against the day-to-day color leads to their choice of bright colors. At last, the research on the indifference of these students from the color in the fad shall not ignore the weak education on colors.

Out of this research, the wall standing between the tower of ivory and the noisy community forms two completely two worlds. On the campus, the preference to dresses does not keep pace of the changes in the society. In a distance from the fad in the society, this community of universities formulates its own dressing style in fact. Probably, it is the wall of campus that produces a classic dressing style: simple but rustic, an alternative of the constantly changed fad. In the stage where the different dressing conception on the students against that of the fad, they conform themselves to their own dressing concept ascribed to traditional Chinese culture and value. They does not run after the fashionable dress but prefer to wear simple, casual one according to their own identity. However, it is believed that the wide spread of color knowledge in the academic education will change the preference of dressing color to a certain extent that they will bring the popular colors in their aesthetics. Probably, there will appear surprising dressing and details in their clothes. What's more, it is imagined that some inspiration for the coming fad can be popped up from the students' dresses.

The research on the dressing color is limited in the relatively small scope of famous universities in Haidian District, Beijing. Such limit may cause the incomprehensive analysis out of the collected data. It is hoped that a further research can be conducted in a more scope.

# Cultural preferences for hair colour

***Y. Kato, T.L.V. Cheung*, S. Kitaguchi**, S. Westland*, H. Yasunaga***, and T. Sato***
*Division of Design Engineering and Management, Kyoto Institute of Technology*
*Goshokaido-cho, Matsugasaki, Sakyo-ku, Kyoto 606-8585 (Japan)*
**Centre for Colour Design Technology, University of Leeds (UK)*
***Colour Imaging Group, University of Leeds (UK)*
****Division of Chemistry and Materials Technology, Kyoto Institute of Technology*
Corresponding author: T. Sato (tsato@kit.ac.jp)

**Abstract**

In order to compare colour preference between Japanese and British people who have a different culture, we examined hair colour preference by questionnaire[1-4], visual assessment[5,6] and SD method[7]. We found several key differences between two countries. They were 'beauty' and 'fashion'. British students want hair colour beautiful, in contrast Japanese students want hair colour fashionable. From the factor analysis, we found that 'fashion' a Japanese student thinks about was affected by the first factor and the second factor. We named the first factor 'refinement' and the second one 'velvet'. In addition, we found that the first and second factors were mainly described by chroma and by lightness respectively.

## 1. Introduction

Previous studies[1,2] of colour preference showed which colours were generally preferred or not preferred. Also influences of cultural backgrounds for the colour preference have been studied[1,2]. However, it assumes that the colour preference and the cultural influences for it are depending on a target such as hair, eye and skin colour. Therefore, in this study, we focused on hair colour. Recently, it becomes very common to dye our hair for the fashion, especially for young people. It is because that we can be easily dyed our hair not only by a hairdresser but also by ourselves at home, since the improvement of the hair dye and the dyeing technologies. In this study, we carried out the comparison and the verification of hair colour preference between British who have various original hair colours and Japanese people who have black hair. In addition, we investigated the relationship between the hair colour preference and gender or the original hair colour.

## 2. Method

At the first, we investigated the preference of hair colour by questionnaires to 50 Japanese students (25 males and 25 females) and 30 British students (7 males and 23 females). The names of favourite hair colours were asked to them as well as their original hair colour and the experience of dyeing hair. Secondly, visual assessment was carried out to scale the preference of the hair colour using artificial hair samples by asking the question that was "If you dyed your hair like the sample, how much do you like that hair colour?". Twenty-four Japanese students (12 males and 12 females) and twenty-six British students (12 males and 14 females) with the normal colour vision; their colour vision were tested using Ishihara colour-blindness test, participated in the experiment. A set of 132 hair samples with a variety of colours were collected from a Japanese hair-colorant company (Figure 1). Each sample was mounted onto a 3cm × 5cm grey card (with CIELAB $L^*$ value of 58.63). The spectral reflectance factors were measured for each of the hair samples at 10nm intervals in the 400nm to 700nm range of the visible spectrum to allow the calculation of CIE tristimulus values. The samples were viewed by observers in a viewing cabinet illuminated by a light source approximating the $D_{65}$ illuminant (Figure 2). The experiment was based upon the Magnitude Estimation method; observers were asked to assign a number to each of the hair samples according to their preference for the sample colour. The preference scores were in an open-ended scale from positive numbers (preferable colours)

to negative numbers (unfavourable colours) whereby zero refers to as neutral. Arithmetic mean of each observer's score was used as a measure of the preference for each sample. Then, the correlations between the preference and the factors such as nationality, gender and original hair colour were examined. Finally, we asked thirty Japanese students (15 males and 15 females) to evaluate each sample by the Semantic Differential method that used both following 12 word pairs and 20 samples (Best 10 + Worst 10) by questionnaire and visual assessment. We presented the samples at random in the viewing cabinet under the $D_{65}$ light source and observers evaluated each sample.

**Table 1**: Word pairs used for visual assessments carried out in this study

| Symbol | Word pairs used in Japan | English translation |
|---|---|---|
| **HS** | Katai – Yawarakai | Hard – Smooth |
| **NU** | Shizenna – Fushizenna | Natural – Unnatural |
| **MG** | Kitanai – Kireina | Matt – Glossy |
| **FU** | Kakkoii - Dasai | Fashionable - Unfashionable |
| **SR** | Tuyayaka – Tuyayakadenai | Shiny – Rough |
| **HL** | Omoi – Karui | Heavy – Light |
| **CU** | Ochitukanai – Ochituita | Comfortable - Uncomfortable |
| **WM** | Joseitekina – Danseitekina | Womanly – Manly |
| **LD** | Suki – Kirai | Like – Dislike |
| **BD** | Akarui – Kurai | Bright – Dull |
| **BS** | JImina – Hadena | Boring – Showy |
| **CA** | Kodomoppoi – Otonappoi | Childish – Adult |

**Figure 1**: Hair Samples (artificial)

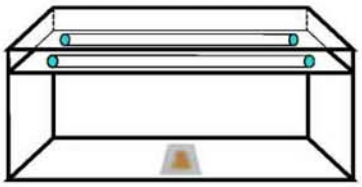


**Figure 2**: Illustration of samples prepared for the visual experiment

## 3. Result

From the result of the questionnaire, it was found that Japanese students liked dark hair colours (dark brown and black), while British students liked bright one (light brown and blonde). In addition, British student's favourite hair colours were only four samples. Moreover, the British students tended to like blonde that Japanese students gave as an unfavourable colour. British student tended to dislike warm-colour (red brown, pink, and red). Figure 3 shows the colour distribution of the hair samples in CIELAB space together with the preference of Japanese and British students obtained from the visual assessment. There were 4 samples that both of Japanese and British students selected as their top 10 favourite colours out of 132 hair samples. And 5 samples were selected by both students as their worst 10 colours. This indicates that the hair colour preference of Japanese students is similar to that of British students when both observers saw the actual hair sample.

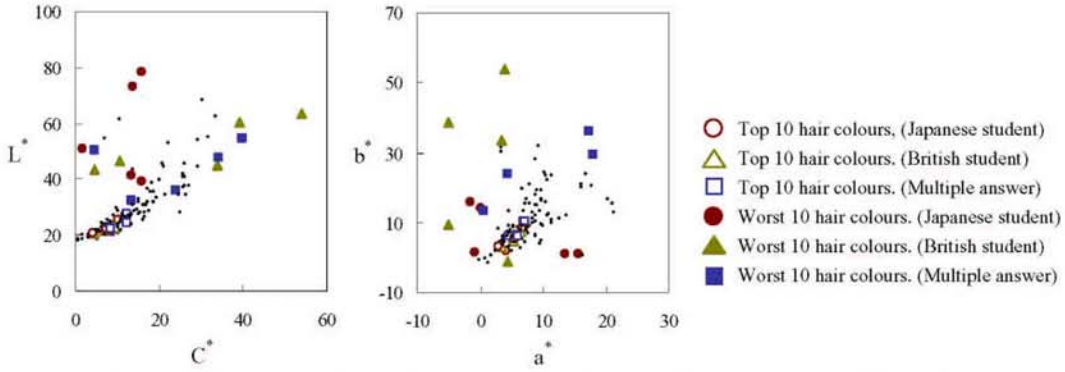



**Figure 3**: CIELAB co-ordinates of 132 hair samples plotted on $L^*$ vs $C^*$ (left), $a^*$ vs $b^*$ (right) diagrams and hair colour ranking (Japanese student and British student

Figure 4 shows the relationship between lightness values of the hair samples and the results of the visual assessment obtained from the British and Japanese students. The visual results were classified into 3 types according to the observers' original hair colours (blonde, brown and black hair). Comparison of 3 types shows that observers who have brown or black hair preferred the low lightness value's hair samples (dark brown and black) rather than the high-lightness value's one. Furthermore, it was a black sample that the observers who have black hair marked an extremely high value. On the other hand, the observers who have blonde hair preferred the high-lightness value's hair samples (blonde) rather than the low-lightness value's one. British students preferred the colours close to their original hair colours rather than other colours.

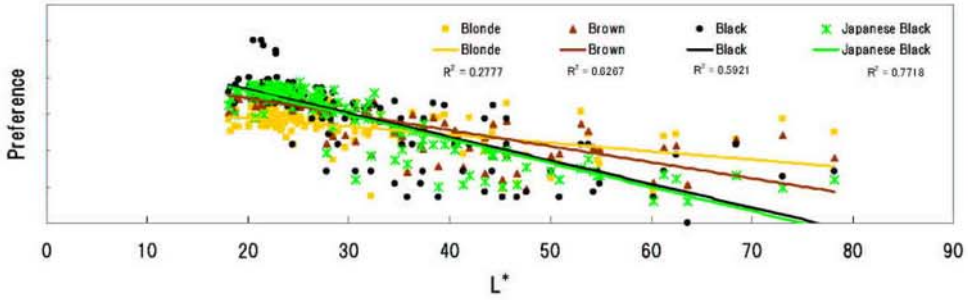



**Figure 4**: The score of preference according to original hair colour are plotted against lightness

From the results of the Japanese students, we found that Japanese students want to change own hair colour a little for fashion, because of they like fancy hair colour, although they preferred black hair as an Asian symbol. Figure 5 shows the top and worst 10 hair colour samples. Finally, we tried the factor analysis based on the evaluation data by the Semantic Differential method. Factor analysis of the colour emotion word pair data was also carried out in order to categorise the word pairs. The results of factor analysis are shown in Table 2 and three factors were obtained for the visual assessment data. The three factors obtained accounted for 89.32% of the total variance in the data set. The factor loadings were obtained by varimax rotation and are summarised in Table 2.

**Table 2**: Eigenvalues and percents of variance explained after varimax rotation

| | Eigenvalue | % of variance explained | Cumulative % of variance explained |
|---|---|---|---|
| First factor | 5.908 | 49.231 | 49.231 |
| Second factor | 3.726 | 31.046 | 80.277 |
| Third factor | 1.085 | 9.039 | 89.317 |

**Table 3**: Factor loadings after varimax rotation

| Symbol | factor 1 | factor 2 | factor 3 |
|---|---|---|---|
| **MG** | 0.959 | -0.056 | -0.106 |
| **CA** | 0.826 | -0.401 | 0.048 |
| **CU** | 0.820 | -0.564 | -0.090 |
| **SR** | -0.695 | 0.268 | 0.424 |
| **NU** | -0.791 | 0.565 | 0.145 |
| **LD** | -0.878 | 0.413 | 0.229 |
| **FU** | -0.928 | 0.293 | 0.199 |
| **HL** | -0.418 | 0.862 | 0.117 |
| **HS** | -0.039 | 0.783 | -0.411 |
| **BS** | -0.685 | 0.706 | -0.044 |
| **BD** | 0.473 | -0.852 | 0.032 |
| **WM** | -0.151 | -0.124 | 0.765 |


**Figure 5**: Samples colour (Top 10 + Worst 10)

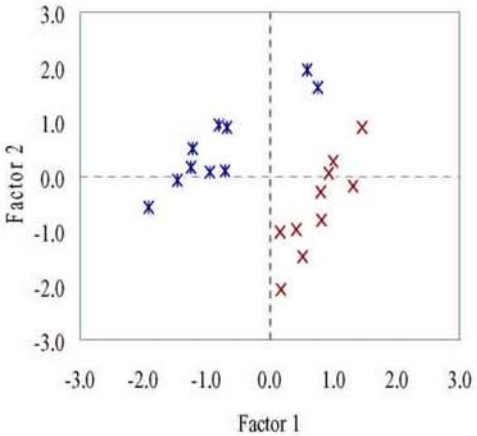



**Figure 6**: Relationships between the 20 hair samples used in this study (× is top 10 hair colours and ✻ is the worst 10 hair colours )

Factor analysis provided evidence that for the majority of visual assessments using 12 word pairs, only 2 factors were needed. We named the first factor 'refinement' while named the second 'velvet'. We found that 'Matt - Glossy', 'Childish - Adult', 'Comfortable - Uncomfortable', 'Shiny - Rough', 'Natural - Unnatural', 'Like - Dislike' and 'Fashionable - Unfashionable' belonged to the first 'refinement' group. 'Heavy - Light', 'Hard - Smooth', 'Boring - Showy' and 'Bright - Dull' were determined to belong to the second 'velvety' group. The word pair for 'Womanly - Manly' did not belong to either of the 2 factor groups and this suggests that WM has some different characteristics from the other 11 colour emotions used in this study. This may be due to the fact that WM is strongly influenced by hue while all the other word pairs are more influenced by chroma and lightness.
Figure 6 shows relationships between the 20 hair samples used in this study. All samples of the preference hair colour top 10 were included in plus side of the factor 1. 8 hair samples out of worst 10 hair samples was included in minus side of the factor 1. Moreover, 7 out of 9 hair samples were included in minus side of the factor 2. The similarities and differences between the 12 colour emotion word pairs were determined using colour emotion formulae[7], correlation coefficients and factor analysis. Results from each of these 3 analysis methods are found to be consistent. These results indicate that the 12 word pairs are classified into 3 categories. The first category is an 'refinement' group which contains the word pairs having a major contribution from chroma. The second category is a 'velvety' group which contains word pairs having a major contribution from lightness. A third category consists of 'Womanly - Manly' alone which is strongly influenced by hue.

## 4. Conclusion

Summarizing the results, we found the hair colour preference of Japanese students was not so different from that of British students. However, British students think that their own original hair colour is the best, and they want hair colour beautifully, not change the colour when they dye hair. On the other hand, Japanese students tend to like not only own original hair colour but also eccentricity hair colour for fashionable. Moreover, we found that Japanese fashion for hair colour concerned correlation between 'refinement' (like a 'Childish - Adult') and 'velvet' (like a 'Hard – Smooth').

## Acknowledgement

This work was supported by the Grants-in-Aid of the Japan Society for the Promotion of Science (JSPS fund).

## References

1. Epps. H and N. Kaya, A study of color memory and preference, *Proceedings of the 10th Congress of the International Color Association*, 321-324, Granada, Spain (2005)
2. T. Hanari and S. Takahashi, Relationship between cognition/attitude on colors and color preference style, *Proceedings of the 10th Congress of the International Color Association*, 329-332, Granada, Spain (2005)
3. Holmes CB and Buchanan JA, Color preference as a function of the object described, *Bulletin of the Psychonomic Society*, **22** (5), 423-425 (1984)
4. Saito M, A comparative study of color preference in Japan, China and Indonesia, with emphasis on the preference for white, *Perceptual and Motor Skill*, **83** (1), 115-128 (1996)
5. Ou LC, Luo MR, Woodcock and Wright A, A study of colour emotion and colour preference Part 3: Colour preference modeling, *Color Research and Application*, **29** (5), 381-389 (2005)
6. Lee WY and Luo MR, A colour preference model for three-dimensional colour-form combinations, *Proceedings of the 10th Congress of the International Color Association*, 321-324, Granada, Spain (2005)
7. T.Nakamura, M.Iwase, T.Sato, M.Lis, J.Valldeperas, Season Reminded from Colour in Spain and Japan, *Proceeding of the 10th Congress of the International Color Association,* 1445-1448, Granada, Spain (2005)

# Color Cosmetic Assessment For China

Latika KHOSLA
Design Director, Freedom Tree Design
63, Silverene, Worli Sea Face, Mumbai – 400018, India
Email: latika@hathway.com

**ABSTRACT**

People have adorned themselves since the beginning of time. It may have been for protection from elements, for ritual purposes, or for the mating dance of attraction and seduction.
This presentation is our design approach and work done for a multinational cosmetic company entering China for the first time. In this world of global commerce and instant information large multinationals have to decide whether to be global or local in practices and products.

Our role was to assess their launch colors keeping in mind their brand promise in the context of the Chinese urban woman. To identify important influencers that had an effect on cosmetic color which may be climate, season, age or physiognomy.
And to translate that abstract notion of what is beautiful into colors, a subjective visual context formulated through subconscious layers of history, culture, art, media and environment, and to thus engage in a narrative storytelling of color with the current lifestyle trend of the urban Chinese woman.

We used the NCS color system to create formats to evaluate color acceptability and tolerance of the color range amongst makeup artists and other influencers and users.
Methodologies were explored, speaking with editors of various fashion magazines, make up artists and designers etc, to establish trend markers as points of reference for successive launches.

Finally after qualitative analysis of global trends in fashion and cosmetics we created a predictive trend for the China market. This was evaluated on the NCS scale to gauge acceptability amongst the women users. These were further held up to the current life attitudes prevailing to assess its relevance to the consumer.
With this construct, the final color palettes were created and detailed out for their application for eyes, lips and nails.

## 1. INTRODUCTION

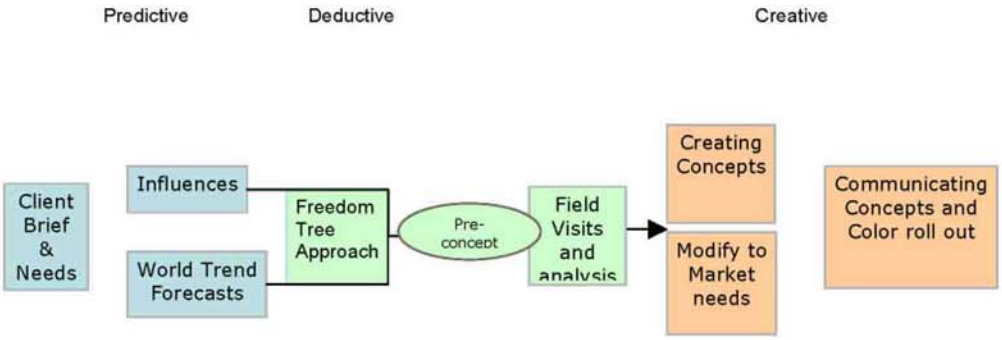
An American multinational who was present in Asia and had operations in China wanted the assistance of color designers to help them with their launch and capability building in the color cosmetics business. The company was present in home care and skin care. The business would benefit from the visibility of good colors in their cosmetics line.

The task before us as Color Designers:
1.1 Evaluation of the current color range development process for Color cosmetics in China.*
1.2 Evaluation/suggestion on color selection for spring summer 2005 and process of Color selection
1.3 Recommendation on medium/long term capability we need to build for on-going Shade forecast capability.
*Color Cosmetics, are lipsticks in, eye shadow, nail color and foundation.

The company had done months of research on various other aspects relating to the project: consumer habits, distribution chain and product production. Our role was to unravel a thread in this fabric to give us color directions in the future.

## 2. METHOD

2.1Overall approach.
Our design studio follows a basic approach to most projects. A predictive component of future trend ideas, testing the market during deductive phase with on the ground field work with pre-concepts. And finally crystallizing the creative ideas and communication.




2.2 Objects of analysis.
The product color samples for launch, lipsticks and eye shadow colors. A paper chart with color depositions showing entire range. A CD presentation of the qualitative analysis of themes relating to fashion in the season.

2.3 Other tools and touch points for analysis.
The NCS was the color system used to record product colors as well as environmental Color Recurrence.
'Color Recurrence' is a proprietary technique we use to record colors in products and environments which are adjacent and influence the category we are working on. This in simple words seeks to record the tones of the colors available in the market in industries related to a client's product. This helps us to validate existing colors. And also find the correct tone for the product. E.g. if the main color palette is warming and there is a lot of brown and orange in the market in fashion and cosmetics. Then you certainly need to plan for those colors. If on the other hand, the mood is bluish red—we need to identify the exact tone and be present in the purple or pink area. So in this case, competitor cosmetic counters in-store fashion, accessories and colors in trend products and places.
'People watching' was conducted by visiting trendy shopping and hang out areas and thru photographs and visual assessment, record the color usage.
In depth interviews with 'influencers' was the other information touch point. Beauty editors of magazines, stylists, fashion designers and fashion design students.

3 ANALYSIS
On analysis of the colors of lipsticks, it was noted that many colors were muted, that is too grayish for Chinese skin tone and acceptance.
This was also ratified by the Make-up-Artists and stylists we met.
The colors need to be lighter and cleaner. We thus feel that the cosmetic company can develop a 'tolerance model' with an area mapping, using the NCS as shown on in Table 1. The colors that lie within this can be acceptable on the skin—whether in fashion or not.
Trend colors will naturally always push at the boundaries, and will have to constantly mapped.
Lip Colors lie equally in the warm and cool red tones. They end at red with 30 percent blue-ish tone as a norm.
Eyes shadow is likely to change the most as it is more fashion driven. Eye shadow also had to be delivered in single color packing. Traditional 3 unit pack of 3 tonal harmonies was unsuitable for the

Chinese eye as there is no lid fold and only one color is necessary. Three tone packing was also considered wasteful to the consumer.
The media are in the arena of information, communication and capturing and selling an idea.
Thus a purpose of our conversations with the media, MUA and stylists was to cull from them information about today's woman they see in China, and the idea/sense of beauty they are addressing.

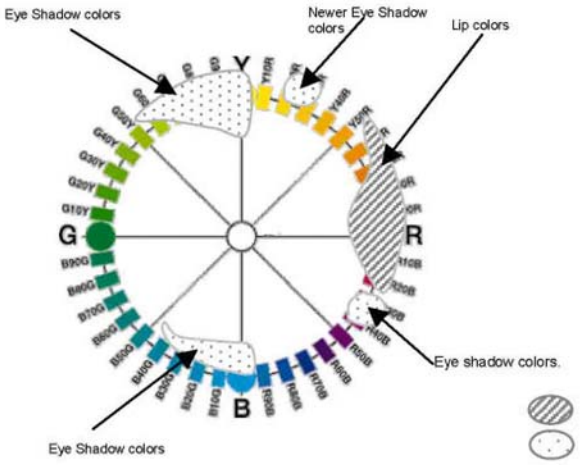



Table 1 Tolerance area for acceptable color for lip and eye color China consumers 2004.

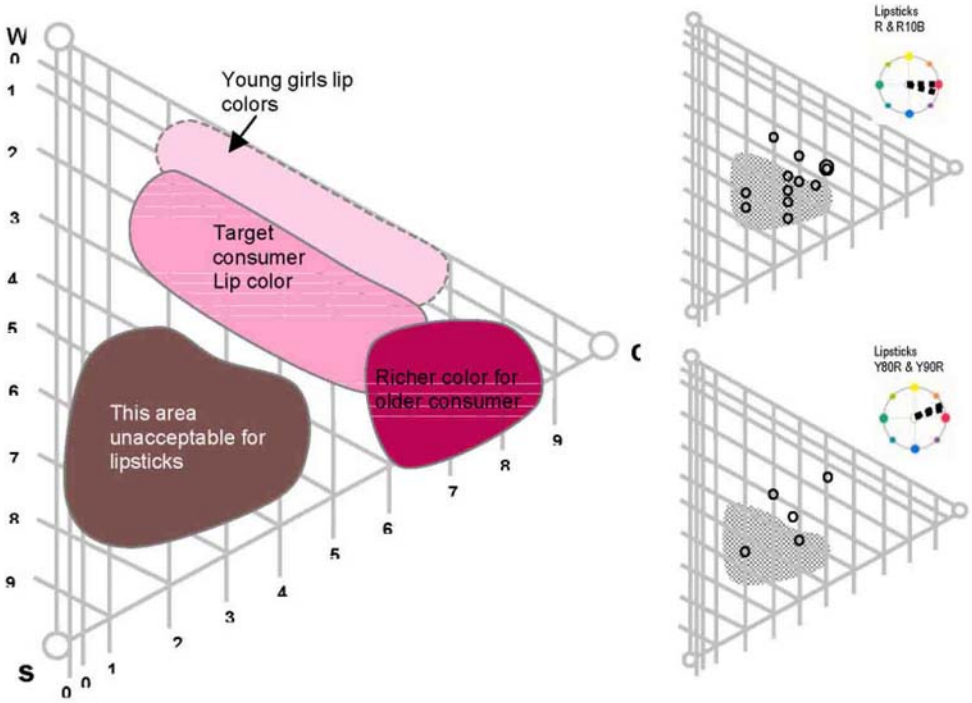



Table 2 Tolerance area for acceptable color for lip color China consumers 2004.

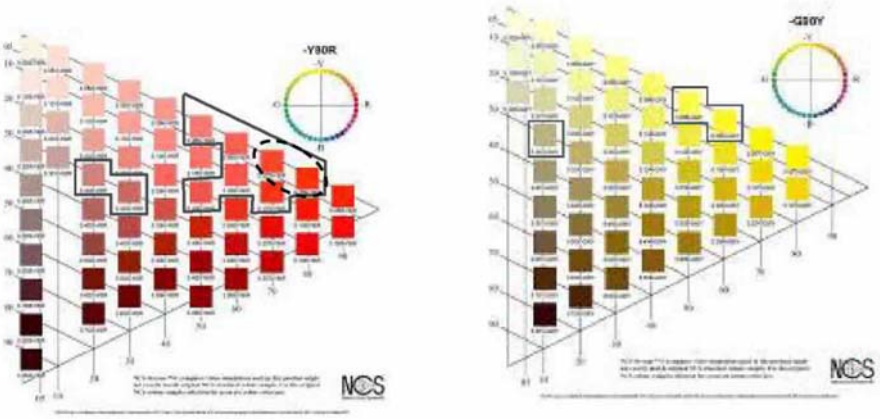



Table 3 and 4 Black outline is tolerance area for acceptable color for lip color Y80R hue and G90Y for eye shadow.. Dotted line is must have color.

## 4 PREDICTIVE CONCEPTS

After qualitative analysis of global trends in fashion and cosmetics we created 6 predictive trend concepts for the China market. Table 5 and 6

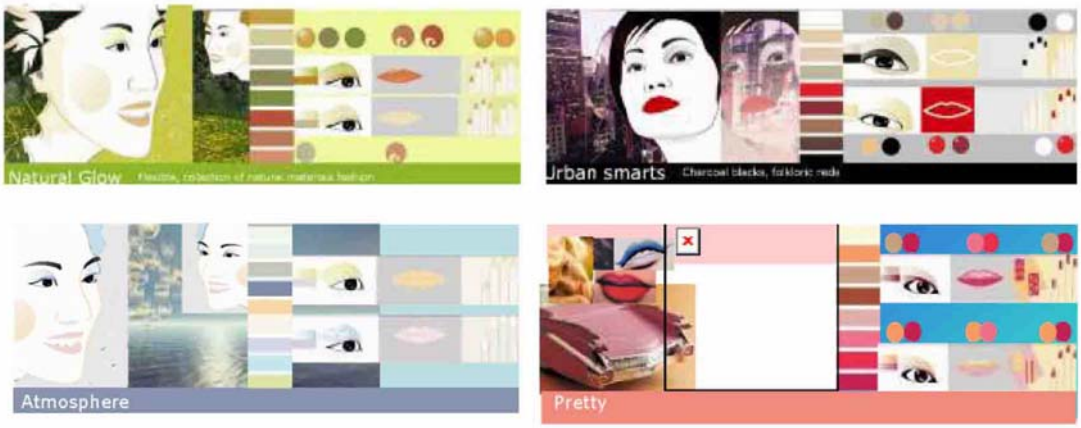



Table 5 Some creative mood boards showing predictive trend concepts.

These ideas were tested with influencers and with a visual audit of retail stores and street wear clothing.

The media are in the arena of information, communication and capturing and selling an idea. A purpose of our conversations with the media, MUA and stylists was to cull from them information about today's woman they see in China, and the idea/sense of beauty they are addressing.


Table 6 Color recurrence images and method of tabulation.

5 DIRECTION and EVOLUTION

Another factor that was important in deciding cosmetic colors, was the client input regards their brand positioning and brand personality based on their ongoing consumer and market research. These predictive trend concepts were further held up to the current life attitudes prevailing to assess its relevance to the consumer.
This enables us to see the link between and inner attitude, in the context of today's lifestyle and what is it's affect appearance. This is like a lens we look through, to trace attitudes to make –up, cosmetics. We found age to be a fairly strong dividing line for color chromaticity and depth. Occasion/leisure dressing an emerging trend.


Table 7 Link between and inner attitude, in the context of today's lifestyle and how does that reflect on appearance.

We also like to do an exercise in customer prototyping. This is a way that we segment the market. People are of a particular type we feel and more often than not make certain life choices. They also make aesthetic choices which are even more personality based. This lens lets us look at some emerging personality types.

Table 9 Some images of cosmetic users in the context of today's lifestyle their appearance.

**Bo Ho**
Enriches her life with small purchases of personal satisfaction.
**NO NO**
Simplifies her life with buying best quality as it has assurance.
**Chinese returnee**
Embraces traditional Chinese elements as believes in their value
**Independent woman**
Practical and individual dresser
**Office girl**
Coordinated with feminine details
**Mother role**
May not try new things easily and would use tried and tested makeup.

**Summary**

**Tools**
The NCS can be used as a Color Measurement and communication tool between the marketing brand decision makers and influencers. Since this is a visible color sample it is easy for non-technical people to work with.

**Trend**
Acquiring global trend information one and a half years in advance. The time lead is necessary as production has to be decided at other global centers.
This should be ratified with China acceptability and then product color choices can be made. Identifying/Modifying trend on the ground thru following lifestyle changes and creating customer prototypes.
Color recurrence can be periodically undertaken with the help of design students who have trained sensitivities in this area.

**Story telling about the product**
Converting trend info into suitable product and package.

# Digital Rejuvenation of Artwork and its Effect on Meaning

***Roy S. Berns***
*Munsell Color Science Laboratory, Chester F. Carlson Center for Imaging Science*
*Rochester Institute of Technology*
*54 Lomb Memorial Dr., Rochester, NY 14623 (USA)*
*berns@cis.rit.edu http://art-si.org/*

**ABSTRACT**

Some colorants and colored materials used by artists do not retain their appearance over time. Nonetheless, art historians and connoisseurs may interpret a work of art in its present state, downplaying or ignoring the ravages of time. This interpretation includes semantics and working methods. Digital rejuvenation is a physics-based method of turning back the clock, creating digital images that simulate the appearance of a work of art before undesirable color and appearance changes. This paper explores digital rejuvenation to study the effects of aged picture varnishes, fading and aging of paper, and fading of lake pigments. As a result, the meaning of art today is likely different than when first executed.

## 1. INTRODUCTION

Many materials used to create art have optical properties that change over time. Colorants such as dyes and pigments can fade, darken, and even change hue. Their binding media and varnish (if used) can yellow. If the refractive indices of the colorants, binding media, and varnish change, opacity and gloss can change. Many factors determine whether a specific work of art will change color and appearance over time including the specific materials and working method, temperature, humidity, light exposure, and biological effects such as mold. The current philosophy in museums, archives, and libraries is preventative conservation where storage and exhibition conditions are such that future degradation is negligible, though in the past, preventative measures affected color appearance, for example, varnishing. For art that has already degraded, restorations are minimally invasive. As a result, a work of art may appear quite different today than in the past. A related and equally important aspect is lighting, the differences in appearance caused by both the spectral power distribution and luminance. Nonetheless, art historians and connoisseurs may interpret a work of art in its present state viewed in a specific gallery, downplaying or ignoring the effects of time and lighting. Certainly meaning is affected.

Digital imaging, particularly spectral imaging, optical models of artwork, and modeling the human visual system enable the simulation of artwork accounting for both time and lighting. Color managed digital images are created to demonstrate the results of the simulation. The amount of factual information determines how speculative the simulation, though in all cases, it remains a simulation.

## 2. OVERVIEW OF DIGITAL REJUVENATION

Digital rejuvenation is a computational technique that simulates appearance changes caused by temporal changes. Details have been described elsewhere.[1,2] As a summary, knowledge of materials and their optical behavior enable the simulation of color changes such as darkening, fading, gloss, and opacity. A color-managed digital image is segregated by color and the optical behavior is reversed to simulate the art before changes occurred.

## 3. PICTURE VARNISHES, CHANGES IN SURFACE ROUGHNESS AND COLOR

Varnish can be applied for both aesthetic and protective purposes. Dealers and owners may varnish or re-varnish a painting. Preventative conservation may result in varnishing. Excessive cleaning may necessitate varnishing. Berns and de la Rie studied the effects of varnishing on color appearance.[3,4] A varnish can reduce surface roughness causing first-surface reflection to orient in the specular direction. Over time, natural varnishes yellow and darken and in some cases, reduce in transparency. This is equivalent to applying a brownish glaze over a work of art. In fact, toning a varnish is a common way to have a painting look aged. A particularly interesting example is Auguste

Renoir's *Odalisque* (French, meaning female slave or concubine in a harem). During 2005, the painting underwent conservation treatment, including re-varnishing. The painting after treatment is shown in Figure 2, left. Before and after details of her right leg are also shown. Before treatment, her leg appears two-dimensional as the subtle range of colors is obscured. After treatment, we see how form is created. The brushwork evokes his later, well-known, portrait style. Although this example was actual cleaning, similar effects could be observed using digital rejuvenation.

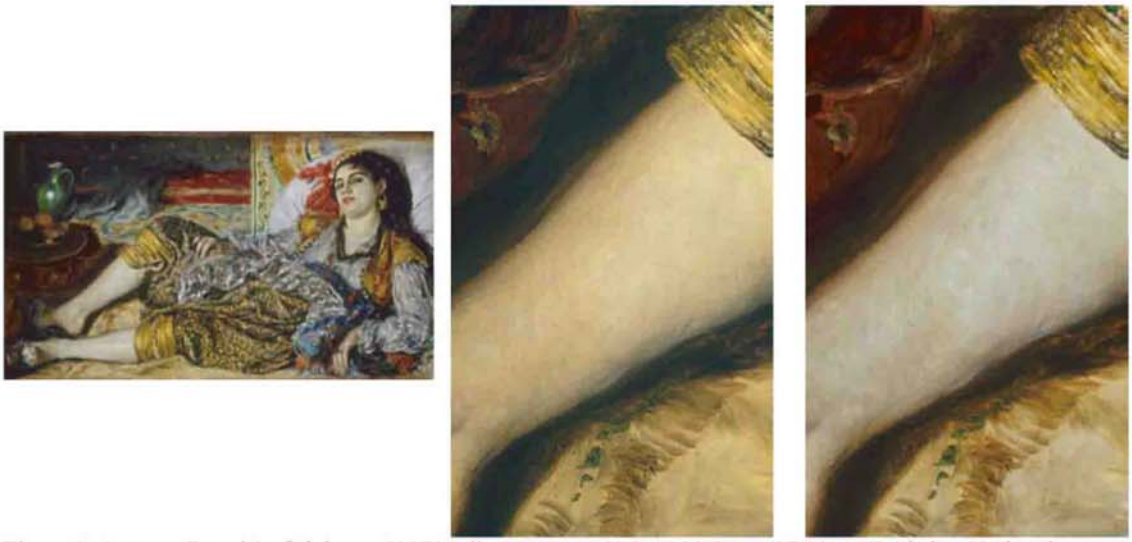


Figure 1. Auguste Renoir's *Odalisque* [1870, oil on canvas, 69.2 x 122.6 cm (27 1/4 x 48 1/4 in.) National Gallery of Art, Washington]. Left: current condition; middle: before conservation; right: current condition.

## 4. WORKS ON PAPER, CHANGES IN SUBSTRATE COLOR

Recently, there has been an interest in Vincent van Gogh's works on paper.[5,6] He used a variety of drawing materials including ink, graphite, chalk, and watercolor and a variety of papers. In early 1887 while in Paris, he executed several detailed drawings on a poor quality bluish-gray paper. These drawings were used by van Gogh to explore simultaneous contrast and assimilation (spreading) effects. Unfortunately the paper had poor lightfastness causing the blue colorant to fade. With the additional oxidation of the cellulose, the paper turned brownish (on average, $L^* = 69$, $a^* = 6$, $b^* = 24$, D65, 1931 standard observer). Fortunately, the Van Gogh Museum has several sheets of this paper with its original color that could be measured with a reflection spectrophotometer (on average, $L^* = 69$, $a^* = -4$, $b^* = 3$). Ageing affected hue and chroma, but not lightness. Using digital rejuvenation, the paper color was changed from brown to its original bluish gray, Figure 2. For this simulation, it was assumed that the drawing materials were opaque. *Window in the Bataille Restaurant* has a very different appearance with changes in the paper color. The brown paper has a chroma of $C^*_{ab} = 24.7$ whereas the bluish-gray paper has a chroma of 5.0. The brown increases chromatic contrast effects for the blue chalk. When rejuvenated to blue gray, it seems that Van Gogh was exploring assimilation effects where the two blues were combined, visually, to some extent. Conversely, the brown color obscures much of the yellow, orange, and white chalk. With the blue paper, it is clear that simultaneous contrast effects between orange and blue were explored and that the white and yellow chalk was an important component of the composition.

## 5. OIL PAINTINGS, PIGMENT FADING

Many lake pigments developed in the late 19$^{th}$ century have poor lightfastness. Geranium red lake, prepared by precipitating the dye eosine on aluminum, was used by van Gogh extensively. This pigment faded rapidly[7] and in skin tones, the color change is obvious; there is a greenish gray cast. In other mixtures, the change may go unnoticed. Van Gogh painted many self-portraits. In 1889 while in Saint-Rémy, he portrayed himself holding his palette, Figure 3. In its current condition, he is wearing a blue jacket and the background is also blue. They are distinguishable from each other because the background is predominantly cobalt blue while the jacket is predominantly ultramarine blue. It is

displayed in a gallery with incandescent lighting such that their hues are readily distinguished. However, there is very little lightness contrast between the background and his right shoulder.

Protected by the frame's rabbet is a portion of the background that has been protected from light exposure. Spectral and microscopic analyses revealed that the background also contained geranium red lake. This portion is purplish. Digital rejuvenation was used to recolor the background. Only hue and chroma were changed and lightness was left unaltered. The image has a much more characteristic appearance of a van Gogh painting where bold colors are used. The large change in hue reveals the strong chromatic contrast between the background and jacket.

Figure 2. Vincent van Gogh, *Window in the Bataille Restaurant* [1887, pen and brown (originally black) ink, blue, yellow, orange, and white chalk on laid paper, 54 x 39.8 cm (21 1/4 x 15 5/8 in.) Vincent Van Gogh Museum, Amsterdam. Left: current condition; right: after digital rejuvenation.

Figure 3. Vincent van Gogh, *Self-Portrait* [1889, oil on canvas, 57.15 x 43.82 cm (22 1/2 x 17 1/4 in.), National Gallery of Art, Washington]. Left: current condition; right: rejuvenated background.

## 6. ETHICS AND CONCLUSIONS

Digital rejuvenation is speculative. Even when real optical information is used as an aid, such as the examples above, the final result is only suggestive, not definitive. Working backwards is inherently problematic: When does one stop? The answer is not obvious when only selective areas are changed. A very successful digital rejuvenation was Georges Seurat's *La Grande Jatte*, created as one of the scientific studies for an exhibition held at the Art Institute of Chicago.[1,8] A full-size print was shown of the digital rejuvenation two rooms away. In order to compare the painting and print, one had to use short-term memory matching. Furthermore, the lighting conditions, framing, and wall colors were quite different, further complicating comparisons. In a review of the exhibition, Charles Stuckey, a current professor and former curator at the Art Institute, voiced strong opinions about isolating the reproduction.[9] "I may be altogether wrong, but under the frustrating circumstances I came to the conclusion that the deterioration of Seurat's color had not resulted in serious distortion, that the original appeared at most slightly dulled…"[9] If he had access to the digital files, as I do, I believe he would have concluded otherwise. Even so, Stuckey assumed that my rejuvenation resulted in the actual colors. He would not have considered its uncertainty, nor the difficulty in creating a color-managed print that had to be covered by a polymer layer. I think that digital rejuvenations without an understanding of their creation and limitations pose misinterpretation, likely on the same order as misinterpretation of works of art with significant changes in color and appearance. For me, it is clear that digital rejuvenation is a work in progress.

## References


1. R. S. Berns, S. Byrns, F. Casadio, I. Fiedler, C. Gallagher, F. H. Imai, A. Newman, L. A. Taplin, "Rejuvenating the color palette of George Seurat's A Sunday on La Grande Jatte – 1884: a simulation," Color, Research, and Application, 31, 278-293 (2006).
2. R. S. Berns, "Rejuvenating the appearance of cultural heritage using color and imaging science techniques," Proc. 10th Congress of the International Colour Association, Granada, 369-374 (2005).
3. R. S. Berns and R. de la Rie, "The effect of a varnish's refractive index on the appearance of oil paintings," Studies in Conservation, 48, 251-262 (2003).
4. R. S. Berns and R. de la Rie, "Exploring the optical properties of picture varnishes using imaging techniques," Studies in Conservation 48, 73-82 (2003).
5. C. Ives, S. A. Stein, S. van Heugten, M. Vellekoop, Vincent Van Gogh the Drawings, (Yale University Press, New Haven, 2005).
6. S. van Heugten, Van Gogh Draughtsman: The Masterpieces, (Van Gogh Museum, Amsterdam, 2005).
7. A. Burnstock, I. Lanfear, K. J. van den Bern, L. Carlyle, M. Clarke, E. Hendriks, J. Kirby, "Comparison of the fading and surface deterioration of red lake pigments in six paintings by Vincent van Gogh with artificially aged paint reconstructions," Proc. 14 Triennial, ICOM Committee for Conservation, James & James, London, 459-466 (2005).
8. R. L. Herbert Seurat and the Making of La Grande Jatte. (Chicago: Art Institute of Chicago; Berkeley: The University of California Press; 2004).
9. C. F. Stuckey, "True colors: Seurat and 'La Grande Jatte'," Art in America, 57-63, November 2004.

# Colour Meaning in Different Settings: Example from the fine arts and experimental colour studies

***B. Stahre and M. Billger***
*Dept. of Architecture, Chalmers University of Technology, 412 96 Gothenburg, SWEDEN*
*Corresponding author: B. Stahre (bea@chalmers.se)*

**Abstract**
How does the context affect the colour experience? Different approaches are compared in order to discuss colour meaning. An analyse is conducted of two chosen inherent colours both applied in the two paintings *The Newborn* by Georges de la Tour and *Death in the Sickroom* by Edward Munch. The experience of the colours in these different contexts is then compared to studies in colour science evaluating singular colours and colour combinations. The aim is to discuss the impact of various degree of context on the colour experience.

## 1. Introduction

The aim with this paper is to discuss how varying degrees of context affect the colour experience. Studies on colour emotions and associations using isolated colour patches often show coherent results; when strong emotions are not involved, people tend to be concordant about aspects such as warmth, activity and heaviness[1, 2, 3, 4]. However, when colours are applied in various combinations or situations, they can to a great extent show variation in meaning, *e.g.* whereas a freestanding colour is perceived as cold and dark, the same colour can depending on the figurative context be perceived differently. In this paper the impressions of two chosen inherent colours applied both in a painting by Georges de la Tour and in a painting by Edward Munch are compared and discussed. The impressions of the two corresponding colours in these paintings are then compared to the results of single colour studies and studies on colour combinations. The analysis is complemented by other studies on colour meaning and colour perception. The discussion concerns contrast effects, as well as symbolic interpretations of more general character.

The starting point for the discussion is the comparison of one orange-red and one light green inherent colour applied in the two figuratively and symbolically different paintings *The Newborn* by Georges de la Tour and *Death in the Sickroom* by Edward Munch (see Fig. 1, 2). The choice of paintings is connected to their similarities in colour scheme, though their strong visual and symbolic differences in expression. It is important to stress that this analysis is based on prints of the paintings in the books of [5, 6]. The two colours focused on are central in and important for the compositions, and furthermore correspond well between the paintings. In *Death in the Sickroom* colour nr 1 is the collected impression of three colour fields that are similar both in nuance as well as size and meaning. The experience of the two colours in both these paintings is compared to previously published single colour and colour combination studies[7, 3, 2, 8, 9]. Furthermore, unpublished Swedish data from a single colour study[1, 10], here referred to as the CE-study, will be used. In the studies of single and combined colours, observers choose the most suitable adjective in a word-pair describing the colour or colour combination. In the analysis of the colours in the two paintings, the figurative context need to be considered and other methods are called for. References to art historians are made, and by applying results from the various studies on colours a discussion can be formed.

## 2. Single Colours and Colour Combinations

In the CE-study which aimed to investigate how people from different countries associate towards colours, single colour chips were assessed with a semantic 2-point method of descriptive, none emotionally charged word-pairs[10]. In Sivik's and Taft's study on colour combinations and associated meanings[7] the focus lay on how various adjectives were associated to different colour combinations. The discussion concerned how different dimensions of meaning were associated to different qualities of singular colours and colour combinations. Few studies have been conducted in order to investigate the relation between the colour experience on a chip and in a context[3]. Sivik[11] compared colour chip ratings with colour ratings of two types of simulated building exteriors. His study showed that

descriptive word-pairs of an evaluative nature, *e.g.* beautiful-ugly, were most affected by the context while none emotionally charged word-pairs, *e.g.* strong-weak, were largely unaffected by the context. Taft aimed in one of his studies[3] to investigate the relation between semantic ratings of colour chips and the same colour applied to every day objects, using both evaluative and none-evaluative descriptive words. The study indicated that there in general is a good correspondence between the judgements of colour chips and contextualized colours. The colour theories of Johannes Itten[5] (1888-1967) included the philosophical, religious, physiological and psychological aspects of colour focusing on the subjective emotion that is associated with the objective colour, for example that blue is cold. Itten assumed that our senses only work with means of comparisons and hence colours can be intensified or weakened by means of contrast. Itten also focused on the contrasts, dividing them into seven groups, including figurative meaning. Nobbs et al has found that the emotional impact of combination seems to depend on the contrasts rather than on the individual colours[12].

**3. Chosen Paintings**

Georges de la Tour (1593-1659) often painted nocturnal compositions, focusing on carefully studied illumination effects. In *The Newborn* a young woman sits holding her newborn child in her arms while another woman sits turned towards her illuminating the child with a candle. The flame of the candle is covered by her hand and hidden from view. The scene is composed to draw the attention towards the child in the centre: how the two women are positioned and the way their eyes and body language are focused on the child. The artist's use of colour is also central to how we perceive the composition. In his works de la Tour, according to Itten, kept almost exclusively to the same colours – black, white and red – and in order to achieve the desired effects used contrasts of lustre and saturation, lightness and darkness, as well as vivid and subdued colours. [5]

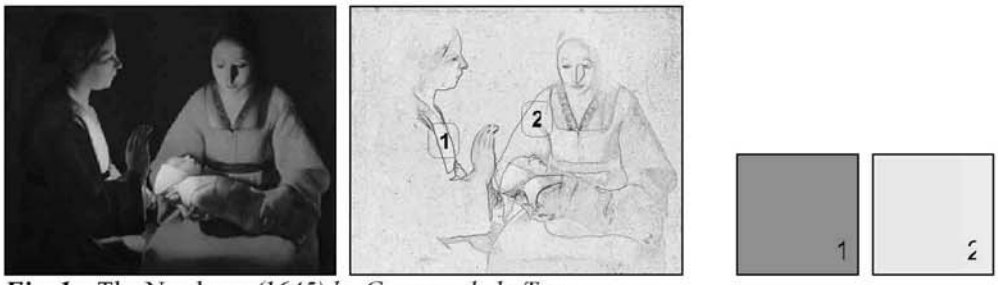



***Fig. 1a.*** The Newborn *(1645) by Georges de la Tour.*
***Fig. 1b, c****. Chosen colours appearing in both paintings: 5YR8 (ca NCS 0580-Y70R) and 5GY2 (ca NCS 0520-G60Y).*


***Fig. 2a.*** Death in the Sickroom *(1893) by Edward Munch.*
***Fig. 2b, c****. Chosen colours appearing in both paintings (see Fig. 1b).*

In *Death in the Sickroom* Edward Munch (1863-1944) depicted his own family, gathered around the death bed of his sister Sophie. The faces of the people in this composition are stiffened in masks; they are all standing rigid and immobile except for the sitting girl, who turns her hands in grief. The communication between the spectator of the painting and the actors in the composition is mediated through the woman facing us. She is our link into the scene; by passing her, the gaze wanders on to the empty bed in the centre.[6] Munch used his colours symbolically. Red was for example used to express

the passion of a woman or, as in *Death in the Sickroom,* as facial colour to illustrate a strong temperament, here depicting Munch's father and one of his sisters, who were known to be more restless and irascible than the rest of the family.[13]

**3. Analysis and Discussion**

Can a picture ever be viewed in its full context? The only thing to do when approaching a piece of art is, according to Manguel to "build a fragile reconstruction of our impressions through our own distorted knowledge and experience"[14].

The compound impression of the colours in each painting agrees well with each other. Besides the strong orange-red and the light green, both paintings contain large fields of dark colours. The lightness contrast is however strongest in *The Newborn*, were the background is mostly dark green. In *Death in the Sickroom* the dark parts are mostly blackish purple. While the significance of the red in none-evaluative aspects agrees between the paintings and the colour studies, the significance of the light green is enhanced in the paintings.

Regarding the none-evaluative aspects, the red in both compositions agrees with the results of the single and combined colour studies; however the experience of the orange-red colour distinctly differs in the two paintings. In Taft's study[3] the ratings for certain colours, such as the orange (1080-Y50R; similar to the orange-red in the paintings) were found to correspond well between a chip and any object. In the CE-study the subjects fully agreed on the isolated orange-red colour to be distinct, vivid, striking, transparent, light and strong. It was also by most considered to be warm and deep.[1] This is concordant with how the orange-red can be perceived in both compositions. However in each painting this colour is associated with positive and negative connotations respectively, important for the impression of the composition. In *The Newborn* the red can stand for love, safeness and warmth. This does not agree with the experience of the orange in Taft's study[3] were the observers agreed on orange as the loudest and ugliest of the investigated colours, not appealing on any object. In *The Newborn* the orange-red is the most central colour in the composition, to which the attention is drawn. It is probably no co-incident that the central figure carries the signal-bearing red colour. The light of the hidden candle makes the colour appear warm and deep. In *Death in the Sickroom* the orange-red is almost anxiety-causing, yet hard with lack of positive emotional aspects. In western symbology red has traditionally been seen as the colour of blood[15]. The association to blood is here coupled with fear. The almost aggressive redness of the floor can be linked to the family members' grief and anger over the bereavement. Through Itten's contrast theory[5] it is visible that the orange-red in the composition to some extent creates a complementary contrast with the green walls. The floor also creates contrasts of light and warmth with its strong orange nuance against the dark tranquil fabrics of the dresses. In both paintings the impression of the redness is enhanced by the contrast with the surrounding fields of colour.

The light green colour was in the CE-study by all observers perceived as light (as opposed to dark), light (as opposed to heavy), weak, subdued, pale and plain, whereas it was uncertain whether it was perceived as cold or warm[1]. Different values for the light green colour are in both paintings reinforced compared to the individual colour in the CE-study because of contrast effects and strong visual and symbolical meaning. In both paintings the contrast effect with surrounding fields of colour makes the light green striking in appearance. In *The Newborn* the light green appears as striking in contrast to the dark background, as well as to the more saturated orange-red in the composition. Visually, the candle light also makes it appear soft. In *Death in the Sickroom* the light green colour can be perceived as cold, light (as opposed to dark), passive, plain, light (as opposed to heavy) and turbid. The fact that it appears colder, more striking and more passive here than in *The Newborn* and in the CE-study can be a result of the strong symbolical value here connected to this colour. The facial light green colour of some of the family members is in strong contrast to the orange-red, and can symbolically be compared to total passiveness. The faces can be interpreted as masks of death and the colour then becomes hard and ice-cold.

The context of colour is similar in both paintings, though they differ in contrasts. Ou and Luo[9] point out that small lightness differences between colours reduce the harmony, which agrees with the distinct difference in pleasantness between the two paintings. This is a knowledge the artists have made use of. The greatest difference between the paintings and the colour studies is however that in the paintings the colour fields tells us a story.

## 4. Conclusion

That the context is important for the colour experience is known. In a composition it is difficult to separate the colour from its symbolic values. A colour in an image can partly be analysed through the contrast with surrounding colours and its properties, but just as much through its symbolic and visual value as part of the composition. If there were no symbolic values, the colours would probably be experienced similar in the two paintings here discussed, since their levels of contrast more or less agree. How theories on art discusses colour differs from the scientific perspective. It is difficult to find precise information on the exact nuances in the palette of a certain artist, other than the visual information a print of it will provide. Art historians discuss the full meaning of the composition, including colour as one aspect of the whole experience. Reversed, scientific methodology requires high precision but sometimes lack a discussion on relevance and context. How various degrees of context and realism influence the colour experience need to be further investigated.

### References


1. Billger M., and Stahre B., Results of the Swedish Colour Emotion-study, unpublished. Dept. of Architecture, Chalmers University of Technology, Gothenburg, 2002

2. Ou L-C., Luo R., Woodcock A., Wright A., "A study of Colour Emotion and colour preference. Part 1: Colour emotions for single colours", Color Research & Application, 2004; 29:232-240

3. Taft C., "Color Meaning and Context: Comparisons of semantic ratings of colors on samples and objects", Color Research & Application, 1997; 22:40-502.

4. Sivik L., "Color systems for cognitive research", In: Hardin, C.L. and Maffy L (ed), Color categories in thought and language, Cambridge University Press, 1997, pp. 185-192

5. Itten J., The Art of Color, The subjective experience and objective rationale of color, Van Nostrand Reinhold Company, New York 1973

6. Hughes R., The Shock of the New - Art and the Century of Change, Updated edition, Singapore 1993, p 276-277

7. Sivik L., and Taft C., "Färgkombinationer och associerade betydelser – Semantiska dimensioner och olika färgackord". Färgrapport F41, Färginstitutet och Göteborgs Universitet, ISSN 0280-2198

8. Ou L-C., Luo R., Woodcox A., Wright A., "A study of Colour Emotion and colour preference. Part II: Colour emotions for two-colour combinations", Color Research & Application, 2004; 29:292-298

9. Ou L-C. and Luo R., "A colour harmony model for two-colour combinations", Color Research & Application, 2006; 31:191-204

10. Our study is part of the international Colour Emotion project, see: Sato T. and Hansuebsai A., "Proceedings for the International Conference on Colour Emotion Research and Application", July 5-7, Chulalongkorn Univ., Thailand; pp. 1-3

11. Sivik L., "Color Meaning and Perceptual Color Dimensions: a study of exterior colours", Göteborg Psychol. Rep. 4 (1974)

12. Nobbs J. H. et al, "Characterising the emotional response to colour in simple designs", In AIC Colour 05, 255-258

13. Eggum, A., "Edvard Munch as a painter"
www.museumsnett.no/munchmuseet/en/munch/munch_painter.htm

14. Manguel A., Läsa Bilder – En Historia om Kärlek och Hat, pp 38 ff. Stockholm, 2000, p 43

15 Gage J., Colour and Meaning – Art, Science and Symbolism, Thames & Hudson, Singapore 1999, p 39 ff


### Images

**Fig. 1a.** De la Tour G., The Newborn, ca 1645, Oil on canvas. Musée des Beaux-Arts, Rennes, France. Simplified from Itten J., The Art of Color, The subjective experience and objective rationale of color, New York, 1973, p 99

**Fig. 2a.** Munch, E., Death in the Sickroom, 1895. Oil on canvas. Nationalgalleriet, Oslo. Simplified from Hughes, Robert, The Shock of the New - Art and the Century of Change, Updated edition, Singapore 1993, p 278

# Cultural Role of Color in Architecture and Urban Environment

Silvia Rizzo,

Abstract
The color-culture bond in the urban environment plays a role in both our historic as well as contemporary cities.
In this paper, several examples are examined, documenting color as an element of tradition, of history and memory of a place, and resulting into a complex geographic-cultural itinerary. Some of these examples have been taken from the urban identity of Genoa, with its characteristic painted facades.
Our considerations then refer to some communication, aesthetic, and social aspects involving our habitat today, including some examples of environmental color design.
In this context, an educational-artistic research is proposed, which is based on an in-depth perceptive-sensory analysis of environmental-urban color.

Introduction
The history of a city is expressed through urban changes, as well as changes over time of its social and cultural life.
Architecture accompanies these processes over time, through different styles, changes of contents, and different place cultures. In this context, color is one component, no longer only for decoration, but because it plays a well defined role in the environment.

The international conference on "Color and Urban Environment between History and Contemporaneity" was a special occasion for an in-depth analysis of the cultural role of color in architecture. This conference offered a comprehensive and complex overview of this topic, as presented in the Minutes currently in print. Invited speakers not only offered a comparison between past and present, but also between different expressions and traditions, thus building a geographic-cultural itinerary on color. The role of color was stressed, as a symbolic element of political and social events, through which we can read their related history.
When discussing colors of historic tradition, also the issue of restoration was raised, based on precious historic documents, historic culture, and the perception of aesthetic implications. As far as contemporaneity is concerned, the revitalizing role of color was pointed out, as well as its communication, aesthetic, and social features involving our habitat today.
Genoa provided a very suitable venue to this conference, owing to its peculiar features of polychromic city facing the sea, as indicated by its historic name of "Genua Picta".

....
In the complex Schutzenstrasse area in Berlin, consisting of 12 reconstructed houses that were integrated with some other existing buildings, color makes them look as an integer, and comprehensive chromatic unit: hence, no longer individual buildings, but outdoor and indoor spaces merged together into a single, non-stop, and dynamic perception.
The link with historic tradition is confirmed by the addition of mouldings and rustications. Part of Palazzo Farnese's façade was reconstructed, an unexpected visual element with the same strong perception effect as the unusual colors, which guide us dynamically from inside to outside the buildings, to "recreate the internal block life", as claimed by the author.
Hence, color is to be experienced collectively; color that asserts itself in the city's urban context, while becoming neighborhood, history, and brave ideas.

Karin Fridell Anter, in her paper entitled "What colour is the red House?" presented a deep analysis of color tradition in Swedish houses. Most of them are red outside, but, with time, also yellow, white, and green façades became popular, until more recent times when, following industrial paint

manufacturing, a much wider range of colors is available. Color design issues were then discussed: the difference between *perceived color* of house façades, which differs and changes, owing to weather conditions, time, and place where the building is located, and the selected *inherent* color, namely the constant quality referred to color samples and their use by professionals. Karin Fridell Anter conducted a survey on this issue, by surveying and observing about 100 houses using the Natural Color System (NCS), while also taking into account color perception by man. The results of this research work have been practically and immediately applied in color design of building façades. At the same time, they have also raised further questions as to color perception.

Fannie Tosca, in her paper entitled "Anti-utopian Considerations: Towards an Art of the Profane" presented a very interesting project on the issue of color design for a neighborhood in the city of Thessaloniki. After having analyzed its history, she illustrated her project featuring the creation of light projections following a careful and unique formal search for lights and colors, also to include sounds and music. The city is a living organism, hence this type of project is to benefit the whole community living in it: anti-utopian color design, without discriminating any tool or material, but rather based on existing elements, while turning constraints into creative opportunities and into a de-materializing operation. Therefore, light and color projections, with their energy, can play a vital role to promote revamping, to the advantage of the community at large.

Tom Porter, the great scholar who first investigated urban polychromy (his book entitled "Colour for Architecture" was written more than 25 years ago together with Byron Mikellides) in his paper "Wonders and Blunders: Back to the Future" dealt with the role of color in our contemporary world, from industry to architecture. Taking the lead from cases of glaring mistakes in the use of color, he presented an overview of his own research works, regarding color preferences, the importance of fashion in color use, and its value in product design and architecture. In other words, color affects our daily life in many different ways. In particular, he has investigated color codes for industrial and architectural use, like the "Oslo Palette", a project that was ordered and later awarded by the Oslo School of Architecture for the buildings of that city. Porter pointed out that, in spite of some conformity in color application especially in the UK, there has been a paradigm shift in the use of color in architecture. Indeed, as of recently, new technology allows for dynamic and programmable colors to be used, for example iridescent and thermo-chromic claddings, which, when applied on the façades of buildings, change their color depending on the time, light, point of view, etc. Hence, the traditional concept of color in architecture has thoroughly changed, thus becoming language of time and place, a sort of unrelated and yet crossed space subject to constant and dynamic changes.

Conversely, in our contemporary times, communication, aesthetic, and social aspects that affect our habitat today must all be examined. Color is thought to play a revitalizing role, or a role which is more intrinsic to design and linked to chromatic dynamics of new construction materials.

Speaking about color, as part of a more comprehensive project to protect a city's historic memory, Giovanni Brino took the floor. He was the first one in Italy to design color plans for cities like Turin, and related data bases. He presented his long and wide-range work also applied to vocational training experiences. These tools have been useful to learn and compare different techniques, materials, and colors on a regional level.
In this way, an endless amount of files and archive documents can be stored about façade colors and relevant types and application methods: plaster, lime coating, artificial or natural stones, bricks, etc. in order to ensure a proper identity, as faithful as possible to the historic document.

Major restoration experiences conducted in Genoa and the various methods employed have mostly been emphasized. Starting from actual examples of historic buildings, a complex reconstruction of colors was carried out by linking them to architectural plaster features and other materials employed.

Via S. Lorenzo

Each building had different architectural and construction features as well as different types of plaster, marble insets, and basements. For this reason, colors as well as other style elements had to be concurrently and harmoniously coordinated.
Every color was actually affecting the choice of other colors, not only for each façade, but also for adjacent buildings along the same side of the street, as well as for the buildings on the opposite side and for those that were only partially visible when enjoying a perspective view of the whole street.

A color plan was required in order to check that all the hues would match and a new overall picture could emerge.
This work was carried out in preparation of the G8 summit meeting. It has generated a grand pedestrian route connecting the city center to the Port. This great example of urban recovery and revamping has drawn international acclaim.

(Falzone)
A
Research and investigations of color, painted features and finishings in general have always been conducted keeping a close eye to architectural elements.
This research area focuses on the methods to interpret, survey, and render, in both a graphic and non graphic form, chromatic-decorative elements as well as all the façade materials making up the architectural surface of the building. The purpose is to survey not only colors and the quality level of paintings, *chiaroscuro* effects of surface materials, their size, texture, surface grain, and treatment, but also to investigate technological issues.

As for Palazzo Tursi, the main problem was to properly clean the façade, while consolidating and/or replacing some parts, without altering the color of existing materials with an unnatural look of "new". The façade of this palace is lavishly decorated with multi-colored, well modulated stones, and white marble statues. It is a masterpiece of Genoese mannerism. First floor mascarons and the monumental portal are by Taddeo Carlone

B
Architects Anna Mantiero and Francesca Salvarani presented a paper entitled "The recovery of Ripa Maris in Genoa: colors and materials". With reference to these renovation works, they illustrated research and implementation methods for the restoration of the ancient row of buildings overlooking the waterfront. Their colors, according to historic tradition, were important as a way to make the buildings stand out and be recognizable from the sea.
Palazzine della Ripa, marking the border between Genoa's Medieval Center and the sea, stand up as a theatre setting proper to the Old Port. It comprises 43 buildings, along an almost 1 Km stretch from Porta dei Vacca to Piazza Cavour.
Documented evidence of the first buildings of Ripa Maris dates back to 1133-1134.
Following the renovation works of Ripa Maris, several hues of yellow, ochre, pink, red, green, ivory, and white have been brought back on these palaces, in a delicate succession which enhances the value of each single building, as part of a seamless architectural and environmental context.

Even in our contemporary times, color in architecture becomes a contextual element to the language of time and place, through constant and dynamic variations, that perfectly reflect our contemporary culture.
Color in contemporary architecture is linked to new materials which significantly affect also the aesthetics of our times. At the same time, color is relied upon in urban space revamping operations as an enriching and perceptive element, even in suburban city areas, with a view to promoting a more sustainable urban life.
Particular attention should be given to the architecture works of Aldo Rossi.

The issues discussed, more in particular, referred to the following areas:

Enrico Bona (Color in the city from tradition to advanced technology) proposed to revamp the Flyway of Genoa (Sopraelevata) through new colors. He also examined urban colors in the port area: no longer painted plaster, but colors on metal plates, ships, containers, through a reinterpretation of the industrial city conducted with a strong reference to its historic fabric.

G. Bertagna presented his research on the use of colors to revitalize buildings outside the city center, that have no particular identity; namely, suburban houses without any particular architectural or artistic value, with the social aim of promoting a more sustainable urban life.

Silvia Rizzo near her project for a "Color Square for Children". She presented some works and installations with a strong aesthetic/artistic sign, thus integrating her personal research, in which creativity becomes an important design element, such as in art in design.

I think it is important now to spend a few words on the issue of color culture.
With a view to identifying and communicating urban environment colors, and in order to promote awareness and sensitivity towards urban spaces, I have conducted research works combining educational features and artistic experiments and based on the expression of both environmental space and color, through the display of color planes on bi-dimensional surfaces (canvasses). On these surfaces, the effect of space suggested by color takes up an 'inductive', a sort of spatially 'psychological' nature, through the interplay of associations with the three-dimensional nature of the urban environment. At the same time, all the different types of buildings and constructions were duly taken into account.
These canvasses were placed in different parts of the city, in historic, contemporary areas, in the suburbs, representing color signs aimed at raising a collective vision of color and extending the communication of environmental signs.
These proposed combinations in which color and architecture meet together also aim at promoting investigations to foster color education, and a better dialogue with our habitat, through wider perceptive, experimental, and emotional spaces with some attention also to color design.

CONCLUSIONS

This paper aims to stress the importance of an intersectoral and learning approach of research works involving aesthetic as well as technical aspects, in particular with a view to preserving ancient colors in our urban spaces.
Therefore, color as culture, as a value which, while stressing the importance of our urban spaces, protects environmental quality and the history of our cities.
The high number of works carried out becomes a "communication of ideas" and a cultural workshop on color that all of us who have been speakers at the conference have dedicated not only to industry operators, but in particular to younger people, so that it will become a subject for further study and research.

"The color of a city is an aspect of its history", from Tom Porter "colour Ambiental", Editorial, TRILLAS, 1988, Mexico D.F.

# Color as Idea: using color as the conceptual basis for architectural and urban design

**G.Minah**
College of Architecture and Urban Planning, Department of Architecture, University of Washington, Seattle, Washington, U.S.A.
Corresponding author: G.Minah (gminah@u.washington.edu)

**Abstract**
This study demonstrates how color used in design drawings, throughout all phases of a design process in architecture and urban design, can clarify and add nuance to the formative conceptual ideas. Color plays a role in design through 1) *color dynamics*, 2) *color tectonics*, and 3) *color imagery*. Using color as a means for recording the experience of a pedestrian view of the city is an additional emphasis in urban design. This is accomplished with *experience maps* (previous study), and using color to represent the life of the street through *street activity diagrams*.

## 1. Introduction

Aristotle, in his *Poetics*, established the rationale used in the *Disegno versus Colore* debate during the Renaissance. This rationale argued that color is secondary to pure line drawing. Le Corbusier saw color in architecture as a form of degeneracy, but proclaimed white as clean, healthy, moral, rational and masterful. White embodied the values of modern times and became a characteristic of the Modern Movement in architecture. Le Corbusier's ideas have had a great influence upon the attitudes toward color in architecture. Except for some experimentation with color tectonics in the DeStijl Movement (1920's), and with color imagery in the Post Modern Movement (1980's), many of the attitudes that subordinate color still hold today.[1] Using color as a rational tool in a design methodology, which combines color and line drawing, is the focus of this study. The goal is to use color as a formative element in the design process, making the experience of color in architecture more meaningful.

## 2. Architectural Design

There are many methodologies which can be utilized in an architectural design process. Most include a conceptual phase, schematics, and a design development phase. Central to the conceptual phase in most methodologies are two ingredients; 1) a formative *idea* or concept, and 2) a *diagram* which becomes an abstraction of the idea in drawing. The role of the diagram is to translate idea into form using language belonging to the vocabulary of architecture. Methodologies by Louis Kahn, architect, and Douglas Graf, design theorist, illustrate this. Kahn would ask the question, 'what does the building want to be?' The answer was always given as a metaphor, which became the generative concept. He referred to the diagram as a 'form drawing'. These were quickly drawn shapes and images that represented the concept, and included what he referred to as the 'inseparable parts'. The parts were categorized as 'servant' or 'served' spaces and each was drawn in a manner, which suggested their structural nature. The metaphor for the design of the Repertory Theater in Fort Wayne, Indiana, was a *violin* inside a *violin case*. The *violin* was the theater, which had precise acoustical requirements, and the *case* was the protective outer shell of the building. This surrounded the theater but had no contact with the *violin*. The spaces in between the two were for circulation, ticket office, lobby, etc. Kahn's form diagram was shown as: (Figure 1).

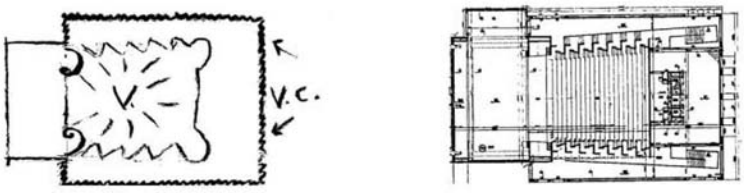



**Figure 1**: Kahn's Repertory Theater; 'form diagram' and plan.

Douglas Graf, Ohio State University, teaches a branch of architectural theory called formal analysis. Formal analysis is a reductive process, which 'loosens' a building into constituent parts and their relationships. In the diagram, these components are reduced to simple points, lines, planes, or volumes. The diagram includes both the configuration of the components as well as indications of organizational strategies. Important to the diagrams are figure/ground juxtapositions which are shown as notations of center and perimeter. [2] Villa Rotunda can be diagrammed as a point in space; Piazza Navona as a void surrounded by lines forming a perimeter. Both are *center*.

Graf's analytical drawings of Louis Kahn's Meeting House at the Salk Biological Labs in La Jolla, California show a central space as figural. The perimeter consists of a series of connected buildings, each with their own centers and perimeters.[3] As in the Repertory Theater, there is a hierarchy in the components that represent organizational strategies in the diagram. (Figure 2).

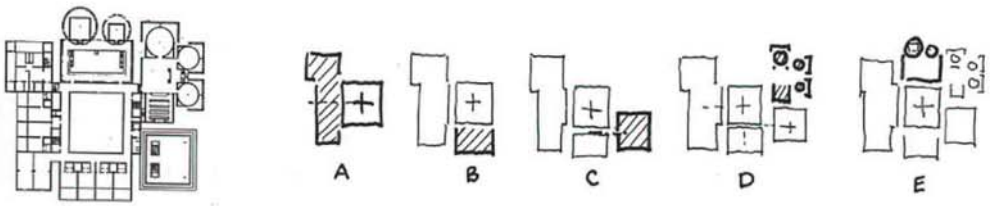



**Figure 2**: Kahn's Meeting House plan and Graf's analytical diagrams.

The addition of color to these design drawings can both clarify and serve as 'interpreter' for the *concept.* Color can become a component or 'partner' in the form drawings, and has the capacity to enhance the concept. Three roles that color can play in the design process are defined here as 1) *color dynamics*, 2) *color tectonics*, and 3) *color imagery*.

Color Dynamics. Visual hierarchies that use figure/ground in the diagram also imply a relationship or dialogue based on their contextual juxtaposition. These can be contrasts of dominant/subordinate, opposition, and/or separation. They can also represent organizational strategies of connection, transition, assimilation, (etc.). These juxtapositions are dynamic and represent events in the experience of the architecture. Color juxtaposition has the potential for representing contrast through these dynamic relationships and as these juxtapositions become part of the diagram, the implicit meaning in the formative idea becomes more nuanced.

Color Tectonics. Tectonics refers to color's potential in defining and clarifying three-dimensional form. In the schematic phase of architectural design, building plans and sections are investigated with form and massing studies. Color helps define elements (physical form, details, etc.) as figure or ground. Color with light is a powerful factor in defining interior space.

Color Imagery. Color imagery is where most attention to color in architectural design has been placed. These are the colors one experiences perceptually in architecture, which convey materiality, physical context, cultural context, symbolism, and emotional response. In the design process described above, where color is a principal partner through all phases of the design process, this imagery will be seen as integral to both the architectural form and the conceptual beginnings of the design. To use color in architecture as formative and rational as well as semiotic will make the visual experience of architecture richer and more meaningful.

**3. Design of the City**

The design of the city begins with a conceptual point of departure. Like architecture, there are many methodologies used in this process. Most urban design focuses upon changes in existing cities, i.e. intervention, renewal, expansion, design of infrastructure, densification, etc. The comprehension of the city form and its conceptual beginning are primary to this work. The first step in the design process is the representation of the urban fabric diagrammatically. As in the previous example of the

diagram of Kahn's Meeting House, the city can be represented as a complex series of interrelated parts which form the constituent elements. These parts, in turn, can be vicinities or neighborhoods at one scale, and details of public/private interactions at another. The components that make up paths, edges, districts, nodes, and landmarks[4] are translated in the diagram as lines, perimeter, center and figure. The intrinsic sense of wholeness, or city as object is ever present, and, therefore, pieces of the city can be referenced as the relationship of the part to the whole. This part-whole paradigm with its implied hierarchical set of relationships suggests foreground/background juxtapositions and, like the architectural design methodologies, will use some of the visual means described above for representing these components graphically. Two drawing examples of particular interest to this study represent the *experience* of a city as well as its physical form. 1) The Nolli map of Rome[5] uses figure/ground drawings to show the public and private realms of 16th c Rome. 2) Louis Kahn's traffic plan for mid-town Philadelphia, Pennsylvania uses movement symbols as the primary component.[6]

Color and Urban Design. Color is used more frequently in urban design than in architectural design. The primary use of color in urban design is to categorize and clarify large amounts of visual information. Comprehensive plans and land use maps of cities use standard coded colors to represent the use patterns of a city. Digital technology has provided the easy access to city maps, plans, and aerial photography of cities. These can be layered and manipulated with endless combination of colors, and some very comprehensive representations of urban form have resulted. Of interest is Richard Wurman's use of color to represent quantitative census data visually in city plans. Each data-base (i.e. population, income) has a specific color. When two or more data-bases are layered in transparent colors, additional colors will emerge as clusters of new information.[7]

City and Experience. Most representations of the city contain information showing physical form and/or quantitative data. The city, unlike most architecture, is difficult to experience as form in its entirety. One experiences the city as fragments over time. How one forms a mental image of the city when experienced over time from an eyelevel perspective is of interest to urban designers. Kevin Lynch used the term 'place legibility' in an investigation of ways people attempt to navigate and interpret the physical form and structure of the city.[8] Amos Rapaport defined 'environmental cognition' as that which is based upon multiple experiences with repetitive pieces of the city that are logged in a memory bank, and are then compared to new visual experiences.[9] This cognition aids in forming 'mental maps' of the city.

Addressing these issues, the *experience map* is a plan view of the city showing individual building footprints. In these building footprints, the color and elevation patterns are recorded within a cone of vision from the opposite side of the street at eye level. The relative heights of buildings are represented by the thickness of lines outlining the buildings. Color, elevation pattern, and building heights are determined to be factors one experiences as visual uniformity.[10]

Streets. Streets also play an important role in this urban fabric. In formal analytical terms a city street is a center between two perimeter walls, and a volume, or room, defined by these walls. Streets are the largest public realm in the city. Streets also form the personality of a district within the city; its energy, its movement, and the kind of public life generated there.

Two maps in the Virgin City Guide for New York City, illustrating the experience of street life are relevant. 1) 'Top Shopping Zones' showing districts in color, streets as voids, and bands of red (R) along the blocks in varying intensity where shopping occurs. 2) 'Night Time Hot Spots' shows streets in light violet (RB), blocks in darker RB (night imagery), and areas of nightlife in circles of YR in a range of sizes depending upon the activity.[11] A third map, the Touring Club Italiano Roma map differentiates streets as white voids and traffic arterials as continuous yellow lines. [12]

Art and City Form. Mondrian's 'Broadway Boogie Woogie' stands out as an example of movement and energy in an abstraction of a city map that represents the Broadway district of NYC. The streets as yellow with red and blue squares appearing in a broken rhythm. Larger blocks in red and blue

become figural nodes, and the totality is an energetic moving stream.[13] Paul Klee has developed a vocabulary of lines and patterns to show many types of movement.[14]

Color and the Street Experience. A challenge in this study is to find a way of representing the street as experience in drawing. One proposal shows information that will include pedestrian and traffic volumes, and identification of activities that give life to the street. (i.e. retail stores, restaurants and food venues, bars music venues, and theater). This shows traffic arterials in Y in varying *c* indicating intensity. Lines in YR parallel to the street show vehicular movement. Line width indicates volume. Pedestrian movement is shown in dashes parallel and on the periphery of the street in darker analogous colors. Volume is shown in quantity of dashes. The street drawings will be combined with the experience map. In the sidewalk space in plan, in front of every building would be a rectangle of color coded to activities that give life to the street. Red (R) is used for retail shops, blue (B) for bars and music venues, and black (S) for theaters. This color plan would be shown for all streets in the city. The *street activity diagram* is the terminology used for these drawings.

**4. Conclusion**

The goal of these studies is to show how color becomes a component and partner in all phases of the design process in both architectural and urban design. Color dynamics, color tectonics, and color imagery are given as examples of a role color can play in the three phases of the design process. In urban design color can also represent *experience* in drawings of the city, and these aid in the process of cognitive mapping. A challenge is to represent an entire city with an *experience map* showing color, elevation pattern, and building heights from a pedestrian view, and a representation of the life of the street with *street activity diagrams*. Color and pattern will comprise the visual vocabulary. The repetition of elements in this map will form constellations or clusters of information recalled from experience and memory that will become meaningful from many points of view. Like the 18th c Garden Carpets of Kurdistan, which were designed to represent both real space and the imagery of the garden, these drawings have the potential to represent the experience of *place* in a city.

**5. References**


1. D. Batchelor,"Chromophobia" in Chromophobia (Reakton Books Ltd.,London, UK, 2000), pp.21-49.
2. D. Graf, "Diagrams" in Perspecta: Yale Architecture Journal, No.22 (Rizzoli International Publications, Inc., NYC, NY, 1986), pp.43-45.
3. Ibid, p.59.
4. K. Lynch, The Image of the City (The M.I.T. Press, Cambridge, Massachusetts, 1960).
5. G.Nolli, Rome 1748: the Pianta Grande di Roma (J.H. Aronson, Highmount, NY, 1984).
6. L. Kahn, "Toward a Plan for Mid-town Philadelphia" in Perspecta: Yale Architectural Journal, No. 2 (Rizzoli International Publications, Inc., NYC, NY, 1953), pp. 10-27.
7. J. Passonneau & R. Wurman, Urban Atlas: 20 American Cities (The M.I.T. Press, Cambridge, Massachusetts, 1966).
8. K. Lynch, The Image of the City (The M.I.T. Press, Cambridge, Massachusetts, 1960).
9. A. Rapaport, "Evaluation, Cognition, and Perception" in Human Aspects of Urban Form (Pergamon Press, NYC, NY, 1977), pp. 113-115.
10. G. Minah, "Memory Constellations: urban color and place legibility from a pedestrian view", in Proceedings of the 10th Congress of the International Colour Association, J.Nieves & J. Hernandez-Andres, eds. (Grafocas A;ja,bra. S.A., Granada. Spain, 2005) pp. 401-404.
11. N. Peck, ed., "New York's Top Shopping Zones", "New York's Night-time Hot Spots" in New York (Virgin Publishing Ltd., London, UK, 1999), p. 98, p. 116.
12. M. Ausenda, ed., Roma: Piante di Citta (Touring Club Italiano, Milan, Italy, 1997).
13. P. Mondrian, Piet Mondrian in the U.S.A., V. Pitts-Rembert, ed. (Parkstone Press, Dulles, VA, 2002).
14. P. Klee, Notebooks, J. Spiller, ed. (G. Wittenborn, NYC, NY, 1969).

# An architectural understanding of colour research

Monica Billger and Karin Fridell Anter
Chalmers University of Technology
SE 412 96 Göteborg (SWEDEN)
corresponding author: M. Billger mpb@chalmers.se

## Abstract
Colour research from different scientific traditions start from different basic questions and use different methods and concepts. This makes it difficult to communicate and to judge result relevance in a wider perspective. Here we start from architects' need of colour knowledge and discuss studies of *colour appearance* and *colour emotion*. We conclude that the multitude of studies with different approaches can be seen as cases, jointly adding to a widened and deepened understanding of colour.

## Can different scientific approaches be reconciled?
This paper is written from the viewpoint of colour in its architectural context. Architects need knowledge about colour in spatially complex situations. This includes rooms with walls, ceiling and floor. It also includes building exteriors co-existing with other buildings, man-made artefacts and surrounding nature. Thus architects and architecture would gain from a better understanding of colour perception, space perception and their mutual interdependence. Issues like these have been dealt with by colour researchers within the architectural profession and by artists. Similar questions are also raised within the fields of e.g. colour science, colour vision and perception psychology. The methods and terminology of these different disciplines differ, often to such an extent that we find it difficult to communicate, although we might sense that we have something to learn from each other. Still researchers from different disciplines and with different scientific approaches have all to gain from a deepened collaboration. We have to discuss issues like: What research questions are fruitful for different purposes; what are the limitations and prospects of different methodological approaches; to what extent can results be relevant under other conditions than those of the study?

One basic problem, which has been pointed out by Paul Green-Armytage (PGA), is that we do not even mean the same thing with the word *colour*.[1] He has greatly improved our possibilities to understand each other, by sorting out the ambiguous colour terminology. He has identified seven different 'things' that are referred to by the word *colour* and calls them *Conventional colour, Substance colour, Formula colour, Spectral profile colour, Psychophysical colour, Inherent colour* and *Perceived colour*. Each of these categories is defined by its own specific means of identification and some of them are further specified into sub-categories. Some of PGA's *colours* can be understood as physical properties, established by measuring instruments. Others are visual experiences whose identification must depend on experiencing human beings. *Psychophysical colour* can be seen as linking the physical and the visual through colorimetric tri-stimulus values and chromaticity diagrams.

## Perceived colour in an architectural context
For architectural practice, there is a great need for a better understanding of several aspects of colour. One of them is the relationship between, on one hand, the varying *perceived colour* in the real spatial situation and, on the other hand, a constant colour aspect of the surface, specified in terms of e.g. *psychophysical colour*, *spectral profile colour* or *inherent colour*. The questions could be posed: How will this (inherent, psychophysical etc.) colour look in that room, or on that facade? And what (inherent, psychophysical etc.) colour should be chosen to get the targeted perceived colour? Such knowledge is essential for understanding how a room or building will look, even before it is built or 're-coloured', and for prescribing the materials and paints that will lead to the planned result. Questions within this field have been studied in interior rooms by Billger[2] and Hårleman[3] and on exteriors by Fridell Anter[4]. Similar questions are also studied within the field of *colour appearance*, primarily with other aims than to provide guidance for architectural design.[5] Colour appearance models are developed for the production of constant *perceived colours* irrespective of medium. A new topic within this research are studies on how colours will appear in different sizes within full scale

rooms.[6,7] These studies ought to be interesting from an architectural point of view, but our differences in problem formulation, method and presentation make it very difficult to relate them to real life architectural situations. Their focus is on one wall only, and not at the rooms as a totality, and the analysis of colours is based on separate qualities of the perceived colour (value, chroma, hue etc) and not on the total colour perception.

Laboratory studies on colour appearance can provide precise numerical results that are very reliable under the given conditions, but do not allow generalisation outside the given situation. Studies in realistic architectural situations, on the other hand, can provide more general results in terms of tendencies and directions that are not, and do not claim to be, very precise. High precision demands full control of the situation, and that obviously cannot be done when you study complex real life. Such studies can, however, with high reliability maintain, for instance, that a painted timber facade seen from a distance is perceived less blackish than its inherent colour (Fridell Anter), and that a yellowish room lit with direct sunlight is perceived more chromatic than an identical room facing indirect skylight (Hårleman). From different examples conclusions on colour elasticity can be formulated, telling how much the perceived colour of a specific material can vary within a range of given conditions.

## Recent studies on colour emotion

In architecture, colour is one of the important factors for creating emotional values in a room or a building. Do people like or dislike specific colours or colour combinations in architecture, do they feel joyful or sad and what associations do they get when being inside the coloured rooms? Studies on colour emotion would seem very adequate for the understanding of how to use colour in order to achieve the intended emotional results. Such studies investigate the relationship between colour and human emotions, attitudes and evaluations. The aim can be to find correlations between colours and basic human emotions like fear, anger and happiness[7, 8, 9, 10, 11] or to investigate other attitudes and evaluations evoked by single colours[12, 13] or simple colour combinations[14].

Oberascher *et al* have compared the emotional meaning of colours in different cultures. They used different methods where verbal concepts for colours and emotions, colour samples and colour compositions were assigned to each other. The colour samples used where chosen to represent easily discernible colours that can be characterised as prototypical. Thus it seems like the study object would be *conventional colour* (using PGA's classifications) and the aim of the study was to find possible emotional implications of the idea of e.g. “red” rather than the exact colour sample that was used to symbolise “red”. The results showed a high concurrence between emotion and colour, but also clear differences both between and within the cultural groups.

da Pos & Valentini have approached similar questions with a very different method. They started from seven human emotions that have been found “basic” in previous research (happiness, surprise, fear etc.) and asked their subjects to “paint” suitable backgrounds for faces expressing these basic emotions. The “painting” was made by adjusting the colours on CRT monitors. The authors conclude that the results show an overall similarity with the first stage of the study by Oberascher *et al*.

The study of Ou *et al* works with a more limited definition of “emotion”. It was carried out in six different countries, with the aim of investigating how cultures influence viewers’ emotional responses and preferences to single colours and to colour pairs. The method was that of categorical judgement of small squares on a digital screen, using the four scales “warm-cool”, “heavy-light”, “active-passive” and “like-dislike”. To evoke emotions and attitudes a colour has to be seen, and this means that the object of this and similar studies is the *perceived colour* in the specific observation situation. The studies have, however, often used other definitions (most often *psychophysical*) of their study objects, in order to obtain a controllable and replicable situation. Thus the results from a colour emotion study in one situation cannot automatically be considered relevant in other situations where the same psychophysical colours are perceived differently. This has been shown in comparisons between attitudes to single colour samples and the same psychophysical colours presented in two-colour combinations[15], and in comparisons between emotions evoked by small colour samples on a screen or white paper and by similar inherent colours when perceived in full scale rooms[16].

The study of *colour emotion* is further complicated by the fact that emotions are not caused by pure colour perceptions, but are largely depending on the situation in a broader sense. Often we are strongly affected by cultural codes and connotations tied to the colours in the specific situation (often

*conventional colour*, e.g. the notion that a bride should wear white without further specification). The same goes for architecture. Janssens has shown that our positive or negative evaluations of facade colours are strongly correlated to what is called the *prototypicality* of the colour. Most often we prefer those facade colours that we are used to seeing on this type of building, and we often react negatively when something, seemingly without reason, differs from what we would expect.[17] With all this in mind, we must read colour emotion studies with many reservations regarding their application in architecture. But still, there is a good chance that some of their results may also be relevant in architectural situations. Maybe this is true above all for those results that are rather general and do not aim at the preciseness tied to a specific situation. One example of this is the finding of Nobbs *et al* that the emotional impact of a combination seems to depend on the contrasts rather than the individual colours. This conclusion could serve as a starting point for investigating similar questions in complex spatial situations.

## Colour emotion in an architectural context

Some studies specifically aim at exploring issues connected to architecture, planning or design, but choose to work within a simplified context, to be able to control all preconditions and arrive at detailed and clearly specified results. Miamoto's study[18] concerns a specific design problem, namely that of choosing guiding colours on sidewalks etc. that would be clearly visible for persons with low vision and at the same time provide visual harmony for people with normal vision. The latter part of the problem could be seen as one of colour emotion (given a wide definition of the word). 'Harmony' (not defined in the report) between the chosen colour combinations was estimated by observers who judged colour manipulated paper prints of different landscapes. Not unexpectedly, the results showed that the greatest harmony was judged for combinations where the colours differed little in hue and chroma and had different values – that is a type of combinations that also have high esteem in other studies.[19, 20]

The study of Ishida & Kawaguchi[21] aims to explore the visual impression of the cityscape through observer assessment of activity, organisation and preference. Their observers are asked to assess photos of cityscapes and simplified colour compositions derived from these photos. Thus the complex architectural situation is reduced twice – firstly to photos and then to colour compositions – in order to execute a study under repeatable and controlled circumstances. The aim of the study seems mostly methodological, and the results imply that the second step of the reduction could lead to results that also apply to the more complex photos. In the study of Brengman & Geuens[22] the purpose was to examine the different effects of colour in stores on the emotions and behaviour on the potential customers. The subjects were shown colour-manipulated photos of a CAD-designed store, allegedly selling furniture and accessories, and asked to answer questions about their feelings towards the design. The conclusion was, that store interior colour could affect feelings of pleasure and excitement as well as tension, but it is not reported what colours that gave what response. Thus the results only say *that* colours could give these emotions, but do not give any hints about concrete application.

The three studies discussed above all work with simplifications of a complex spatial situation and try to achieve results relevant for the complex situation itself. They do not, however, show in a convincing way that the simplified two-dimensional representations evoke the same emotions or valuations as their full scale three-dimensional counterparts, and thus it is not possible to judge how relevant the results would be for real life design and planning purposes. Also, the situations studied are so special that the conclusions could hardly be generalised to other design and architectural problems.

Another type of study works directly with three-dimensional spatial set-ups, asking observers to assess their feelings and evaluations while being inside full size or model rooms of different coloration.[23, 24] For model studies, Billger has concluded that colours and colour combinations are perceived differently and evoke different emotional reactions if you (or at least your head!) are inside the model room, as compared to viewing it from outside through a hole. The results from real room studies may be considered to be highly reliable for the studied situation studied, but can be suspected of having limited value for other architectural situations, where connotations and expectations are different. There would certainly be cultural differences. For example, Hårleman found that her Swedish subjects had strong feelings regarding pink rooms and often associated them with feminine

values – positive or negative. This is, however, not universal, as can be noticed by the use of pink also for strictly male localities in other parts of the world. Also the design, form, size etc. of experimental room ands its materials would arouse certain emotions and associations that would be difficult to separate from those evoked by the colours.

## Conclusions

The discussion above shows that neither results from colour appearance studies nor those from colour emotion studies could be considered directly applicable in other situations than those of the study itself. As for the specific field of architecture, we might be forced to accept that results that are both precise and general are not possible. When studying complex situations we can gain understanding through finding tendencies and possibilities rather than exact data. A thorough analysis of existing architectural environments can, in addition, highlight problems, questions and patterns that have so far not been paid attention to, and provide the tools for better thinking and seeing.[25]

Although they cannot be easily compared and combined, the multitude of studies with different approaches and methodology provide understanding of an increasing number of cases, which will gradually make it possible to draw more generalised conclusions. Knowledge and understanding obtained this way is neither precise nor very reliable, but it can point out probable tendencies and, not least important, generate hypotheses for further research. Unorthodox discussions and comparisons between research from different disciplines could disclose unexpected concordance as well as deep discrepancy. One important gain could be to clarify where we agree and where we do not agree. To what extent are our seemingly contradictory results caused by different methods and concepts, and how could these be reconciled? We hope for a continuing cross-disciplinary discussion on these issues!

## References


AIC Proc 01 = *The 9th Congress of the International Colour Association, June 24-29 2001. SPIE vol 4421.*

AIC Proc 03 = *Proceedings of the 11th Congress of the International Colour Association, Bangkok, Thailand 2003*

AIC Proc 04 = *Color and Paints. Interim Meeting of the International Color Association,* Porto Alegre, Brazil, November 3-5, 2004. Internet: http://www.fadu.uba.ar/sitios/sicyt/color/aic2004.htm

AIC Proc 05 = J L Nieves and J Hernández-Andrés (ed): *AIC Colour 05. The 10:the congress of the International Colour Association. 8-13 May 2005, Granada, Spain*.


---

[1] Green-Armytage, P: 'The value of knowledge for colour design' *Color Research and Application* 2006; 4:253-269.

[2] Billger M: *Colour in enclosed space*. Chalmers University of Technology, Göteborg 1999.

[3] Hårleman M: 'Colour appearance in different compass orientations' *Nordic Journal of Architectural Research* 2001;2:41-48

[4] Fridell Anter K: What colour is the red house? Perceived colour of painted facades. KTH, Stockholm 2000.

[5] Publication CIE (International Commission on Illumination) 159:2004 A Colour Appearance Model for Colour Management Systems: CIECAM02

[6] Xiao, K., Luo, M. R., Li, C. J., Rhodes, P. A., and Taylor, C., Specifying the Colour Appearance of a Real Room, *The 11th Color Imaging Conference, IS&T and SID,* Scottsdale, Arizona, November, 2003 308-312.

[7] Xiao, K., Li, C., Luo, M. R., and Taylor, C., Colour Appearance for Dissimilar Sizes, *CGIV 2004*, Technology Centre AGIT, Aachen, Germany, 5-8 April, 2004, 12-16.

[8] Oberascher L. & Gallmetzer M: 'Colour and emotion' in *AIC Proc 03:* 370-74.

[9] Oberascher L , Oberascher F & Gallmetzer M: 'Colour and emotion: an intercultural approach' in *AIC Proc 05:* 213-216.

[10] da Pos, O & Valentini, S: 'Colouring the emotions' in *AIC Proc 05*: 263-266.

[11] Harrington, L & Lechner, A: 'Is Colour a Language?' in *AIC Proc 05*:. 267-270

[12] Hårleman M: 'Colour emotion in full scale rooms' in *AIC Proc 04:* 223-226.

[13] Sivik, Lars: 'Color systems for cognitive research', In: Hardin, C.L and Maffi L (ed), *Color categories in thought and language*, Cambridge University Press, 1997, pp.185-192

[14] Ou, L-C et al: 'The effect of culture on colour emotion and preference' in *AIC Proc 05*:259-262

[15] Sueeprasan S, Srimork P, Hansuebsai A, Sato T & Pungrassamee P: 'An investigation of Colour Emotions using Two-Colour Combinations' in *AIC Proc 05*: 271-274.

[16] Nobbs JH, Hyman M, Duncan J: 'Characterising the emotional response to colour in simple designs' *AIC Proc05*:255-258.

[17] Stahre B, Hårleman M, Billger M: 'Colour emotions in larger and smaller scale' in *AIC Proc 04*: 27-30.

[18] Janssens J: 'Facade colours not just a matter of personal taste' *Nordic Journal of Architectural Research* 2001; 2: 17-20
[19] Miyamato M: Study on visibility and evaluation of color combination of Braille pavers and sidewalk *AIC Proc05*:559-562.
[20] Ou L-C and Luo R. 'A colour harmony model for two-colour combinations'. *Color Res Appl* 2006;31:191-204
[21] Hård A and Sivik L. 'A theory of colors in combination - A descriptive model related to the NCS colour-order system.' *Color Res Appl* 2001;26:4-28
[22] Ishida T & Kawaguchi F: 'Color Composition of Cityscape and its Visual Impression' in *AIC Proc 05*: 397-400.
[23] Brengman, M & Geuens M: 'Assessing the Impact of Color in the Store Environment. An Environmental Psychology Approach' in *AIC Proc 05*: 551-554.
[24] Billger M: 'The experience of the painted room. The significance of light and colour combinations' *AIC Proc 04*: 219-222.
[25] Hårleman, M, Werner, I-B & Billger, M: 'Significance of colour on room character: A study on dominantly reddish and greenish colours in north- respectively south-facing rooms', In *Proceedings for Design & Emotion 2006, September 27-29, Chalmers University of Technology, Göteborg, Sweden, In print*
[26] Minah, G: 'Color constellations in the Seattle cityscape' in *AIC Proc 01*: 146-149.

# The Survival Of Cengâr As A Cultural Meaning

Ayşe Yıldıran
Istanbul Kültür University, Faculty of Art and Design
Istanbul, Turkey
Corresponding author: A.Yıldıran (a.yildiran@iku.edu.tr)

**Abstract**
A special local color, *cengâr (=Ιος*, *Ios* in Greek and *Verdigris* in English) as a reflection of the common cultures of Cyprus, The Green Island, owes its survival to its symbolic universe. The case study of a cultural model related to color will expose the background of this cultural perception. The meeting of this brilliant blue-green with *gök,* the astral blue and the mystical green in Turkish, is identified in the various aspects of the sacred. Even more surprisingly, vowing pieces of cloth in *cengâr* tied to saint tombs are like a memory reflecting the heritage of a distant past.

**Introduction**
*Cengâr* is an element of a language and dialect specific to Northern Cyprus, and is situated in the corpus of green. The importance of this beautiful bluish green, denoting the color of rust on copper, is in its linguistic and cultural survival. As a color field it has a multidimensional universe of significance in comparison to its equivalents *ios* (Greek) and *verdigris (*English) which both are absolete. Accordingly, the color term is a copper green, a green patina which is the rust of copper.[1] While *cengâr* in the dialect of Gaziantep means the green rust of copper,[2] old denominations *cengârî*[3] and *jengâri* [4] are defined as the green of rust of copper. *Cengâr* in the dialect of Cyprus is located in this color field with the verbal form relating to copperware and its similars.[5]

From the past to present the story of *cengâr* derives from the common cultures of Cyprus, legendary as a *green island* and a *green paradise*. The myth begins with the worship of a *Green Goddess*, Aphrodite, with 'green grass growing up her' … well-shaped 'feet' as said once upon a time by Hesiod. [6] And, in the verses sang by Euripides, she created there (in Cyprus) *'the paradise island'* to weave the soul-enchanting spell.[7] Besides being a self-contained realm, its wealth was legendary. Strabo in AD 23 mentions the extensive copper mines at Tamassos.[8] From this time on, the correspondence between copper and the planet Venus, which is also symbolized by the color green, is associated with Aphrodite[9] as well. Finally, it is also important to remember that Cyprus gives copper its name, probably deriving from *L. Cyprium (aes*), copper of Cyprus as *cuprum.*[10] In this framework it is possible to consider *ios* (Ιος χαλκου *Ios kalkon* = rust of copper)[11] in relation to the greens of Aphrodite and as one of the first representatives of the *ios/verdigris* theme.

All this seems to confirm the most common green of the palette proposed to the west as *viride Graecum,* a green of Greece.[12] The etymology of *verdigris* in English and in French *vert-de-gris* both seems to reflect this.[13] Another approach is the German word *spangrün*, connoting the Arabs who brought it to Europe via Spain. *Verdigris,* identical to *jengâri*, the Persian root of the Ottoman usage, is a collective term for copper acetates that range in color from green to blue. It is described as a moderately transparent bluish green with low stability. Various sorts of *verdigris* can be divided into basic or neutral.[14] In spite of its damages mentioned in literature, it was treated where there was a need for such a bright and intense blue green until the nineteenth century. And, figuring in all kinds of paintings, *verdigris/jengâri* could exist in panel and easel paintings, miniature and illuminations as *verdigris of the Occident* and *jengâri of the Orient.*

**Cyprus and the Symbolics of Green**
A radical change of the myth of the *green island* corresponds to the birth of Islam and the periods of Islamic invasion. The Islamic raids to Cyprus in the beginning of the 7th century have supported the legend of the conversion to Islam by a holy myth, *Cezire-t-ül Hadra.* This is the equivalent of the concept of *the green island* in Arab. Behind this holy substratum Mohammad and the concepts of the disciple and the martyrdom are reflected, all symbolized by the color green. The common point of all

these greens is that they belong to heaven. The legend begins with a dream of the prophet Mohammad where he has a vision of the first sea conqueror companions entering into heaven in the name of God. [15] But after this good news, the death of the sainted woman Umm Harâm (or Hala Sultan) who is the foster mother of the prophet heralds and forms the first martyr of Cyprus,[16] the source of the Cypriot Islamic identity. Cyprus or *cezire-t-ül hadra* is the land where the lady disciple who was on the way to paradise and eager to reach the promised paradise, enters paradise. Here, the element which transfers the astral paradise to the earthly paradise, is green. For the first time, green appears as a part and an expression of this sanctity. In this context, it will be more convenient to understand the expressions '*a very green island'* or *'paradise island'* as the concrete metaphors of this mystic content.

As seen in the verses *'Dürre-i zâtına Kıbrıs sadef olmaktandır - Anı Deryâ-yı Sefîd aldı âguşe tamam*', Cyprus is a mother-of-pearl and the holy martyr is the pearl of that shell with the Mediterranean embracing her. Here, the Mufti of Cyprus, Hilmi Efendi, has used Aphrodite's symbols in his poetry. [17] We then see that Hala Sultan who utilized the convergence between idolatry and Christianity to reinforce her power of sanctity by which miracles are worked turns the idea of paradise and green to a very new symbolics. Parallel to Aphrodite's stone, her sepulcher is enclosed by an antique trilithon which can be considered as an important echo of the belief of the female principle and the cult of the holy stone.[18] This stone, which is told to have been suspended in the air miraculously seems to be a metaphor of the Holy Cross of Christ that had been brought to a small chapel on the Trodos Mountain by Saint Helena and was raised and suspended without being attached nowhere. Indeed, because of Hala Sultan`s thaumaturgic powers she grows into an important cult of martyr and her humble shrine which is held in great veneration by her believers in time became a complex with a convent and a small mosque to which the Mohammedans perform pilgrimages.

At long last the appearance of *cengâr,* brought to the island by Turks, was in scene in the 16th century. Did it come only as an element of language or as a sign of a subtile color salience of textile art, or with *jengâri*, the same bluish green of the Ottoman tents? All is possible. In the history of color of the Turkish Cypriot community, the green represents these people and their religious identity. Particularly during the English reign, the green banner was more accepted than the national red flag that was forbidden for political motives. In this context its importance depends more on its rich concepts of color fields rather than communicating as a mere sign of identification. Green is the color of Mohammad, it also symbolizes his banner and the members of the family of the prophet, the 'seyyids'. In addition, the angels and the saints wear green[19]. The color of paradise[20] which is depicted having green furniture and green cushions[21] is attached to a representation of the *eternal garden* which is an *emerald green*[22]. At this point we should not be too surprised when the Türbe/Mausoleum which is connected to the series of mourning colors[23] like *'gök'-blue, violet, black* and *green* becomes denominated by an other color term "*türbe yeşili"* or the "*mausoleum-türbe green"*, the green of the tombs. When analyzing *cengâr* as a dialectal existence and a local color, and its position in a symbolic context, it should be evaluated in the framework of the *paradise green* and the *emerald green* that are determined by the context of the *Islamic green,* and with *türbe green,* which reflects religious, cultural and social aspects. But both the religious and the sacred, besides the syncretic and traditional ritual of *türbe*, are a practice peculiar to Cyprus. Being located in the interval of blue-green, *cengâr'*s position should be considered as a signifier that relies on the signified *gök*. The symbolic power of *cengâr* is original and unique and is born from the relationship between the manifestation of the hierophany of the sacred and the symbolics of *gök*. This is the most significant connection that will secure its survival as a religious culture as well as a subcultural element.

**A Cultural Model related to Color**

Today, *cengâr/verdigris* is a cultural perception which expresses itself visually in Cyprus. In spite of the burning sun, we can still see it as a color preference in the architectural context with its glamourous and powerful tones. This is considered as a sign of continuity of the past, yet *cengâr's* real significance comes from its survival with all its differences as a hue of its hyperonym, not because of its common features with other greens of Cyprus. Therefore *cengâr* as a permeability

between blue and green, seemingly represents the equivalency of *gök* and *yeşil,* the Turkish blue and green. Thus, it appears to unite the pre-Islamist status of the divine and holy blue of *gök*, Turkish *'*sky', with *green*, the symbolic color of Islam as seen on the inscription of Selimiye Mosque or Saint Sophia. In addition, veils in *cengâr* signal the saint tombs. Even more surprisingly, the *cengâr* cloth pieces tied on the tombs' window grills to make a wish are like a real memory reflecting the heritage of a distant past.

**Cengâr on Saint Sophia**

*Cengâr* creates a morphology specific to Cyprus in the official and the popular religion as reflected in the manifestation of the sacred on the most important monument of Cyprus, the inscription of Saint Sophia. It was placed in honor of Emperor Sultan Aziz's visit in 1874.[24] This historical representation symbolizes the cathedral-mosque, the country and the Moslem islanders. It has a certain quality that fits with the architectural image and exposes the aesthetic level of the people. The remarkable choice of color involves all common greens, one by one, that belong to the traditional understanding of various contexts as reflected in the use of more cold and bright tones next to dark and hot greens. But there is *cengâr* as well*,* and its presence here is in a dominant position. The relationship between *cengâr* and limestone presents itself to us as the most constant historical element to carry the local to the future. As an enduring sign of local harmony, it seems to be as perpetuel as is this cathedral that was converted to a mosque. It should be pointed out that the color *cengâr* obtains a special function and significance, not because it is manifesting the sacred directly, but because it captures it in this sacred space. In this way, apart from the function of the sign, the function of symbolism is realized by the choice of the most available nuance of green to indicate the divine. With the aid of this choice, it can be differentiated from its environment and continues to be sacred by the preferred eternal hierophany. The expression of the local sacred is completed through *cengâr* which is connected to the green of the universal modality of Islam in relation to the *paradise green* and the *emerald green.* On the other hand, the astral blue, *gök,* of the *Sky God* belief, the religion of ancient Turks before Islam, and its content of green and the equivalency of blue and green as *gök* and *yeşil* with Islam*,* which are the reflections of *cengâr* as the modality of this hierophany, reinforce more its symbolic power.

**Green and Cengâr on Fabric**

Another appearance of the worship of the martyrs that began with Hala Sultan is about the miracle-worker-warrior-saints who were martyred during the conquest of Nicosia in 1571.[25] The most important aspect here is the transferring of sanctity to ancestors by offering sacrifices to them such as candles, green scarfs or by tying fabric and by venerating to their shrines.[26] This ritual of sacrifice which originates from the ancient Turkic beliefs and shamanism before Islam, is a sign that old beliefs never die. In fact, tying vowing cloth and threads to the window bars when visiting holy places in hope for help is not permitted by the Islamic religion, but it became a tradition that was kept alive during centuries, [27] although to expect help directly from saints is also forbidden by Islam. But in spite of this former prohibition regarding visits to holy places, the recommendation of intercessions with holy persons is also referred to the prophet Mohammad.[28] People in Cyprus, too, still believe in the miracles of the *'savaşçı abdallar',* military saints, and still hope for help of the *'şehidas',* venerated martyrs of the heroic legends with their 'green turbans[29] and grey horses.[30] Very special to the island of Cyprus is the presence of the color green in the tied pieces of cloth, and, sometimes, *cengâr's* predominance among them. As these traditional practices of the popular religion are considered degenerated and non-conventional acts, the fabrics are removed from the holy places by the authorities from time to time, so that the proportion of *cengâr* varies from place to place.

**Cengâr as a Metonymy**

From the tombs that were removed in 1896 by the English and that seem to have been pressed into the wall of a corner of Police Street, a remaining holy place of a *şehida/*martyr represents the most interesting and typical sight of green and *cengâr* in Cyprus. This place, where a tomb rests, is the spot where a soldier was attacked and yielded up his soul in the conquest of Nicosia and on that very spot he was buried at once. According to a new inscription, it preserves the shrine of Mahmut Pasha [31] inside. The visitors can reach through a niche in the wall to put in their offerings and to connect with this holy place of devotion that apparently does not resemble a grave. Maybe for this reason it is

called *'adsız şehit türbesi'*, tomb with no name.[32] The remains of the burnt candles, the soot on the surface of the wall and, very close to the corner, the green and *cengâr* fabric tied to the electric mast and the traffic pillars are votive sacrifices designating this holy tomb. This can be interpreted as the union of the sanctities of the *cult of türbe* and the *cult of the tree*. The united sanctities are symbolized by the saint, the owner of the place, who embraces the sacred tree, which is a symbol of center. The centralist symbolism is connecting the sky and the earth and turns it to a hieronomy for the holy communication by using simple objects situated in the surrounding by chance that stand for a tree. In spite of the tied cloth and all kinds of covers and scarves, all considered perverse and frequently removed and cleared by normative religion, the practice of this syncretic ritual is repeated again and again perpetually and continues to survive with green and especially *cengâr.* This colored practice of the votive cults in Cyprus, *the green island,* is unique because it is related to color and because of the color preference of the sacramental offerings that are linked to the relationship between *green, cengâr* and *gök.* In spite of other greens, it is possible to claim that *cengâr* as a communicative color attracts attention and occasionally works as a metonymy taking 'the wish trees' completely under the influence of its own color. Thus the very privilege of the survival of *cengâr* distinguishes it from *ios* and *verdigris*.

**References and Notes**


1. Z. Tez, Anorganik Doğal ve Yapay Boya, Boyarmadde ve Boya Katkı Maddeleri Kılavuzu (Gazi Büro Kitabevi, Ankara, 1994). It can be proposed as Pantone 326C and RGB R=0, G=175, B=173.
2. Ö. A. Aksoy, Gaziantep Ağızları Sözlüğü II (İbrahim Horoz Bas., İstanbul,1945 -1946).
3. N. Sönmez, Yapı ve Malzeme Terimleri Sözlüğü (Yem Yayın, İstanbul, 1997).
4. Büyük Larousse Sözlük ve Ansiklopedisi (Milliyet Gaz. A.ş., İstanbul, 1992).
5. Türkiye'de Halk Ağzından Derleme Sözlüğü, TDK. (Ankara Ü.Bas., Ankara, 1993).
6. P. W. Wallace and A. G. Orphanides, Sources for the History of Cyprus Greek & Latin Texts to the Third Century A.D. Vol I (Iconos Press, Cyprus, 1990) 4.
7. P. W. Wallace and A. G. Orphanides, 17.
8. V. Tatton-Brown, Ancient Cyprus (British Museum, 1997) 6.
9. R. And R. Shepherd, 1000 Symbols (Times &Hudson, New York, 2002) 21, 343.
10. New Webster's Dictionary and Thesaurus of the English Language(Lexicon P. I., Danbury, Ct, 1993).
11. H. Kühn, 'Verdigris and copper resinate' in Studies in Conservation 15, (1970) 12.
12. F. Delamare and B. Guineau, Colour Making and Using Dyes and Pigments(Thames &Hudson, New York, 2000)145.
13. New Webster's Dictionary and Thesaurus of the English Language.
14. H. Kühn, 12-13.
15. H. M. Ateşin, Kıbrıs'ta İslami Kimlik Davası(Marifet Yay., İstanbul, 1996) 37.
16. H. M. Ateşin, 42; H. Fedai, Kıbrıs Tarihi Ziver Bey (KKTC Milli Eğitim Kültür.Bak.Y., Ankara, 1999) 46; M. H. Altan, Belgelerle Türk Vakıflar Tarihi(Kıbrıs Vakıflar İ.Y., 1986) 502-503.
17. H. Fedai, 'Kıbrıs müftüsü Hilmi Efendi'den Ümm-i Haram Şiiri' in İkinci Uluslararası Kıbrıs Araştırmaları Kongresi, DAÜ Kıbrıs Araştırmaları M., 1999, 359.
18. M.S. Bergil, Doğu Akdeniz'de Bir Uygarlık Gemisi(Galeri Kültür Y., Lefkoşa, 1997) 39.
19. A. Schimmel, İslamın Mistik Boyutları(Kabalcı Y., İstanbul, 1999) 367, 111.
20. R. Kılıç, Osmanlıda Seyyidler ve Şerifler(Kitap Y., İstanbul, 2005) 77.
21. S. Ateş, Kur'ân-ı Kerîm Tefsîri 3 & 6 (Milliyet, 1995) 18.31 & 36.21.
22. A. Schimmel, Tanrının Yeryüzündeki İşaretleri(Kabalcı Y., İstanbul, 2004) 38, 44, 23.
23. S. Bağcı, 'İslam toplumlarında matemi simgeleyen renkler: mavi, mor ve siyah' in Cimetieres et Traditions Funeraires dans le Monde Islamique II, Ed. J.L.Bacque-Grammont et A. Tibet(Türk Tarih Kurumu, Ankara, 1996) pp.163-168.
24. B. H. Hakeri, Kıbrıs Türk Ansiklopedisi II(A-N Graphics(Kıbrıs)Ltd, 1992) 315.
25. H.M.Gürkan, Dünkü ve Bugünkü Lefkoşa(Galeri Kültür Y., Lefkoşa, 1996) 113,114.
26. N. Beratlı, Kıbrıslı Türklerin Tarihi Vol II (Galeri Kültür Y., Lefkoşa, 1995) 174.
27. A. Gölpınarlı, Tasavvuftan Deyimler ve Atasözleri (İnkilap ve Aka K., İstanbul, 1977) pp 364-365, 10.
28. A. Schimmel, 2004, 81, 249.

29. N. Beratlı, Kıbrıslı Türklerin Tarihi Vol I (Galeri Kültür Y., Lefkoşa, 1995) 163.
30. N. Beratlı, Vol II 1995, 175.
31. T. Bağışkan, Kıbrıs Türk Halkbiliminde Ölüm (KKTC Milli Eğitim Kül.B..Y., Ankara, 1997) 296.
32. H. Hikmetağalar, Eski Lefkoşa'da Semtler ve Anılar(Marifet Yay., İstanbul, 1996) 282.

# Interaction of Colour and Culture - Environmental Colour Design 1900-2010: An Anthology on Colour

Verena M. SCHINDLER
Chair AIC Study Group on Environmental Color Design
vmschindler@yahoo.com

LAUNCHING A NEW PROJECT. This year at the AIC Interim Meeting in Johannesburg, South Africa, I will be launching a project which was already under discussion at the AIC Interim Meeting in Porto Alegre in 2004. It is entitled INTERACTION OF COLOUR AND CULTURE. Environmental Colour Design 1900-2010: An Anthology on Colour. The aim of the project is to publish an anthology containing a collection of texts on colour written by practitioners such as architects, landscape architects, colour consultants, artists, designers, cultural heritage commissioners, and lighting designers, as well as other professionals who have been directly involved in the conception, realization and application of colour in the environment and urban space.

The intention of the project is to show the diversity of approaches used worldwide in culturally, linguistically or geographically defined regions. Developed through the interaction of theory and practice, the aim will be to better understand the ways theory has an impact on practice, as well as the ways that specific principles in practice are generalized to form a body of theory. The project will also address traditional and changing notions of the local, regional, national or international meaning of colour.

Many key texts on colour remain unknown for a variety of reasons, e.g., they are unpublished or published in journals that are now out-of-print; or, they are simply difficult to access or have appeared in a fragmentary form in texts on the general theory of architecture, art and design.

Collecting and publishing these texts together will not only serve to validate individual efforts and achievements, but also put these in an historical context. This will serve the larger aim of promoting a deeper understanding of the relevance of colour in the overall design process of the twentieth and early twenty-first centuries. As a result, a basis for trans-national discussions concerning a cross-cultural appreciation of environmental colour design will be established.

CALL FOR CONTRIBUTIONS. Please send us any text on Environmental Colour Design in any language for our database. Include the name and address of the author(s). This is important for the copyright in case of its publication. As well, add your name, your first name(s), and your address so you can be contacted. And finally, add the bibliographical information so we know where the text has been already published. Please indicate clearly if it appeared once or several times and specify the language of each publication. Articles for the anthology will be selected from this database. Further details will be provided soon. In the meantime, please contact me if you have any questions about submission.

# Colour as Cultural Indicators During Ottoman Period

R.Küçükerdoğan(Asc.Prof.), B.Küçükerdoğan(Asc.Prof.), I.Zeybek(Ass.Prof.)
Communication Arts Departement, Art and Design Faculty, Istanbul Kültür University,
Atakoy, Istanbul (TURKEY)
Corresponding Author: R.Küçükerdoğan (r.kucukerdogan@iku.edu.tr)

**Abstract**

The colors are the most important factor to indicate dynasty's and empire's life style, culture, entertainment, attitudes, behaviours and beliefs. Within this context, it is an effective method to examine people's lifes, habits and expectations through colours as a symbols. In this case, it must be emphasized that the meaning of colors differ from place, culture and society. According to this, the colours are cultural products that are produced by the individuals' perceptions, in a period of time, for exemple during Ottoman period. This study, with semiotical method, includes researches about costumes, miniatures, flags, literature which were produced during the Ottoman Empire.

**Introduction**

The variety and richness of religion, language and culture in the Ottoman Empire is reflected to its structure, goverment policy and social life. In this context, as the subject is the Empire, naturally, we are confronted with the concept of polyphon; in otherwords "multi-culturalism". On the contrary to the strong central authority of the government, it is an important action to highlight the display of the polyphony being an action at the hierarchy out of the central authority. This action has a power on the formation of a cultural identity, meanwhile, time, it has a power to give rise to create hyperidentity. The characteristics of this upper- identity is reflected the polychromatic life at the Ottoman Empire. In the frame of Ottoman's life style it is possible to see the aesthetic point of view from architecture to weaving, and from rhetoric to literature in a wide perspective. Especially, polychrome can easily be perceive at the weaving art.

The examination approach of using colour at the Ottoman Empire can be discussed in two different ways, first one is the influence at the substrate and superstrate culture that sources goes back before the Ottoman Empire. The second one is the religious point of view which is inevitable for a cultural work that is related with Ottomans: the cultural situation before and after the Islam. Needless to say that the Ottoman were affected from the two periods, besides when we add the magnificient periods of the Ottomans we can see the richness of the symbolic reality on the cultural distance.

**Colours as a cultural element at the Turks and the Ottoman**

Colours in Turkish culture is explained according to "cosmology" and "mythology". Starting from cosmology, roots of the concept of colour lies down in the view point of Turk's to the universe. Turks are affected by the four direction principles of Chinese cosmology.[1] For Chinese the symbol of the north is "black", the symbol of the south is "red", the symbol of the east is "blue", the symbol of the west is "white". The colour of the earth and the center is "yellow" or "black". Other symbols that are associated with these colours are animals, stars, water, fire, tree metal, earth that indicates how colour is in close relationship with cosmology and mythology in reality. For example, the north is "black snake", the south is "red magpie", the east is "blue or green dragon" the west is "white panther" in the Uighur language. Huns and Gokturks perceive colour, that is defined according to directions, differently from Chinese. The north is black, the south is red, the east is gray, the west is white for Huns. However, the north is dark, the south is dark, the east is gray roan, the west is white at Gokturks.

**Black**

Generally, in all mythologies and cultures the colour black is associated with negative impressions: death, sorrow, destruction, spell, (wickedness badness),gods, kaos, devil etc. are expressed by black. In China, black symbolizes darkness which is related to "death" , "the north" , "the land", "the water". For Turks it is associated with:

- A place in "the north" (city, river, lake) for instance; Karakum desert, the capital city of Mongolia etc. And a community who lives at the north, for instance; Karahanlılar.
- To express power and excessive violence and annoying events such as death and moutning; e.g : Karahan the guardian of Islamic frontier ( the powerful emperor of the north); in Turkish "heavy

winter" meaning an excessively cold winter. The phrase "Kadır Kış" representing that "kadir" meaning "kara". In this context, the word "kara" when used for Turkish emperors and royalty, refers to "strong, powerful". When the word "kara" is placed before the name of a Turkish emirate, it carries a meaning of heroism and fairlessness.

- To express negative or worthless opposing to favour or in order to determine two different things without defining them as negative or positive.
- In order to express the common people (community).
- Black indicates greatness in Turkish culture.

In Islam the colour of the flag (banner, ensign) is black, one of the three colours that is used by the Prophet Muhammed (white, black, green). Later on, the colour "black" turns into the symbol of Abbaside flag.[2]

**Red**

In cosmology and mythology the colour red represents strong and deep feelings such as anger, violence, terror, passion/love and also has a dialectic meaning such as death/life and marriage/rituel. This concepts used by Turks cover similar meanings.[3]

- Red, the colour of sun, gods of war, and victory "red" is generally used with the concepts of fire, royalty, love, pleasure, bride, and marriage.
- In Ottoman Divan Literature,[4] because of the colour of wine, it symbolizes divine/spiritual supremacies, and secular / flesh (cosmologique) pleasure.
- Red was also equated with rose and the cheeks of beloved.
- Material and spiritual values find their great value with the colour of red.

- Since the beginning of early Turkish period, the usage of al bayrak has been assumed to have a close relationship with the protecting spirit.

- Heading towards kindness, which has a similar meaning with treatment is equated with the colour of red.
- Red which is the colour of government represents power. Red has spiritual value with its brightness, "kızıl" (le rouge vif), and defines nationalism.
- Red defines directions. For Turkish people, the colour of south is red.
- Red is the colour of death. It carries a meaning similar meaning to the honour of death. It is also a colour of life after death.
- The colour of Khans is red, in fact it is scarlet.
- For Turkish people, colour of ceremony especially the wedding is red.
- The colour of red / scarlet has also a negative meaning.
- The symbol of the world hegemony is red apple or red sphere in Turkish mythology. "Red Apple" which has an outsanding role in the whole Turkish Emperor symbolism is seen in the hand of the emperor in oil paintings.

**Blue**

Blue symbolizes visdom, common sense, loyalty, peace, and virtuous behaviour in the World Mythology. As blue is reconciled with sky and god, it also has a meaning of supremacy, eminence highness and inaccessibility. Also, as it is the colour of a reflection of the sky to water, sometimes it is also used as the colour of water. For Turks and Ottomans, the colour blue refers to[5]:

- The unity of negative and positive meanings. Although it has positive associations for Turks, in Ancient China that is the base of Turkish cosmology, blue has more negative meanings.
- The frequently used colour in architecture is blue. The cobalt mine which was derived from the south Caspian Sea make the colour turquoise appear. The colour of turquoise which is called with the name Turks, is used in the Middle Asia especially in the field of arcitecture during the reing of the Emperor Timur.

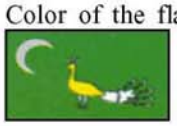
- In Turks, It is the symbol of God of Sky. The colour of blue is the symbol of The God of Sky, in the ancient Turkish texts it is the symbol of male wolf which is born from the light and coloured in blue.
- The description of the powerful Khan;
- Blue also symbolizes, funeral ceremony, mourn, sadness and pessimistic feelings. The texts written in Middle Asia support this kind of usage. In the Turkish miniature, mourn symbolizes purple, black, sometimes white and sometimes blue.

**Green**

In Turks and Ottamans, symbols related to green generally carry similar meanings with various cultures in the world. It refers to youth, hope, reincarnation and heaven, it is darker, there is a referral to death. Although, red is usually reconciled with the 'passion' in other culture, according to the records of Kasgarlı Mahmud, who lived in the 11th century, demured women wear red while graceful women prefer green. In Turkish mythology[6], the source of blue is the sky and the source of green is the nature. Green is the reminiscent of the tree and the forest. The origin of the word comes from the source of "wet" which means to appear.

- Just as the togetherness of the sky and earth opposition, green and blue reconciles each other. "Green Sky" is used as the sky in Tukish. In Turkish mythology[7] sometimes green is also used instead of blue.
- God of the nature: One of the seven sons of Ulgen, who is the God of the goodness, has the name "Green Emperor".
- Green which is generally reconciled with the empire and sovereignity is also used as the symbol of the religion, in the Islamic Religion it was used as a symbol of religion and belief.

Color of the flag: One of the colors of the banner in the Turkish army is green.



Also, the green headed wolf on the Gokturk flag, with a blue base also captures attention.

**Yellow**

As it is stated in various cultures, yellow is the color of sun in the Turkish culture.[8]

- The colour of Golden Yellow symbolizes the court of the country, the throne of the emperor, in other words it is used for the empire. This meaning comes from Chinese mythology. Yellow is accepted as the colour of Empire. This is the reason why to wear in yellow was forbidden in the community.
- According to the Shamanism which is the Eastern Principle, the colour of yellow symbolizes the center of the world.
- In Turks, apart from being the symbolism of center and emperor, the colour yellow also symbolizes the religious people.
- The name ALTIN ORDA was given to the Empire that had a power between the 13th and the 16th centuries in the Middle Asia, as golden (ALTIN) symbolizes empire. Yellow is usually related to golden which covers the meaning of "dominance" and "empire".
- In Turkish culture, golden yellow symbolizes power as in the case of the East, meanwhile, various tones of this colour symbolizes negativeness emotions. This is the reason why the colour is associated with fever, albastı and illness.
- During the Shamanism period, according to Turkish belief, bad devil red "Albastı" is opposed to "Sarı Albastı" or "Sarı Albıs" that symbolizes ghoul.

**White**

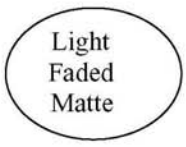
In cosmology and mythology, white represents pureness, cleanliness, calmess and peace. The colour of white is common in Turkish mythology and culture.

- As an effect of Shamanism, which is an old Turkish belief, the concept of GÖK TANRI (blue) is replaced by TANRI ÜLGEN which is qualified with the colour of white. During the genesis, ÜLGEN was inspired by "AK ANA". That's why, white is the symbol of the God of Sky and the God of Goodness. In the prays o Abakan Shamans, "the existense of Ak Ana" is often mentioned.
- In the Turkish cosmology, the symbol of west is white. White is also used for the naming in the related directions.
- White, in Turkish culture symbolizes cleanliness, purity and supremacy. It also carries a meaning of old age, experience and wisdom.
- It is the symbol of sublime, justice and power of the government.[9]
- After Islam in Turkish culture, the selection of white for the Emperor is related to martyrdom, as the colour of shroud is white.
- White horse is also a symbol in ancient Turks and Ottoman Emperors. Black symbolizes vassal, white symbolizes the nobleman.
- Depending on the positive meaning of white, "being a hoary noble" and defining the nobility of the soul, through this colour, uttering the nobility of the family (the mother and the father), the nobility of the marquee, the nobility of human and animal body and guns are oftently used in Turkish history.
- In the "AK ATA" legend from the Altay Turks, white symbolizes the father of man ADEM.

During the period of Ottoman Empire,colours that we analyse within the terms of poliphony is a determining and distictive communicational system.[10] At the same time,this system consisting of 3 different identities such as cultural ,semiotical and functional identity,provides forming of different semiosphers[11] through finding a living space.As an example, the status of people, usage of colours according to their position states the distinctiveness as a symbol and states whether they are residents of the palace or not.In spite of padishahs, sultans usage of bright,warm and dark colours, the usage of faded, pastel and light tone colours of residents outside the palace whose status is not top-level is a distinctive indicator of status and identity. If we consider especially golden yellow, because this colour was used by sultans during Ottoman period it points out that it has a cultural identity and because yellow symbolizes meanings such as power, dominance,centre and uniqueness it symbolizes semiotical identity;and the usage of this colour in different spaces and fields indicates that it has a functional identity.

**Palace**


**People outside Palace**




**Referances and Notes**

1. Y. Çoruhlu, Türk Kozmolojisinin Anahtarları (Kabalcı, İstanbul, 2002), pp.181-194.
2. F. Kurtoğlu, Türk Bayrağı ve Ayyıldız (TTK, Ankara, 1992), pp.21-22.
3. E. Esin, Türk Kozmolojisine Giriş ( Kabalcı, İstanbul, 2001), pp.25-26.
4. İ. Pala, Ansiklopedik Divan Şiiri Sözlüğü (Akçağ Basım, Ankara, 1995).
5. F. Devellioğlu, Osmanlıca- Türkçe Ansiklopedik Lugat ( Aydın, Ankara, 1982).
6. B. Ögel, Türk Mitolojisi II ( Milli Eğitim Bakanlığı, Ankara, 1994), pp.16-18.
7. B. Ögel, Türk Mitolojisi (Kaynakları ve Açıklamaları ile Destanlar) Vol. I (Türk Tarih Kurumu, Ankara, 1998), pp.133-137.
8. E. Esin, Orta Asya'dan Osmanlıya Türk Sanatında İkonografik Motifler ( Kabalcı, İstanbul, 2004), pp.60-61.
9. M. Pastoureau, Dictionnaire des couleurs de notre temps (Ed. Bonneton, Paris 1992).
10. J. Fontanille, Sémiotique du visible (PUF, Paris, 1995).
11. Y. Lotman, La Sémiosphère (Limoges, PULIM, 1999).

# Meaning of Colours for Ottoman Costumes

S. Gündeş (Prof.Dr. ), M.Oktug (Ass.Prof.), D.Ozden (Dr.)
Communication Design Department, Art and Design Faculty, Istanbul Kültür University,
Atakoy, Istanbul (TURKEY)
Corresponding Author: S.Gündeş (s.gundes@iku.edu.tr)

**Abstract**

There is no culture or society that has not used basic colors. Colors are like indicators that bring concepts, facts and beliefs to people's minds. Within this context, color, a symbol for many things, is an effective tool to affect and convince people. The perception of colors differ from one culture to another, just like the concept of language. During the Ottoman times, meanings given to colors reflect the Ottoman culture and life style. Also, during the Ottoman period, Islamic religion influenced the colors of objects, pictures and clothes as well as the other fields of arts. For example, costumes of sultans and the art of weaving that are typical for the various Ottoman periods are going to be analyzed by semiotical method here.

**Introduction**

The colours of Ottoman costumes are one of the most essential characteristic features of the life inside and outside of the Ottoman Palace. According to the hierarchical order in the palace, shapes and colours of the padishah(sultan)'s costumes are relatively different from the costumes of the other government officials.

The colours of the Ottoman identity became clear after cultural interferences. The real appereance of the dominant colours of Ottoman identity depends on the quality, pattern and handiwork of the fabric. The appereance of the fabric (costumes displayed) is illustrated with the characteristics in the written documents according to the conjectural changes in their semiotical reflections. After the 15$^{th}$ century, that can be defined as the transition period, during the 16th century, fabrics such as 'kemha (piled velvet or silk fabric)', 'seraser (weawings with golden or silver strings) telle dokunmuş fabric)', 'velvet', 'satin' can be described as 'Ottoman silk' were mostly used for the costumes of the Sultan. During this century, the dominant colour was red and red tones. 'Golden yellow', 'yellow', 'green' and 'blue' were also dominant. During the 16$^{th}$ century, with the frontiers expanding to the east, the Empire under Süleyman The Magnificient's rule had its golden age. Victories had an effect on the colours of the costumes. During the 16$^{th}$ century, bright and warm colours were mostly used. After the first half of the 16$^{th}$ century, by the effect of the caputulations and the geographical discoveries in the Ottoman society, color red (one of the dominant colours) was called as Claret red (purplish red) that can be defined as the colour of red wine under the influence of western civilization.

During the Pre-Islamic and Post-Islamic times, colour applications were distinctive elements in the State Government and it differentiated the ordinary people and the people in the Palace, muslim and non-muslems. It's illuminated with its'semiotic and iconic function. These colours were used by every living quarter in the society are also were used in the government, during the hierarchical ceremonies. (Death, funeral and mourning, accession; Friday salutation (Saluting the padishah on the way for the Friday prayer and back), hilat (costumes given by padishah to the certain person appointed to a certain duty). These translate different meanings in different periods of time and different spaces. Also, costumes of Padishah, prince (his son), lady sultan (his wife) and other residents in the palace had functional, semiotical, and esthetic appereance and they were the base of the culture of Ottoman colour.[1]

In this study, especially colourwise semantic field of these ceremonical costumes[2] are considered as the culturel values of the costumes within the ritual context is more evident.

**Death, Funeral and Mourning Rituals**

According to the examples taken from Topkapı Palace, the costumes that Sultans used during their predessesor's funeral and their own accession ritual were made of atlas and wool; they are mostly in black, purple and dark blue colour, these simple costumes were generally worn during funeral ceremonies. It's assumed that Ottomans believed in superstitions about colors like black and purple. According to this belief, in case of a big economic loss or terrible disaster, Turks don't wear black. While the colour purple indicates royalty, during the war it was also known as a symbol[3] for the news of death.

Byzantines used purple only by higher class and the usage of this colour by people outside the dynasty was banned. Sultans wore costumes in dark blue and green when their sons died. Also, colours like dark blue and brown seem to appear as dominant colours in funeral ceremonies.

**Acceptance(Ceremonny for Enthrone)**

During the acceptance(ceremony for enthrone) ceremonies, dark blue costumes were common. When these colours were used during the acceptance ceremony after the death of the sultans' fathers', the mourning process ended with a gird on a sword ceremony during which sultans preferred white. White is the lucky colour for Turks and it symbolizes that the mourning process is over.

The Shaman coifs, which have a spiritual meaning, are white. In the Ottomon Period the senior soldiers were given white horses and white clothes. During the ceremonies which were for the princes to be an adult, people from the court and the family used to choose colourful and joyful clothes while the prince put on white clothes.

When a padishah was going to war, he used to wear "kapaniçe" which was a dress without sleeves, its inside was sable or lynx fur and had a full collar. Dır-ı Postın, was a war dress made up of armor from the light chain and its was covered with silk textile. In the sources, Sultan Mehmet III is described as wearing a long yellow dress without an armor and also has a güvez kapaniçe which had a golden sun motif on it. He is also described as wearing baggy trousers which was covered by three dotted golden and silver called "çintemani" and also with striped motifs. While Sultan Mustafa II was going to Hungary for the expedition, he was described as wearing a thick jacket which was embroidered with pearls and had a fur astin on its breast. During a trip to Edirne for the wellcoming ceremony, he was described as wearing a sable kapaniçe covered by yellow seraser, embroidered with jewellery.[4]

**Friday Salutation**

Friday Salutation was important as it was a ceremony where everyone saw the padishah. In the Friday Salutation, Ottomon senior officers and government clerks were described as wearing dresses weaved with gold and silver and had big motifs on it which were seen from far away. In these ceremonies, kazaskers, who were the most senior officers of the legislative branch wore silk dresses. The type of the dresses changed according to the ceremonies. In these type of ceremonies woolen dresses were chosen while for their daily clothes single coloured dresses were selected. At Friday Salutation, padishahs were on their horses, used to have a big sarık on their head and caftans which had sun, moon and star motifs in single colour.

**Hilat Ceremony**

Hilats were a kind of protocol reward which had a meaning of honouring a person. It was similar to the ones in which medals were offered to the kings in Europe. The colour and the quality of hilat changed according to the position or the status of the person. The full equivalance of this word in Arabian is Honour Cloth Garment. For all important events, it was offered to the Turkish or the foreign people in all ranks. Most of the hilats worn by princes were made of white or silver seraser.

**Colours in Princes' and Lady Sultans' Clothes**

In the 16th century, satin, silk taffeta, and serenk were used in Prince's clothes. Red, yellow, creme, bright yellow, golden yellow were dominant in this period. In the 17th and 18th centuries varieties of fabric were increased. Iran fabric, şalaki, seraser, kutnu (cotton fabric), silk canfes, satin, indian cotton and seraseri, sevayi (silk fabric), selimiye (dedicated to padishah Selim the III), tepebaşı (name of the district in İstanbul) and sometimes kemha and silk.

**Nemika Sultan's portray in purple dress which means nobility in the Byzantine period.**

Babies' caftans were made of satin. Baby Princes's clothes were generally beige, yellow, grey, brown, pink, green, yellowish orange, white, bright yellow. Beige, green, grey, yellow, bright yellow, white, orange, and gold embrodery were oftenly used at child princes' clothes. In the 17th and 18th centuries main colours were; scarlet, yellow, green, golden yellow, light blue,and bright green.

**Mustafa IIIrds' garment called "şalaki" AC 1722**

Girls' clothes in the dynastic family were made of satin and embroidered with lace. These clothes were mostly beige. The same colour is also seen on a girl's dress in the Ottoman Period when western culture was effective. Its silk satin fabric is striking with its yellow wire embroidery and careful handlings. This dreess was worn on another dress which has laces at the bottom. There are also beige boots which have the same embroidery with the dress.[5]

**Celile Sultan's with princes' garment XIX AC**

**Public Garments**

In the 19th century, with the establishment of a fabric factory in Hereke, silk and satin were mass produced. For this reason, commons also wore the same type of fabrics which Ottoman Dynastic Family oftenly used and these types were not special for nobles anymore. The colour of these clothes were güvez, the colour of orange, golden yellow, red, green, white, dark beige, cotton pink, light pink, lilac, bright yellow, green, brown, and sometimes white. Especially, blue is often used for the satin fabrics. The clothes are covered with furs and embroidery like the dresses of the court.[6]

**Non-Moslems Clothes**

Clothing in the Ottoman seems as a fundamental factor for the community's label principles in other words, to protect the social class.The padishah firmans which were published to prevent their demonstating for the non-Moslems and to show the difference between Moslems and non-Moslems bring these boundaries.

**1.Colour:** The green colour which was sacred for Moslems was forbidden for Non-Moslem people. Moreover, the white colour was for the Moslems who used it for sarıks. For example the Jewish peoples' street clothes generally were dark colour or black. There were same boundaries for shoes. Moslems were wearing yellow, while Jews were wearing black.

**2.Cloth:** The clothes which Non-Moslem people used shouldn't be more luxier and high-quality than the ones belonging to Moslems. Besides, some cloth types were forbidden for Non-Moslems.

**3. Cutting with measurement:** The cloth length for turbans, the wideness of black gown (cassock) had to be suitable to certain measurements.[7]

Non-Moslems wanted cloth difference in the Ottoman Period. Thus, they were easily separated from other communities.They were carrying out some commands as follows; 'You won't be proud of the Kenan soil's habits where I brought you and from Egypt where you stay. Also, you won't carry out their customs'. Jewish men are distinguished from non-Jewish people only by the colour of their clothes' and caps. They were wearing a cap called boneta and kaveza which was like a cylinder. The bottom of the cap is surrounded with a colourful turban. Clothes of the men were tided up with wide belt and were completed with purple or dark colour gowns. When Jewish women went out, they didn't use to light colour ferace of the Moslem women, they generally used dark brown.

Indicators of the colour of the Ottoman culture differentiate according to time, space and people. This structure also determines the governmental hierarchy.

| Colour | Time/Space | People(s) | Indicator |
|---|---|---|---|
| Purple | Funeral - Mourning | Nobles | Death |
| | War | | |
| Dark Blue /Navy Blue | Culus (Acceptance – Ceremony for Enthrone) | Sultan's Son | Enthrone (Sultan) |
| | Funeral-Mourning | Nobles (Residance of the Palace) | Death |
| White | Culus (Acceptance–Ceremony for Enthrone) | Sultan | Gird on a sword |
| | War | | Good Luck |
| | A step to adulthood | A Sultan's Son | Adolescence |
| Green | Funeral-Mourning | Nobles (Residents of the Palace) | Death |
| | War | Sultan | Power of the Government |
| Brown | Funeral-Mourning | Nobles (Residents of the Palace) | Death |
| Black | Funeral-Mourning | Nobles (Residents of the Palace) | Death |
| Yellow | War | Sultan | Power of the Government |

In the Ottoman costumes; like the colour of the costume, the sort of the fabric also features the characteristics of the person and the time. The daily costume of Kazasker(soldier of high rank, civil service commander, man of letter) was made of wool and the ceremony costumes used during Friday Salutation was made up of silk. Sort of the fabric also determined the difference between the Moslems and the non-Moslems. Fabrics such as atlas, silk and kemha that Moslems wear were banned for non-Moslems. In addition to this, while fabric such as atlas, silk, şalaki (an imitation of shawl), seraser, canfes (bright coloured silk with no patterns), kemha and velvet used to be a symbol only for royalty at the 16-17$^{th}$ and the 18$^{th}$ century, with the changes of technology improving from hand weawing loom to serial production, the commons also began wearing this sort of fabrics. Consequently, at the 19$^{th}$ century, the contradiction between nobilty and public according to the usage of different sort of fabrics lost its clarity.

In the Ottoman culture, accessories such as fur and gold-silver handwork demonstrates that the costume belongs to padishah and his family, high rank of officers and government officials. In this context, handiwork and accessories symbolize power and royalty of the government. These indicators can be used to interpret the large patterns used in fabrics. The style of caps can be featured as accesorries differenciate between Moslems and non-Moslems. While Moslems put on sarık (piece of fabric that coils around the head), non-Moslems such as the Jews put on kaveza and boneta.

The features of colours depending on the tones, whether they are bright or faded functions as a distinctive element both among the hierarchial structure and in between the Moslems and the non-Moslems. Bright colours are the colours used by padishah's descendants of the Empire. It depicts royalty and power. Among the public, Moslems wear light coloured and Jews wear dark coloured ferace(ladies outdoor mantle). As a result, colours of Ottoman costumes were indicators of;

1- Multi-culturality in an Empire with a broad geographical frontiers.
2- The hierarchical order in the Empire
3- Time and space in the life of palace
4- Differantiation criterias between Residents of the Palace and the public
5- Religious beliefs.

We see that the term 'sub verbo'[8] is in relation to the term elocutio. Then, a color that has a peculiar syntax turns out to be an elocutio. In this study, we tried to search the syntax of colour in the Ottoman clothes.

In this context, colour in the Ottoman Empire forms the functional and cultural identity[9], according to the role inside of the society/government. Ottoman costumes also reflect aesthetic view of that time with the colours, sort of fabric and ornaments.With its broad geographical frontiers diffusing through three continents, and as an indicator of multiculturality and poliphony. Ottoman Empire reflected its richness not only to the costumes but to the whole lifestyle.The reflections from both the east and the west were mixed with its own culture.Starting from 20$^{th}$ century, western identity took place of the cultural identity. In another words, 'grey stepped in and polychrome died.'

**Referances and Notes**

1. L. Porcher, Introduction à une sémiotique des images (Didier, Crédif, Paris,1987).
2. N. Atasoy, W. B. Denny, L. W. Mackie, Hülya Tezcan, İpek Osmanlı Dokuma Sanatı (TEB, İstanbul, 2001).
3. M. Cazenave, Encyclopédie des symboles (La Pochtothèque, Paris, 1996).
4. M. Sözen, Şemsi Güner, Geleneksel Türk El Sanatları (Hürriyet, Istanbul, 1998), pp.192-208.
5. H. Tezcan, Osmanlı Sarayının Çocukları Şehzadeler ve Hanım Sultanların Yaşamları, Giysileri (Mas, İstanbul,2006).
6. Ö. Küçükerman, Türk Giyim Sanayinin Tarihi Kaynakları (GSD Dış Ticaret A.Ş., İstanbul, 1996), pp. 253-265.
7. Osmanlı Yahudi Kıyafetleri, http://www.osmanlimedeniyeti.com/Bilgi/Osmanlı%20Yahudi%20Kıyafetleri.
8. Groupe μ, Traité du signe visuel pour une rhétorique de l'image (Seuil, Paris, 1992), pp.16-17.
9. B. Cocula; C. Peyroutet, Sémantique de l'image (Libr.Delagrave, Paris, 1997).

# Colours and basic emotions

Osvaldo da Pos, Paul Green-Armytage*
Dipartimento di Psicologia Generale - Università di Padova
35131 - Padova (Italy) – osvaldo.dapos@unipd.it
*Curtin University of Technology, Perth, Australia – p.green-armytage@curtin.edu.au

**ABSTRACT**

We investigated whether the pairing of facial expressions of emotion with colours is consistent among different cultures, in particular between Australian and European people. Two groups, one of younger and the other of older people, participated in two experiments: For each of six faces, which expressed basic emotions, single colours and combinations of three colours were selected for the best visual 'fit' with the faces. The performance by the two age groups was identical. The colour and emotion bond was examined by ANOVA and Multi Dimensional Scaling in terms of the presence of the unique hues, their chromaticness, and their L*a*b* dimensions. The 6 emotions were compared with regard to the position of each colour in the CIELAB colour space, the warm/cold characteristics, and the contrast between the three colours of the triplets. The different emotions appear well characterised by the paired colours in a similar way with the European results by Oberascher & Gallmetzer, da Pos & Valentini, but also with some interesting difference.

## 1. INTRODUCTION

Emotions are complex states of mind which include physiological correlates, social roles and cognitive factors. Emotions give a person the energy for a reactive behaviour with the possibility of delaying and thus controlling the actual response (Ekman & Davidson[1]). Some emotions are considered basic (Ekman[2]) as they are not reducible to others, and their external manifestation plays an essential role in social adaptive interactions (Darwin[3]). Basic emotions seem to be fundamentally universal, and their external manifestation seems to be independent of culture and personal experience (Lane and Nadel[4]). For this reason they can be easily revealed and identified by facial expressions without the intervention of verbal language (Ekman & Friesen[5]).

A fundamental role of colours is to give the viewer information about the nature of objects. Among the perceivable characteristics of objects we can count their positive and negative values for the observer. There is increasing evidence that the link between emotions and colours is rooted in human biology and therefore it seems possible to describe some correspondence rules between them (Oberascher & Gallmetzer[6], da Pos & Valentini[7]). In this research we aimed at verifying that Australian and European observers associate colours with emotional expressions in a similar way.

## 2. EXPERIMENT A

In experiment A we studied which colours a selected group of people associate with faces showing specific emotions. A7 size colour samples of the Natural Colour System were placed on large tables for the use of the participants. To reduce the verbal influence in combining colour and emotion we used black and white pictures of faces chosen from a collection which Ekman & Frisen[5] selected as universal representatives of the main emotions. Each picture was reduced to the same size and inserted into ovals (8.5 x 5.3 cm), then printed on white paper and finally cut all around. Six basic emotions were studied: anger, surprise, disgust, sadness, happiness, and fear. Two groups of participants took part in the experiment: the first included 20 adults with long experience in the field of colours, while the second included 16 young students (about 20 - 25 years old) launched in colour studies. All participants were attending a workshop during the Tenth Biennial Conference of the Colour Society of Australia in Fremantle (2005, Western Australia). The task of the participants was to choose from the NCS collection colour samples which they considered fitting particular emotions and to paste the corresponding oval faces in the centre of the colour samples.

The NCS colour notations were transformed into the CIELAB colour space for an easier analysis of the data. First of all a statistical comparison performed by ANOVA showed no significant difference between the two groups of participants, which gave extremely similar results. Therefore their data were pooled for the following analyses. Fig. 1 shows the average lightness and chromaticity of the colours associated with the different emotions. As regards the lightness, there are distinct groups of emotions: happiness, surprise and fear combined with very light colours (L* > 63), sadness and disgust with colours of intermediate lightness (50 < L* < 60), and anger with rather dark colours (usually black and red).

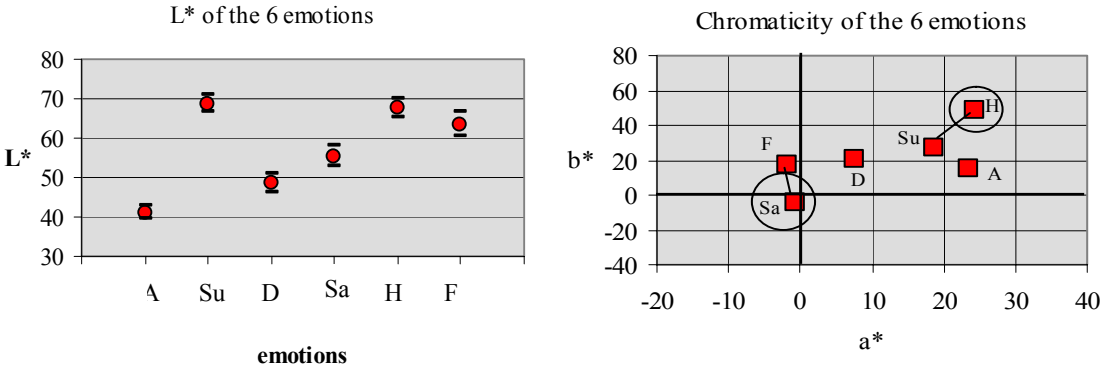



**Figure 1**. Mean lightness (L*) and chromaticity (a*, b*) of the colours associated with the different emotions. *A* = anger; *Su* = surprise; *D* = disgust; *Sa* = sadness; *H* = happiness; *F* = fear.

The colours relative to sadness and fear are very desaturated (close to 0,0), while happiness, surprise and anger are associated with highly chromatic colours. These results agree with the idea of considering 'active' these last three emotions and 'passive' the other three. Moreover most colours belong to the yellow-red quadrant, indicating that the 'active' emotions show a warm appearance. Fig. 2 shows the NCS colour attributes characterising the single emotions: surprise, sadness, and fear are quite whitish (and therefore desaturated) as noted before, anger shows strong blackness, in agreement with previous findings (Oberascher & Gallmetzer[6]), surprise and happiness show little blackness and are strongly orange, as found in most previous research.

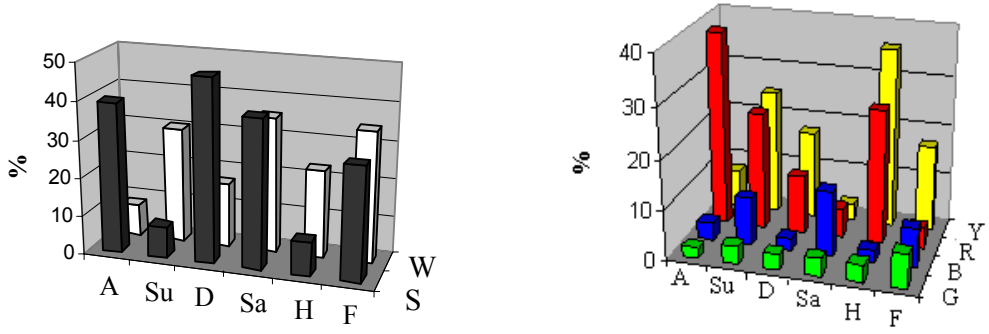



**Figure 2**. NCS attributes of the colours associated with the different emotion.

Fig. 3 shows the plot of a multidimensional scaling operated on the colour distances in the CIELAB space. As in a previous European research (da Pos & Valentini[7]) surprise and happiness are far from each other and from the other emotions. Anger, disgust and sadness are relatively close to each other, and fear apart (in that research a 3D space was better fitting the reciprocal colour relationships)

Fig. 4 compares the results of 2 European studies with this Australian research. Most emotions appear to share the same pattern of colour association, with few differences: anger is characterised by red in 3 and black in 2 studies, surprise by yellow and red in all 3 studies, happiness again by yellow and red in all 3 studies, sadness by achromatic colours in the 3 studies, fear by

achromatic and some red and blue (purple) and finally disgust appears a little more heterogeneous in the three studies.

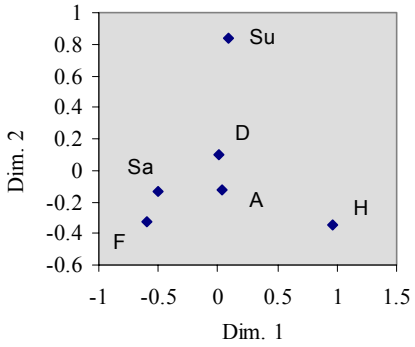



**Figure 3**. A 2D representation of the distances between the 6 emotions in a Proxscale multidimensional scaling plot. *A* = anger; *Su* = surprise; *D* = disgust; *Sa* = sadness; *H* = happiness; *F* = fear.

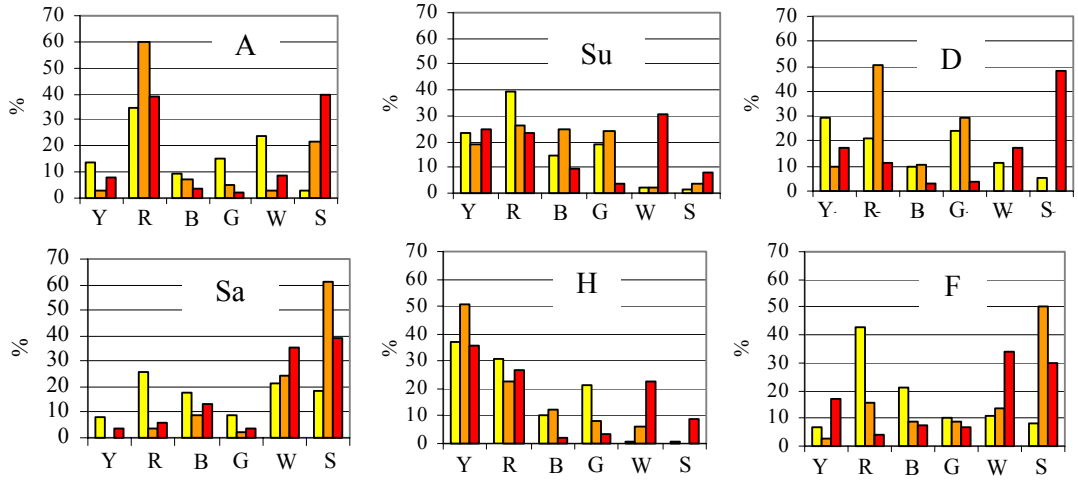



**Figure 4**. The unique colours characterising the 6 emotions in 2 European studies and in this Australian work. *Light yellow*: da Pos & Valentini[7]; *orange*: Oberascher & Gallmetzer[7]; *dark red*: da Pos & Green-Armytage. *A* = anger; *Su* = surprise; *D* = disgust; *Sa* = sadness; *H* = happiness; *F* = fear.

The three studies present remarkable similarities, all presenting rather warm colours (little blue and still less green). It seems therefore confirmed that the association of colours with emotions greatly depends on some universal, biological factors. Probably this result is largely due to the purely perceptual task which requires a minimum of verbal language; the larger variability of the first study by da Pos & Valentini[7] probably derives from the particular procedure by which observers could produce all the colours allowed in a computer monitor, but also in that case the results are very close to those of the other 2 studies.

## 2. EXPERIMENT B

In this experiment a group of 22 experienced persons and a second group of 20 less experienced students associated three colours with each of the faces described above. They used paper samples (2.1 x 2.2 cm) extracted from the whole set of 210 colours of Paul Green-Armytage's Colour Zones System and glued three colour squares, side by side, on a sheet of card to produce a colour impression that best fit the face. Then, in a follow-up task, the three-colour combinations were collected and given to other participants whose task was to decide which face best fit each colour combination.

The original colour notations were transformed into the CIELAB system by a visual procedure carried out by comparing the original sample with a complete collection of the RAL colour system. As in the previous experiment the 2 groups of observers produced almost identical results,

which were then pooled for the following analyses. Each three-colour combination was treated as a triangle in CIELAB colour space, whose centres are shown in Fig. 5.

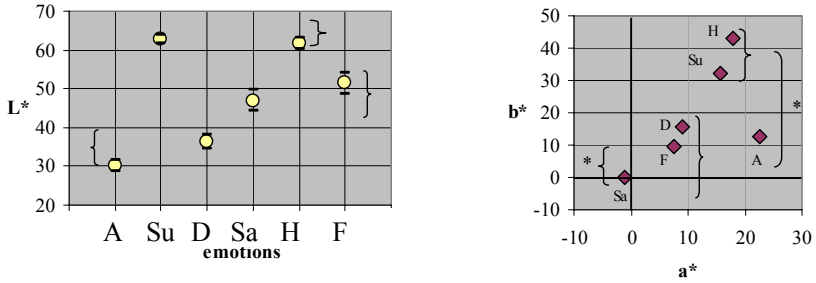



**Figure 5.** Lightness and chromaticity of the centres of the combinations for each emotion.

Three groups of emotions are well separated by the lightness of the combinations: surprise and happiness are the lightest; anger and disgust are the darkest; sadness and fear are intermediate. The chromaticity of the combinations is quite similar to that of Experiment A: happiness and surprise appear very saturated, yellowish and reddish; anger quite red; sadness and fear almost desaturated.

**Figure 6**. Distance of the three colours from their centre. Larger distances mean that the 3 colours are quite different from each other. Shorter distances indicates more similar colours.

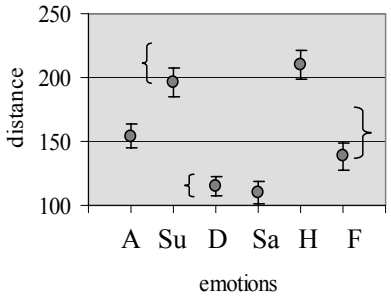



Fig. 6 shows the colour contrast inside the triangles for each emotion: surprise and happiness show highly contrasting colours, disgust and sadness the lowest ones.

Lastly, in 125 cases participants attributed the original face to the colour triplet made by another participant, in 61 cases the chosen face was expressing a close emotion, while in 68 cases the emotional expression of the faces was rather far from the original.

## 4. CONCLUSIONS

The two groups who took part in this experiment agreed closely in producing colour associations with facial emotions and, despite different procedures and different sets of coloured papers, they also agreed with participants in previous European studies. The results seem to confirm a strong concordance among humans in perceiving emotional expressions, colours and their relationships, probably on the basis of biological universal roots.

## References

1 P. Ekman and R.J. Davidson, "The nature of emotion. Fundamental questions." (Oxford University Press. New York, Oxford. 1994)

2 P.Ekman, "An argument for basic emotions." Cognition and Emotion, **6**, 169-200 (1992)

3 C. Darwin "The expression of emotions in man and animals". (University of Chicago Press. Chicago. 1965-1872).

4. R.D. Lane and L. Nadel (Eds.), "Cognitive neuroscience of emotion." (Oxford University Press. New York, Oxford. 2000)

5 P. Ekman and W.V. Friesen, "Manual for Facial Action Coding System." (Palo Alto: Consulting Psychologists Press. 1978)

6 L. Oberascher and M. Gallmetzer, "Colour and Emotion", In Proceedings of AIC 2003 Bangkok: Colour Communication and Management. (The Colour Group of Thailand, Bangkok) 370-374 (2003)

7 O. Da Pos, S. Valentini, "Colouring the emotions." In: AIC Colour 05, Proceedings of the 10th AIC Congress, Sociedad Española de Optica, Granada, 263-266 (2005)

# A Ten-years Follow-up Study of Psychological Influences from the Disastrous Earthquake: Color Images and Earthquake Experiences

Haruyo Ohno  Yoshie Nakano
Otemae University, Hyogo, Japan
Faculty of Socio-cultural Studies, Otemae University
2-2-2, Inano, Itami, Hyogo, 664-0861 Japan
Correspondence：H.Ohno (ohnoh@otemae.ac.jp)

## *ABSTRACT*

This is a study on the Hanshin–Awaji earthquake and focuses on, due to the passage of time, two perspectives; 1) psychological change in victims, and 2) the change of color Images from earthquake experiences. This research has adopted a retrospective method to collect data. In the first research, concerning the color images of the earthquake, the victims reported achromatic colors (black, white and gray). Ten years or more has passed after the earthquake by now.  However, people still express emotional feelings which are quite similar to those expressed during the phase of 6 months after the earthquake.

Keyword; earthquake, color images, retrospective method, psychological change in victims

### 1. Introduction

In the early morning on January 17 in 1995, Japan experienced the Hanshin – Awaji earthquake, which was one of the most disastrous incidents in its history. The estimated seismic intensity was more than a level 7th degree and ten years or more has passed since then. The disastrous experiences of a huge earthquake on people were unfathomable.

This study is concerned with the relations between the color image perceived by the victims and emotional state when people were in the midst of the earthquake. In fact, this kind of study is seldom found in past literature. Another aim of this study would be to look at the perceptual change in color images after the earthquake. Moreover, it is important to explain the relationship between color images in the fearful experiences, people's color preference, and the continuity of color images of the earthquake after 10 years.

### 2. Summary of the research

This research has adopted a retrospective method to collect data. The researchers constructed self-administered questionnaires. Questionnaires included ratings, yes-no questions, and brief descriptive items on various dimensions of the earthquake experiences. To take their situation into consideration, it is beneficial perceptual data on record, such as people's emotional state, levels of housing destruction, levels of damage on the public utilities (electricity, water, gas, and telephone) and color images of shaking as an individual experienced.

The subjects were asked to use color words to describe how they felt while they experienced the earthquake. Those color words are composed of three achromatic colors and 10 chromatic colors. The former colors are white, gray and black, and the latter colors are red, yellow-red, yellow, yellow-green, green, blue-green, blue, purple-blue, purple and red-purple. Each question is the same as in the first questionnaires conducted ten years ago□□. However, the questions concerning color images are newly added item to the first one.

Subjects are students from one university in Hyogo, Japan. Most students, whose houses were located in the disastrous areas, were hit by the earthquake. They had experienced one of the most disastrous incidents in its history. We obtained 279 responses, (156 males, 122 females and one unknown) with an average age of 19.6 years old (range: 18 to 25).

Questionnaires were delivered to the participants in the lecture rooms from January 13 to 20, 2005. The interior of each room was finished in achromatic colors and the windows covered with lightproof curtains, while the average illuminance on the desks was approximately 500 lx. Target date was intended for commemoration of the 10th anniversary of the disastrous earthquake.

## 3. Results and Discussions

### 1) Living environment on earthquake

People were in trouble since the utilities to support the everyday life such as gas, water, and phone systems were destroyed by the earthquake. There are so-called "lifelines". In many cases, the greater damages on houses and properties, the more malfunctions on the lifelines.

The most inconvenient incident was lack of water. The reasons of inconvenience were toilet problems, meal problems, bath/shower problems, and so on. Needless to say, it is natural to have such reasons because these represent the basics of our every day life. Concerning the usefulness of information, people could obtain some information about what was going on out there. Under the disastrous earthquake, most people considered that the earthquake was fearful.

### 2) Psychological Influences from the disastrous earthquake after ten years

Now more than ten years have passed after the earthquake. This study would be to look at the perceptual change in color images after the earthquake. Additionally, it is important to explain the relationship between color images in the fearful experiences, people's color preference, and the continuity of color images of the earthquake after 10 years.

Our first study had led three general hypotheses. First, because of a great deal of fear by the earthquake, it was hypothesized that the victims would indicate dark color such as black and gray, as the color image of the earthquake. Second, It was expected, as the time would pass by, the victims would show the change of the psychological state, like gradual transformation from great fear to anxiety and from anxiety to relief. Then as the third hypothesis, considering of the emotional changes in victims with the lapse of 10 years, we researched that the color images of each psychological experience from the disastrous earthquake by using the first questionnaires.

### 3) The image of color after the earthquake occurred

In the questionnaires, subjects were asked to answer what colors these experiences brought to their minds. The emotional state was inquired at seven different phases of time when/after the earthquake occurred: 1) the color images of their emotions when the earthquake just occurred, 2) the color images of the emotions during the earthquake, 3) the color images of the emotions when the earthquake just stopped, 4)the color images of the emotions a week after the earthquake, 5) the color images of the emotions 3 months after the earthquake, 6) the color images of the emotions 6 months after the earthquake, 7) the color images of the emotions one year after the earthquake, and 8) the color images of the emotions ten years after the earthquake. Most people reported that they experienced great fear when the earthquake occurred and while the earthquake continued.

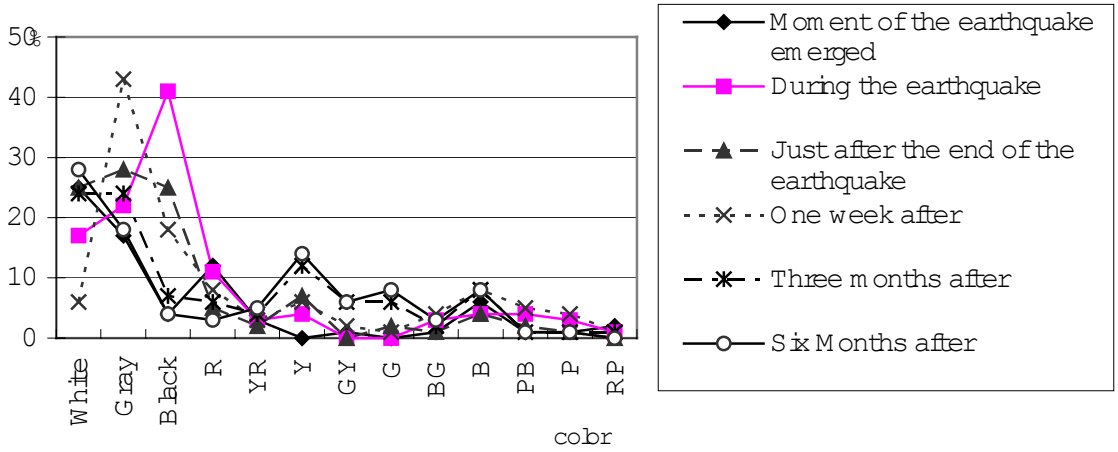



*Fig.1 Change of color images after the earthquake*

Fig. shows the evaluation results of color words obtained from the emotional state at the eight different phases of the time when/after the earthquake occurred. For the emotional state when the

earthquake just occurred, over 31□ of subjects answered for black, over 23□ for white and about 20% for gray. The black color means darkness and silence. At the immediate occurrence of the earthquake, they had lost their voice because they were terribly shocked by the great fear. So the victims were overwhelmed by invisible nature-power with the color image of black.

The color image of gray means anxiety. The emotional state when the earthquake just occurred was filled with anxiety, confusion, surprise and uneasiness. Alternately, the color image of white means blank, empty, insignificant and mysterious. When the color image of white combined with black, it means separation-anxiety. The emotional state represents both anxiety and fear due to separation or deprivation from something attached to (familiar to) victims' daily life.

Fig.2 shows the change of color images with the lapse of the time. At these three phases, 1)when the earthquake just occurred, 2) during the earthquake, and 3) when the earthquake just stopped, most people represented that the color images were black, gray and white. These results are same to those of 10 years after. Fear produced black and gray in the victims' mind. What amazed us was that a large number of people expressed the color image of white through this horrible experience. Then the time has passed by, the victims' emotional state had changed and the color images were quite different. In Fig.2, green and blue were eminent.

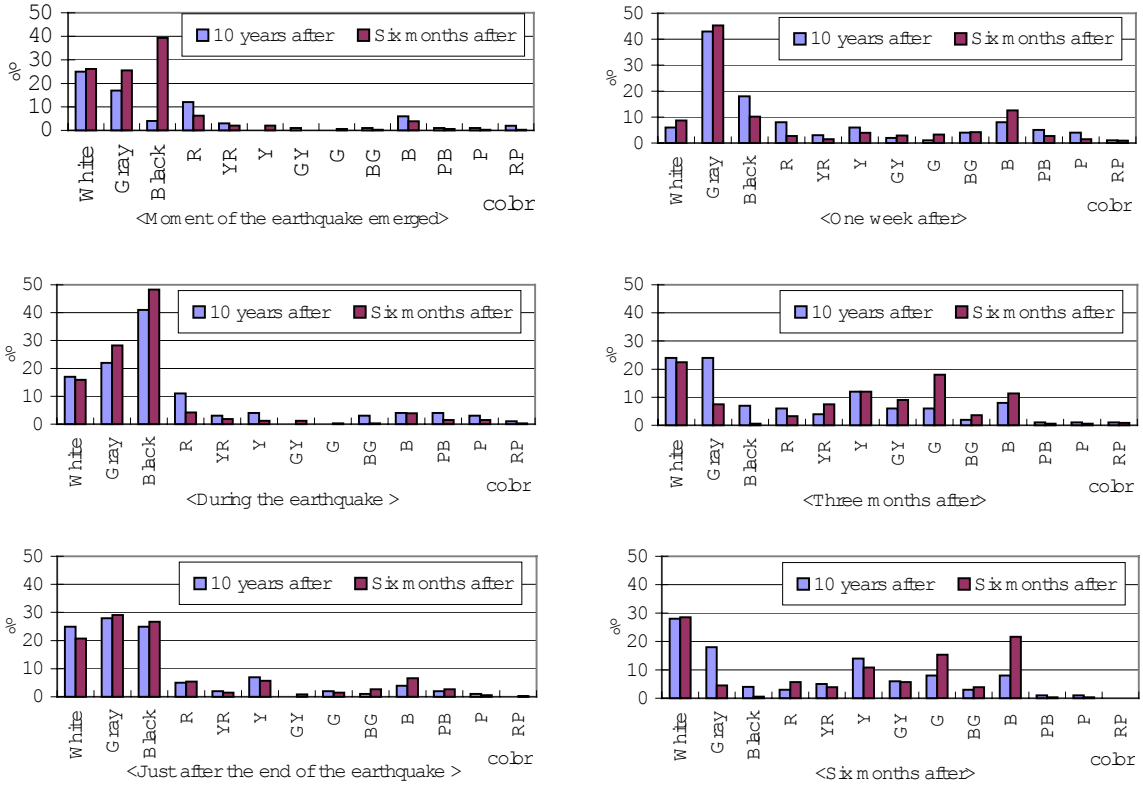



*Fig.2 Perceptual change of color images with lapse of time after the earthquake*

## 4. Conclusions

It is believed that the perception of color is influenced by cultural context. Our investigation also has shown the environmental and experimental effects on color images. In this study, the experimental dimension was the actual earthquake. The environmental dimension was the seasonal changes and the tangible circumstances. More importantly, the change of psychological state at each phase of recovery from the disaster will bring about the change of color image in people.

By now, ten years or more has passed after the earthquake. However, people still express emotional feelings which were quite similar to those during the phase of six months after the earthquake.

**ACKNOWLEDGMENTS**

The authors express gratitude to the students at Otemae University, especially to Ms. Hitomi Uemura, a student graduated from Otemae University in March 2006.

.

## References

1)H. Ohno & Y. Nakano: A Study of the Color image and the Earthquake Experience in Kobe, Japan, Color and Psychology conference AIC interim meeting 96 , June 1996, Goteborg, Sweden.

2) Bruner, J.S.: Acts of Meaning, Harvard University Press, 1990.

# A Semiotic Approach To Colour

Lars Lundgren
Södertörn University College, Stockholm
Södertörns högskola, SE-141 89 Huddinge (SWEDEN)
E-mail: <lars@oliv.se>

**Abstract**
This paper underlines the common method of classification and system-building used by researchers on colour and semioticians. The 17th century colour circles and atlases are the points of departure of this exposition. The philosopher Locke is the originator of the word semiotics. He also outlines the task of the semiotic science. Modern semiotics starts with Saussure and Peirce. The paper gives an account of Barthes' two orders of visual signification, termed denotation and connotation, and especially of his attention to colour. Approaching Goodman's theory of symbols the paper registers the American philosopher's interest in metaphor and in related systems. A few homonyms are discussed from a pictorial point of view, and so are warm and cold colours. The paper ends with the question whether Goodman's distinctions between metaphorical and literal denotation may be a contribution to the discernment of the separate and the combined qualities of colour.

**Background**
An obvious similarity between colour research and semiotics is the interest in classification; the use of systems, structures and schemes. This is a basic and fundamental methodology of both fields.

Ever since the 17th century colour theorists have depicted colours in bodies, circles, schematas and atlases. Two of the pioneers are in fact Scandinavian. The Swedish astronomer **Sigfrid Aron Forsius** is the constructor of the first known colour circle, generally interpreted as a globe. His manuscript is from 1611 (and thereby he precedes the famous colour circle from Newton's *Opticks*, published in 1704, by almost a whole century). – And **Elias Brenner**, a Finnish-Swedish painter and printmaker, published the first colour atlas in 1680, containing 31 colour samples named in Latin, French and Swedish.

The originally Greek word *semiotics* is derived from the English philosopher **John Locke's** *Essay concerning human understanding,* published just a decade after Brenner's colour atlas. In the very last chapter (ch. XXI) of his chief work Locke outlines a three-part division of science. The first is Physica, a theoretical science seeking speculative truth. The second is Practica, an ethical science for the attainment of a good and useful conduct. The third science is Semeiotica or "the doctrine of signs", also named logic whereby we consider the nature of signs. Locke explains the latest category as the instrumental part of the sciences, in contrast to the other two divisions. One assumes that Locke has in view a set of tools used in performing an action for the scientific work.

On the side of his semiotic plan, Locke in his *Essay* lays the basis of an empirical view of colour. He launches a theory of primary and secondary qualities. Primary qualities, he says, such as solidity, figure, extension and motion, are inseparable from bodies. Secondary qualities, on the other hand, are only percipient, that is, perceived by man. Without the eye there would be no colours. Just as without the ear there would be no sounds.

**Modern semiotics**
Two hundred years later, modern semiotics is simultaneously and independently founded on both sides of the Atlantic. In the United States the philosopher and logician **Charles Sanders Peirce** picks up the term "semiotics" from Locke. Semiotics is for Peirce the "formal doctrine of signs". And he writes even more frankly: "Logic, in its general sense, is, as I beleive I have shown, only another name for semiotics." [Peirce, p. 4]

In Europe at the same time the Swiss linguist **Ferdinand de Saussure** uses the term *sémiologie* in his influential *Cours de linguistique générale.* He writes:

> It is … possible to conceive of a science *which studies the role of signs as part of social life*. It would form part of social psychology, and hence of general psychology. We shall call it *semiology* (from the Greek *sémeîon*, 'sign').[quoted from Chandler, p. 5]

The semiotic or scientific programmes of Locke, Peirce and Saussure have indeed a striking likeness. But this philosophical – or linguistic – origin is only one side of the essence of colour. First and foremost we look upon colour as a visual phenomenon, and that includes a pictorial aspect.

**Barthe's concept of visual semiotics**

Visual semiotics was first introduced in the article *Rhetoric of the image (Rhétorique de l'image)* written by the French structuralist **Roland Barthes** and published in 1964**.** In his text Barthes analyses a poster advertising the brand of Panzani's Italian pasta [fig. 1]. Barthes to some extent establishes a semiotic vocabulary for the interpretation of images in this study of the advertisement's messages. He does not miss to draw attention towards the signs of colour in the picture. He writes that the image provides a series of discontinuous signs. A first sign in this matter represents the return from the market with fresh products in the used string bag. "A second sign is more or less equally evident", Barthes writes (and please note in the following quotation the semiotic key words as well as their linguistic origin); therefore the second sign's

> signifier is the bringing together of the tomato, the pepper and the tricoloured hues (yellow, red, green) of the poster; its signified is Italy or rather *Italianicity*. This sign stands in a relation of redundancy with the connoted sign of the linguistic message (the Italian assonance of the name *Panzani*) [p. 34].

Alas, right from the beginning the semiotic language is rather specialized. Barthes proceeds from Saussure's tradition of semiology. Saussure's model of the sign consists of two parts: the signifier and the signified. Consequently the linguistic sign links a sound pattern (the signifier) to a concept (the signified). In Barthes' study of the photograph a pictorial pattern saturated with information connots an abundance of cultural associations. And all of them, from the carefully chosen victuals to the tricoloured ensign, connect with Italy.

We may notice that Barthes in his essay makes use of the terms denotation and connotation (actually picked up from the Scandinavian 20th century linguist **Louis Hjelmslev**, founder of the Copenhagen school of linguistics). The first term (denotation) refers to the "basic sense" or literal meaning of the sign. Barthes also talks about the first order of signification. The second term (connotation) refers to socio-cultural and personal meanings awoken by the picture or the text examined. This is Barthes' second order of signification.

This is a short explication of a colourful portion of Barthes' *Rhetoric of the Image*, which in some respects is the core of this influential but still rather obscure text. In his last book *Camera Lucida: Reflections on Photography* (1980), Barthes returns to the photographic image. This time he analyses, in a more lyrical and less theoretical way, a number of classical black and white photographs. He transforms his (or Saussure's or Hjelmslev's) bipolar model into the neologisms of *Studium* and *Punctum*. Barthes' Studium is what is understood according to the individual viewer's culture and interests. Punctum is "that accident which pricks me" (p. 24); the disturbance that punctuates the anticipated conception or picture of the world.

But what happenend to Roland Barthes' attentive observance to colour? In regard of the theme of this meeting – *Colour in Culture and Colour in Fashion* – it might be appropriate at least to mention his most elaborated semiotic research, *The Fashion System* (1967). In this detailed and systematic study of the modes and codes of fashion, colour is surprisingly absent. Certainly, Barthes refers to a few expressions from selected fashion advertisements, used as mottos to the chapters of his book (e.g. "Every woman will shorten her skirt to just above the knee, wear pastel checks, and walk in two-tone pumps.", p. 263). But above all Barthes' *Fashion system* is a reminder that fashion is much more than the seasonal colours.

**Goodman's attitude**

In the absence of further colour observations by Barthes we may turn towards the American philosopher **Nelson Goodman**. As a contemporary of Barthes he draws up "an approach to a theory of symbols", to cite the subtitle of his book *Languages of Art* (1968). This work contains a semiotic theory of aesthetic knowledge, including clarifying distinctions concerning colour.

We are taken back to systematics and classification, the usual features of colour researchers – and of semioticians. Peirce, the semiotic pioneer and also pragmatist philosopher, is hardly mentioned in *Languages of Art* but nevertheless one can recognize a certain American pragmatism in Goodman's handling of labels and samples.

Metaphor – the literary figure, the trope of resemblance – is an essential part of Goodman's theory. One of his definitions of metaphor, taken from *Languages of Art,* runs as follows: "Briefly, a metaphor is an affair between a predicate with a past and an object that yields while protesting." [p. 69].

In a chapter dealing with the everlasting semiotic notion of reference, in his book *Of Minds and Other Matters* (1984), Goodman writes:

> Metaphor arises by transferring a schema of labels for sorting a given realm to the sorting of another realm (or the same realm in a different way) under the guidance or influence or suggestion of the earlier sorting. The new sorting echoes the old and is genuine, as 'factual', but is different. [p. 61]

We notice immediately that Goodman does not show interest in any bipolar or dyadic structure, so important in the European semiotic tradition. In exchange of the order of connotations he launches an aesthetic attitude of action. The following program is stated in the final chapter in *Languages of Art*:

> It involves making delicate discriminations and discerning subtle relationships, identifying symbol systems and characters within these systems and what these characters denote and exemplify, interpreting works and reorganizing the world in terms of works and works in terms of the world. [p. 241]

**Goodman on colour**

We are now, hopefully, furnished with at least a minor set of conceptual tools for investigating Goodman's visual clarifications.

This is one of Goodman's examples from the pictorial domain: "Before me is a picture of trees and cliffs by the sea, painted in dull grays, and expressing great sadness." And he concludes:

> A picture literally possesses a gray color, really belongs to a class of gray things; but only metaphorically does it possess sadness or belong to the class of things that feel sad. [p. 50f]

The colour of the picture is a fact, but the sadness is a figure. Accordingly, a concept is transferred by a metaphor from a certain field to a new province. The new sorting has a resemblance to the old one but is incompatible.

Let us now observe how Goodman deals with a *blue* picture, in which the literal and metaphorical applications are closer, almost convergent. In English we use idiomatic expressions like "things are looking blue" and "feeling the blues" for conditions of gloominess and melancholy. In jazz music and the blues (hear! hear!) we are listening to the blue notes in the minor key. Blue has also a literal application to pictures. Goodman writes that "the metaphorical and literal applications are to the same territory" [p. 83], and in a clear way he states his position:

> What has happened here is transfer from realm to realm and back again. A schema of color-predicates is carried first over to feelings and than back to colored objects. Its travels result in some displacement on its return (otherwise we shouldn't even know it had been away); but the displacement is far from total: a metaphorically blue picture is more likely to be literally blue than literally red. [ibid.]

Goodman does not develop on the rationality that a picture mediating blue feelings also is painted in blue colours. After **Picasso's** Blue Period (1901–04) [fig. 2] – which ended in numerous exclusively bluish paintings of beggars, outcasts and poor circus performers, suffering poverty and sadness – we are likely to agree with the philosopher: It is plausible that a metaphorically blue picture is literally blue. He may also have thought of the commonly used expressions warm and cold colours. Ever since **Goethe's** *Theory of Colours,* two hundred years ago, the colour red is generally associated with vivacity, agility and aspiration. Blue, on the other hand, designates worry, weakness and longing for nothingness. From this dichotomy originate the positive warm colours expressing warm feelings and the negative cold colours expressing downhearted feelings of chill, to give a simplified picture of this symbolic use of a pair of primary colours.

This way of seeing – or feeling – colours indeed plays an important role in our lives. Today we have incorporated this outlook in our way of worldmaking. The Danish architect **Steen Eiler Rasmussen** observes in his much used book *Experiencing Architecture* (1959, the quote is from the 27th English printing forty years later) that "in the early morning, you not only *feel* that the air is cold but you imagine that you can *see* it" [p. 221]. A long day's journey later you "*feel* the warmth of the evening sun and you *see* its warm light" [p. 222]. Goodman's explanation is of similar character: "warm colors are those of fire, cold colors those of ice" [*Languages of Art*, p. 76]. It is worth noticing that both theoreticians make their determinations ten and twenty years after **Matisse's** famous painting *Intérieur rouge, nature morte sur table bleue* (*Red Interior, Still Life on Blue Table*, 1947) [fig. 3]. In this oil on canvas the artist experiments by using the warm and cold colours in inverted order. The beholders feel the coolness of the red-painted room, while looking through the open door in the picture, at the vibrating summer heat from the greenery, and sense the lukewarm blue water in the garden-pond.

Be that as it may, Goodman's achievement is to have pointed out that there is a difference between metaphorical sayings and literal sayings. A symbol – e.g. a description or a picture – denotes metaphorically what it does not denote literally. However, at the same time Goodman declares that metaphors are spread into every part of our discourse, "and we should have a hard time finding a purely literal paragraph anywhere" [p. 80].

Fig. 1


Fig. 2

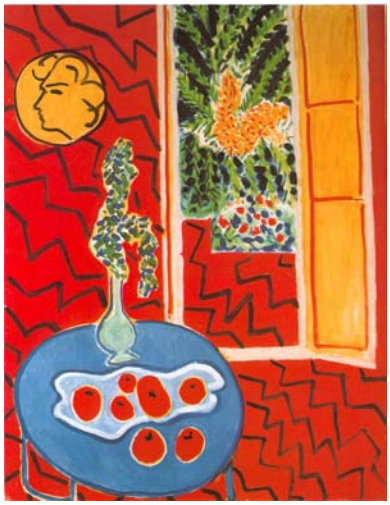


Fig. 3

**Coloury relevance**

It is often heard – at least in Scandinavia – that colour is what one sees as colour. But perhaps Nelson Goodman is sorting out a more complex conception of colour – and also of *Weltanschauung* (to use the precise German word for world view or outlook on life). When a colour is transferred from a realm to another its referential properties are changed. We attend to new qualities. The colour sample on a piece of paper has a low degree of redundancy or density. Therefore it is solely able to show one

aspect at a time, “but just which among its properties a thing exemplifies can often be hard to tell”, Goodman writes [p. 66].

The American philosopher teaches us that it is not sufficient only to look at something. We must know what we are looking for.

**References**

Barthes, Roland: *Camera Lucida: Reflections on Photography*. Transl. R. Howard. (New York: Hill & Wang 1981) [1980]
— *The Fashion System*. Transl. M. Ward & R. Howard. (Berkeley & Los Angeles: University of California Press 1990) [1967]
— ”Rhetoric of the image”, in *Image Music Text.* Transl. S. Heath. (London: Fontana Press 1977) [orig. *Communications* 4, 1964]
Chandler, Daniel: *Semiotics: The Basics*. (London: Routledge 2002)
Goodman, Nelson: *Languages of Art. An Approach to a Theory of Symbols*. Second Edition. (Indianapolis: Hackett Publishing 1976) [1968]
— *Of Mind and Other Matters.* (Cambridge, MA: Harvard University Press 1984)
Locke, John: *An essay concerning human understanding.* (London: Wordsworth 1998) [1690]
Olsson, Gertrud: *Färgperspektiv – kunskap och forskning om färg i arkitekturen*. (Stockholm: KTH Arkitekturskolan 2004) [Colour Perspectives – knowledge and research on colour in architecture]
Peirce, Charles S.: ”Logic as Semiotic: The Theory of Signs”. *Semiotics. An Introductory Anthology.* Ed. R. Innis. (Bloomington: Indiana University Press 1985) [1897]
Rasmussen, Steen Eiler: *Experiencing Architecture*. (Cambridge, MA: MIT Press 1999) [1962]

**Illustrations**

1. The Panzani poster
2. Picasso: *The Tragedy* (1903, oil on wood, National Gallery of Art, Washington D.C.)
3. Matisse: *Red Interior, Still Life on Blue Table* (1947, oil on canvas, Kunstsammlung Nordrhein-Westfalen, Düsseldorf)

**Keywords**

Colour theory, colour philosophy, colour classification, visual semiotics, semiotics, aesthetics, metaphor, fashion, Roland Barthes, Nelson Goodman

# Identitary Colour And Fashion

# Renata POMPAS, * Lia LUZZATTO
# Istituto Europeo di Design (Milan – Italy)
*Accademia di Comunicazione (Milan – Italy)

## 1. Introduction

Our presentation is connected to our earlier works on the use of colour and its communication in fashion[26], followed by our research on its meaning and forecast's validity on trends-colours in today's fashion, previously given to the first convention of the Italian Group of Colours (05)[27].
The consideration about actual fashion colour processes and planning implies some more questions: why also in production and in consume some colours are chosen instead of others? What meaning do they have? From what this choose depend on?
Affirms P. Bourdieu[28] that "style is a manner to represent expressing the manner to perceive the world and to think an age".
Exploiting the observations that the different historical periods have expressed with some chromatic qualities of range, the worldwide market has responded with the offer of a structured chromatic proposal able to anticipate, appeal and lead the consumption of colour.

## 2. Fashion and colour

As we had clenched, we believe that not only did specific colors have - and still have - a meaning, but their "range quality" has also been decisive. By this term we mean not only the three perceptual attributes of color (hue, lightness and saturation) but also surface finishing (matte, shiny, metallic, pearly, grayed, etc.) and the full palette in its chromatic significance.
The fashion/textile industry required tools to identify and anticipate color market demand. In the Color Trend Forecasting Agencies a teams of researchers - made up of designers, sociologists, psychologists, marketing experts and other experts - analyzes consumption and behavior, making hypotheses on chromatic appreciation trends two years in advance, to allow time for industrial production.
We believe that today color cards no longer have an intrinsic forecasting and orientation function, but have taken on the just as valid function of highlighting certain themes among the many that are present simultaneously on a market that is always more global, unstable and uncontrolled in its stylistic developments.
The function that colors take on today is that of giving proposals visibility, strength, emotion and recognizability, separating them from the background noise made up of a messy accumulation of styles, hybrids, mixtures and positioning of visual relations, taking on an identity role between global and local markets.

## 2. Colours and territorial identity

In a time where it seems there are no more confinements of consumption neither on the commodities goods nor ideas; in which from everywhere in the globe it is possible to reach the most remote place and to purchase the same products, globalisation introduces itself not only as the thinning of merchandises boundaries but also of local identities.
The result of this global uniformity is a sense of general anxiety and loss of singularity which provoke, on one hand, the need of reassuring a sense of belonging, a return to the roots - to the past and traditions; and on the other hand, the exasperation of the individual's expressiveness.
As Norberg-Schulz said, the fundamental relationship between the human being and the environment concretizes itself in an existential space defining the nature of the place. A *genius loci* that describes the mood and the cultural landscape[29].
Nowadays, the specificity of the place and the local traditions have been rediscovered and exploited in new ways, giving a value to the symbolic dimension that connotes the definiteness of the national culture.
During the last suggestions of the fashion worldwide market, examples of colours taken from national flags were used as emblem of nationwide identity: for example the Italian flag was used to create a

sportive jacket for the men's collection; in its ephemeral particularity this seemed to us an uttermost of a social trend.
Even without reaching this excess, one of the key points of fashion is to look at the local identity by citing it or even reinterpreting it, in order to get that taste and those colours which appear more representative than others.
In this research we asked ourselves how it was possible to express in term of fashion chromaticity, the identitary belonging. Therefore, in order to do so we took into consideration four different and distinct areas with the aim to verify whether it still exists an identity colour for each of given regions. Our choice fell on these countries: Africa, South Korea, Japan and Latin America. In the worldwide fashion market these four chromatic cultures are presented both directly by their products, and indirectly by the interpretation given by other countries.

## 3. Icon colours of Africa

The sub-Saharan palette is characterised by some intense and precise tonalities. Green, gold and red are considered the pan-African colours and are used in many flags across the continent: green is considered to be the colour of nature's prosperity, of the African motherland; gold-yellow is the colour of the sun, of the expanse and blazing desert, of the Savannah; red is the colour of the "noble blood that unifies all people of African. The black colour symbol of the swarthy complexion of the population is joined to this triad, which appears in the UNIA ACL's flag (Universal Negro Improvement Association African Communities League) of 1920, adopted as "Flag Liberation Black" to represent coloured people.
In the palette, the brown colour is introduced in all its shades, from that clearer to those sulphur to the darkest ebony, becoming one of the most pregnant colours. In fact it represents the colour of the earth and wood, of the habitations made of straw and mud of those villages not yet reached by the urbanization - and for this reason photographed by glossy magazines from all over the world to represent the African's authenticity - from the fabrics made of cortex, raffia and to the ones decorated with mud which are contended by the most exclusive antique dealers. This is the colour that in today's fashion has become the icon of the African's inspiration.
In present days, the export of the African expressiveness in the world is testified by the diffusion of its rhythms, from the melodic sound of the percussions to the exercised influence in the art.
In its overall impression, this colour palette is characterised by a full-bodied range, earthy, but also vivid, merry and with a very contrasted "range quality", where tonalities, often primary and intense, are underlined by contours as well as black and white backgrounds.

## 4. Fashion and Africa

Africa has always inspired European artists, musicians and fashion designers who studied, collected and often passively copied the expressions of its numerous cultures. In fashion, Africa has been and is frequently re-proposed in every season in order to reflect the imaginary of non-African consumers. This is carried through the research of materials, fantasies and colours, besides fabrics, wooden accessories, leather and raffia. Ranges of black ebony, cocoa, cortex and sand with indigo accents tinge the prints, which are inspired by African's patterns, connoting them with an extremely recognizable communication. The fragmentation of vertical loom and patchwork manufactures is common in many cultures, and finds its territorial identity through the chromatic local combinations based, in most of the cases, on the prevalence of black and yellow contrasts with vivid colours and prints of animals skin (*animalier)* as well as with the powerful expressiveness of black ink background with prints of primary colours.
The ambassador of the African fashion is represented by Omou Sy, a prestigious fashion designer. Sy, of Senegalese's origins, is considered one the most important organizers of the SIMON's fashion week in Dakar. She interprets under a contemporary key the tradition of her land and transposes on bright fabrics the sensuality, the joy and the physicality of its colours. The collection "King and Queen of Africa" has been exposed in the 2000 to the Expo of Hanover. Besides the production of suits, accessories, headgears and jewelleries, the fashion designer has a limited edition of high fashion's only pieces and traditional customs reproduction. In her fashion, the globalization's assimilation originates a sumptuous contamination in which the glamorous of the centre of Africa is melted with the universal contemporary style. Fabrics are dyed by hand or printed with bright

chromatic combinations, from the exuberant to the merry tones which are often mixed with the ochre and brown inspired by the colour of desert, the earth and the trees.

## 5. Icon colours of South Korea

South Korean's flag is based on three colours: white, which represents the background and means purity for the Confucianism and emptiness for the Buddhism; red, which symbolises the qualities included in the yang; and blue, which symbolises the ones of the yin. However, the icon colours are better represented by the traditional clothing. They represent the principles and the concepts of formality taken from the Confucianism and translated into a style based on the dignity for the man on the modesty for the woman. These concepts were sublimated in a particular aesthetic conception, which wanted simple and self-coloured clothes. This was done in order to communicate an appearance of calm and respectability, in which the contrasting colour was used to revive in the multicoloured strings and, in women clothes, with different colourful accessories and in multicoloured and in rhythmic progression of parallel stripes in sleeves.
Referring to the five elements blue, red, yellow, white and black, the most relevant South Korean's icon colours set a codified system of colours able to distinguish the social classes and ceremonials.

## 6. Fashion and South Korea

In spite of the importance of the South Korean's textile industry and fashion events that are held in Seoul, today's fashion market has swept off the traditions, which still survive with the local festivity and, it is difficult to identify in the fashion collection presented in the global market some stylistic and chromatic indications as Korean.
Therefore, we have not been able to trace specific influences in the Italian or western collections, however we focused, among others, on a South Korean fashion designer and artist whose creations are appreciated and known also in the Western countries, and are placed in the Victoria & Albert Museum of London as well as the Jack Lenor Larsen Foundation of New York.
Between all fashion designers inspired by both the aesthetic history and the contemporaneity of their own country, Chunghie Lee, reinterprets the colours and shapes of traditional Korean clothing, creating a living testament to anonymous female ancestors. She uses bold colours - blue, red, yellow, white and black, which represent the five basic colours of nature - in light, transparent and delicate silk organza, with asymmetric lines like ancient local patchwork technique (pojagi).
The influence of the tradition is found today in those colours such as red, green, indigo, yellow, jade, crimson, purple, violet, above all when they are used in flat and monochromatic tonalities with bright colour combinations in asymmetric patterns, like in the traditional apparel.

## 7. Icon colours of Japan

Although contemporary Japan introduces itself to Western countries with the vivid polychromes of cartoons and young clothing, which are also so copied in Europe, the colour palette that best represents the commercial imaginary of Japan is the one related to the traditional of the Zen's aesthetic as it expresses the conception of calm sobriety, measured harmony and essentiality. The tonalities given by this palette are based on a sense of reduction, and are mainly sober and indefinable. They welcome the patina of the time looking for a turbid effect, veiled of penumbra. The natural shadings of the wood, the bamboo, the stone, the ink, in their cultured symbolic desaturation define, perhaps more than others, the brand colours; the soft black of the ink, the earthly red of clay as well as the deep and bright one of lacquers, the ivory of rice paper, the indigo of the refined fabrics and ceramics production, to all the shadings of burnished and brown's values.

## 8. Fashion and Japan

Western fashion designers have cited and reinterpreted, even to its extreme, traditional Japan referring often to this palette. However, when Japan imposed itself in the worldwide fashion market during the 80s, revolutionising the tradition of western couture and gaining an international success and clamour thanks to the collections exhibited in Paris by its fashion designers, it gave birth to a new generation described as "poets of the black".

Issey Miyake presented her first collection in natural colours, employing traditional Japanese dyeing methods such as indigo and mud dyeing, navy and brown and others unsophisticated colours act to emphasize the qualities of natural fabrics. Also, if with for the "Pleats Please" collection, in polyester, he used vivid, clear colours, and also fluorescent, he contributed to spread of mud gradations. Rei Kawakubo debuted with a palette dominated by "darkness theme: black, grey, white, plus beige and navy. He always came back to the use of black, even though for some time he was inspired by primary colours, saturated and intense like yellow, magenta and cyan. Yoshij Yamamoto expresses a very Japanese aesthetic, incorporating Western European fashion and Zen buddish minimalism, choosing black and achromatic tones, with vivid colours as accent.
The important presence in this fashion's palette of the indigo colour cannot be forgotten. Its roots can be traced back in the ancient Japanese tradition of dyeing (Ai-zone) during the Edo period (1603-1868). It is here reinterpreted by Issey Miyake, and made contemporary by Junia Watanabe with the artificiality of synthetic fibres and chemical dyes of his palette.

## 9. Icon colours of Latin America

Since some years, Latin America imposed itself in fashion with its lively happiness due to some versatile, joyful and vital proposals, which find their affirmation in the richness and freshness of chromatic solutions. Sparkling and joyous colours which, at first, appeared audacious and irreverent to the European market, later on imposed themselves with the image of tropicalism and all the suggestions that it evokes: landscapes that are a melting pot of races and colours, forests of luxuriant vegetation, limpid air and bright sky in which shines an intense and warm sun.
With the Tropicalism Musical rhythms of samba and merenghe, techniques of capoeira and football game the colours of Brazilian's flag (green, yellow) have imposed themselves around the world, remarking this identity. These colours can be considered icon among the others and are exported in the international market of fashion, connoting the Tropicalism style: worm yellow, light orange, green-yellow and turquoise.

## 10. Fashion and Latin America

In the commercial imaginary, the Tropicalism bursts into fashion from the street style to the catwalks of Milan, Paris, London and New York with a bright, gaudy and sunny "range quality" of colour.
If in the forms it exalts the abundance and the fluidity of the fabrics with flounced and ruffles, in the colours it proposes the sensual and cheerful exuberance of the contrasts of the full and saturated colours with a dominance of warm tonality
The typical fabrics that tourists buy in order to testify their trip in the countries of the South America also show, at times, a chromatic variety and a vivacity of contrasts exalted by the proximity of the complementary ones often divided by black and white underlines. The tropicalism introduces itself with glowing colours played between the concept of tradition and modernity, stereotypes and imagination; the "Maya turquoise" full of solar symbolism does not lack it. These colours are also proposed to the male fashion. The disposition of the décors and their shades, accented by the introduction of white and black tints, results in line with the communication even when the dominant colour is a cold tonality. Another way to interpret these colours is in the mixture, in the kaleidoscopic fragmentation, in the overlapping of decorative motives. A radiant whole that corresponds to the soul of the continent. Here, the fashion is chromatically represented by the icon colours of Brazil, which has imposed itself on the international scene as a brand, exporting the colours of its flag.

## 11. Conclusion

This paper introduces only a starting of our research that we intend concluding in future by looking at the relationship between colours of the global market and those defined as identitiers within their fanciful interpretation of post-modernism.

**1** L. Luzzatto, R. Pompas, "La moda e il consumo del colore: quale approccio?", Convegno "Colore e Design", Genova, 2005. "Color and scent", AIC Congress Granada, Spain, 2005. "I colori del vestire", Convegno "I segni e le scritture del sé: il colore", Udine, 2005. "Colori interiori, esteriori, sociali", Convegno "Un'impresa a colori. La seduzione del messaggio cromatico", Palermo, 2004.

“Teaching Color Plans”,7° Congresso Argentino del Color, Facultade de Arquitectura Diseno y Urbanismo, Universidad de Buenos Aires, Argentina, 2004. “Teaching Color Plans”, AIC Congress “Color and paints”, Pontificia Universidade Catolica de Rio Grande do Sud, Porto Alegre, Brazil, 2004. “Artificial Environment, cyber space and new colours projects”, AIC Congress “Color Communication and Management”, Chulalongkorn University of Bangkok, Thailand, 2003. “Made in Europe, design a confronto: il caso italiano”; British Council, Milano, 2002. “Color of textile as chromatic alphabet of society, AIC Congress: “Color & Textile”, Maribor, Slovenia, 2002.

**2** L. Luzzatto, R. Pompas, “Colori e moda”, in “Colori e Colorimetria”: Prima Conferenza Nazionale del gruppo del Colore, Pescara, 2005.

**3** Pierre Bourdieu. La distinction, Les éditions de minuit, Paris, 1979.

**4** Christian Norberg-Schulz. Genius Loci (1976). Electa Milano, 2003.

# Exploring Personal Colour Analysis Data for the Colour Forecasting Process

T.D. Cassidy
Department of Clothing Design & Technology, Hollings Faculty, Manchester Metropolitan University
Old Hall Lane, Manchester. England.
T. D. Cassidy (t.cassidy@mmu.ac.uk)

**Abstract**
Initial research found the current colour forecasting process to be under-performing and an improved system was proposed and tested eliminating the anticipation of consumer acceptance in favour of consumer colour preference data. Research continues to identify optimum sources of preference data for inclusion in the improved system model. This paper focuses on exploring personal colour analysis data through a critical analysis of three popular systems in terms of the semantic descriptions given and colour measurement using elements of Grounded Theory Methodology to develop initial model theories. Findings suggest that the understanding and communication of colour is still very rudimentary and further exploration is required to develop a suitable model of consumer colour preference data for the colour forecasting process.

**Introduction**
This research began through the recognition of the need for a more substantial understanding and knowledge of the colour forecasting process. The initial investigation aimed to demystify and clarify the process, though there was never any intention to dismiss the part that intuition and inspiration play. Soft Systems Methodology (SSM)[1] was used to model the current process and to develop an improved system model[2]. It is claimed that forecasters aim for 80% accuracy[3], yet through consumer surveys the current process was found to be only 51% efficient[4]. Currently, a seasonal colour story is disseminated through trade fairs / exhibitions and forecasting information from national and international colour meetings creating a consensus of colour that is compiled into packages and marketed globally[5]. With increasing competition and marketing efforts becoming more sophisticated and target market specific, companies surveyed from the fashion and textile industry showed a strong interest in the improved forecasting model which proposes the inclusion of accurate consumer colour preference data. A system is now required to model colour preferences but that is also not so rigid that it compromises intuitive, creative or inspirational colour story compilation for product ranges. It is envisaged through continued research to develop a sophisticated colour forecasting system incorporating a consumer colour preference model to enable the confident development of colour ranges for products that are specific to any fashion-related company's target market.

**Aims and objectives**
The aim of this paper is to further establish the potential of personal colour analysis systems in the development of a colour preference model using semantics and colour measurement. This will be achieved through the following objectives:

- Evaluate the significance of using semantics in relation to colour preferences
- Establish correlations between semantics, colour preferences and the four seasons model
- Evaluate the use of personal colour analysis system types as a foundation for a colour preference data collection system for the colour forecasting process
- Establish a course of action for further research and model development

**Methodology & Survey**
Elements of Grounded Theory Methodology[6] were used to begin the theory building process from a survey of 49 respondents. In this first instance, the sample was used collectively as one case study, however due to the diversity of responses it will be necessary to treat each participant's responses as individual case studies in a further and deeper stage of analysis. A questionnaire and a set of on-screen images were used for the data collection. Respondents were asked to indicate words that best describe their colour preferences from the words given taken from the personal colour analysis systems' semantic descriptors, which had been cross-referenced for accuracy in accordance with

pantone[7]. Respondents were then shown a set of 12 colour palettes from the Colour Me Beautiful[8] system to rate their preferences for each using a Likert scale of 1 (Low preference) to 5 (high preference). Similarly, images of a garment collection were shown using a small number of colours from each set of the previously shown palettes for colour preference responses, again using a Likert scale. Respondents were given the Angela Wright's colour personality test[9] to identify their seasonal palette type and recorded the result on the questionnaire. Finally respondents were given a series of 90 colour samples and asked to indicate their preferences for each using the same Likert scale. Colour samples included brights, tints, tones and shades, black, white and a range of greys. Various tables of information were developed from the responses for analysis and prompted the realisation that the results do not indicate a point on the Likert scale where the colour becomes unacceptable to purchase. It was thought that colours given values of 1 or 2, being of low preference would be unacceptable to the respondent when making a purchase and colours given a score of 4 or 5 would be more favourable. A score of 3 being neutral without the consideration of other design features been taken into account in the decision making process the product may or may not be purchased. In other words, it is unclear at which point on the Likert scale the colour would be considered unacceptable to the consumer when purchasing fashion goods. Due to the complexity of the cross-referencing and using the sample at this stage in its entirety, the findings discussed in this paper relate to the early stages of analysis where the researcher was primarily looking for correlations between the sets of information gathered to provide an initial evaluation of the potential use of personal colour analysis data. The analysis will operate on a much deeper level at a later date when considering the individual case studies and later amalgamating them into a complete colour preference data system.

**Personal colour analysis systems and early findings**

Personal colour analysis data was selected due to the growth of colour and style analysis, image building and fashion styling concepts, consultancies and industry in the Western world and is also becoming evident in the East. Through media, consumers in general are becoming far better educated in recognising styles and colours that work best for them as individuals and more sensitised to their own personal preferences[10]. Also as marketing efforts are evermore target customer-centred and trend forecasting is becoming a more integral part in the marketing effort as well as its more traditional place in design and product development, it was considered appropriate to look at personal colour analysis systems in the first instance. There is also a general consensus among those reporting on fashion forecasting that four themes are commonly produced for each period based on the characteristics of the four seasons model used by some personal colour analysts[11]. Three of the better-known systems have been used in this study. These are the works of Mary Spillane of the Colour Me Beautiful organisation[8], and author and consultants Angela Wright[9] and Barbara Jacques[12]. The former two systems use the four seasons model, these four groups are generally viewed in simplistic terms as: Winter – bright, cool and contrasting, Spring – tints, warm and clear, Summer – tones, cool and muted and Autumn – shades, warm and rich, and are claimed to be based on the three dimensions of colour; Hue, Saturation and Value. Barbara Jacques' system uses a different approach but still claims to be based on the same three colour dimensions. However, in the initial stages of analysis it was found that the semantics used by the Colour Me Beautiful system, which is refined by using three different sub-sets known as types or palette types within each of the four seasonal groups making a total of twelve palette types, only two of which make use of the three dimensions of colour. Similarly when analysing the semantic descriptions used by Angela Wright's system, which uses only the four season groups, only one makes full use of the three dimensions of colour. In Barbara Jacques' system all twelve of the palette types make use of only two of the dimensions of colour in the semantic descriptors for each. In the earlier stages the three selected systems were critically evaluated by the measurement of each colour sample given for each personal colour palette type in relation to the system descriptions given (semantics). The RGB colour measurement option was used on the Pantone Colour Cue ™ tool to measure the colours. The RGB values were then converted into HSL values using the colour box facility in Microsoft Word ™. Colour temperature was determined as hue numbers 0 to 118, red through orange and yellow to yellow-green as warm and hue numbers 119 to 255, cyan through blue and violet to magenta as cool. The point at which lower saturation affects clarity of hue was determined to be 190. Where the saturation level is 190 and above the colour is considered to be highly saturated and 189 and below is of low saturation. These values were decided

upon by the researcher and are therefore subjective and at this stage do not take different levels of saturation into account. The default of the software for pure colour is a luminosity value of 128. Hues with luminosity values of 129 to 255 result in a tint and values of 127 to 0 result in a shade. It was found that of all the colours in the Colour Me Beautiful system only 22.3% matched the system description exactly, 37.5% in Wright's system and 38.5% in Jacques' system. It was found from the results derived from the questionnaire referred to in the methodology that a high preference for a large sample of colours does not guarantee a high preference for a small selection of colours from the same sample. Preference rates for the small ranges were only 10.7% of those for the larger palettes. This suggests that care and knowledge of the target market is needed when selecting a limited colour range from a larger palette as a designer may do when using colour forecast packages.

**Further analysis**

When using the three dimensions of colour a simplistic model of eight combinations are possible, however, this could be greatly expanded if mid-ranges are included for value and saturation levels. The eight combinations are: Warm, High Saturation, Light (WHL), Warm, High Saturation, Dark (WHD), Warm, Low Saturation, Light (WLL), Warm, Low Saturation, Dark (WLD), Cool, High Saturation, Light (CHL), Cool, High Saturation, Dark (CHD), Cool, Low Saturation, Light (CLL) and Cool, Low Saturation, Dark (CLD). This simplistic model was used to analyse the semantic preferences for each respondent and later cross-referenced against the preferences for the relevant colour samples used in the survey. Five different words were used that are all related to high saturation – clear, bright, vivid, rich and deep, and five different words related to low saturation – soft, muted, tones, dusty and delicate. Two words were used denoting warmth - warm and golden and one word - cool to represent cool colours. Two words were used for lightness of value – light and tints and one – dark for darkness of value. Using colour preferences indicated by semantic choices only 22.4% of the respondents fit into one of the eight types. The rest fit into two or more as their responses showed preference for both extremes of one or more of the three dimensions. Respondents' understanding of the semantics in relation to colour could be considered as being subjective. For example one respondent selected a preference for colours that are vivid, rich and deep (high saturation) but not clear and bright. Similarly, another selected a preference for soft, muted, delicate and tones (low saturation) but not for dusty. This would indicate that each of the five words used for both high and low saturation indicate different characteristics of colour and therefore different levels of saturation appear to be preferred based upon individual's understanding and judgement of what each semantic used means to them. Each colour tested in the survey was allocated to one of the eight types determined by the three dimensions of colour. Early indications show that after collating preferences for each in almost every case respondent's actual colour preferences were overall higher for colours in one or more of the other types than the type their semantic preferences were matched to. Initial findings suggest that using Angela Wright's self test to determine seasonal type there is only a 58% correlation between the seasonal type as a result of the test and the type determined through semantic preferences. Further analysis would be required to establish any links between seasonal types according to Angela Wright's test and actual colour preferences. However, as previously mentioned, the allocated colours for each type in both the Colour Me Beautiful and Angela Wright systems when measured had little correlation with the descriptor semantics given for each and therefore further exploration of this objective would appear to be of little benefit.

**Conclusion**

This survey has been treated and analysed as a single case study in its entirety and while some useful conclusions can be drawn from the exercise there is still the necessary stage of treating each of the 49 individual sets of data as separate case studies in accordance with grounded theory methodology in order to develop a theory leading to an appropriate colour preference data collection model. The findings established through the cross-referencing of semantic preferences, colour preferences and personal colour analysis models suggest that correlations are low. This may be due to inaccuracies in the systems used as there was little correlation between the semantics used in the type descriptors and the three dimensions of colour of which the systems claimed to be based on. Similarly, little correlation between the colour samples given for each palette type within the systems in terms of the three dimensions of colour and the suggested colour characteristics of each. While the purpose of this

research is not to disprove or discredit the systems used in matching colour for fashion to personal colouring, it does suggest that at least the three systems used here have sufficient flaws in the configuration to present potential flaws in a model based on one or more of these systems without suitable modifications. When bringing semantics into the equation, firstly the models themselves do not make full use of the three dimensions of colour when describing the colour characteristics for each type within any of the systems. Secondly, the precise meaning of each semantic in relation to colour is influenced by the subjective judgement or understanding of each individual respondent. Colour language and the communication of colour within industry has always been recognised as problematic, so much so that colour systems that have been developed have a tendency to use numerical notations rather than semantics and colour names have become important as a marketing tool rather than an accurate colour descriptor. The study concludes in this respect that simply asking consumers about their colour preferences using semantics is of no real benefit when attempting to model those preferences and it is suggested that in order to gather precise colour preference data actual colour samples are required in the survey. While the exploration of personal colour analysis systems thus far has provided further considerations, the systems themselves appear to be too loosely constructed to be of use as a colour preference data collection model. However, this may be disproved after the next stage in the research where the 49 samples will be treated as individual case studies.

**Recommendations for further model development**

It has already been established that the 49 samples will be analysed individually in accordance with grounded theory methodology. It has also been stated that a system needs to be developed that will take different levels of luminosity and saturation into account in relation to colour preferences. It is therefore recommended that a suitable method of plotting the colour preferences is developed and tested. This may then be further built upon from data to be collected in the future using a more sophisticated method of collection, particularly as the method used to gather preference data was questioned in terms of the subjectivity of the Likert scale. The point where a colour becomes unacceptable when considering a purchase has not been established. This is of great importance in the development of a colour preference data collection model to include this type of data into the colour forecasting process. It may also be a worthwhile exercise to test the judgement of colour preferences of the same colours presented in different formats. A colour printed on paper may not have the same appeal as the same colour on for instance, a fabric. It is intended that a new survey is conducted using a more rigorous data collection method gathering colour preference data using only colour samples. The model used to plot these results needs to be developed. Firstly careful consideration is needed to select colours for sampling as well as the medium to be used for the colour representatives. Further analysis of correlations between colour preferences and the four seasons model may then be made.

**References**


1. D. Patching, Practical Soft Systems Analysis (Pitman Publishing, London, 1990)
2. T. D. McLuckie & T. Casssidy, "An investigation of colour forecasting" Key Note Paper in proceedings of IFFTI (Hong Kong Polytechnic University, Hong Kong, 2002)
3. R. Perna, Fashion Forecasting (Fairchild's Publications, New York, 1987)
4. T. D. McLuckie, An Investigation of Colour Forecasting PhD Thesis (DeMontfort University, Leicester, 2003)
5. T. Diane & T. Cassidy, Colour Forecasting (Blackwell Science, Oxford, 2005)
6. A. Strauss & J. Corbin, Basics of qualitative research. Grounded theory procedures and techniques (Sage Publications, Inc. USA 1990)
7. L. Eiseman, Pantone Guide to Communicating with Colour (Grafix Press Ltd., USA, 2000)
8. M. Spillane, The Complete Style Guide from the Colour Me Beautiful Organisation (Piatkus Publishers Ltd, UK, 1995)
9. A. Wright, The Beginner's Guide to Colour Psychology (Kyle Cathie Ltd., UK, 1998)
10. Drapers Record, "How to be a successful retailer. Colouring customers" Emap Readerlink, Ltd., Issue 23. pp i - ii July (1998)
11. E. L. Brannon, Fashion Forecasting (Fairchild's Publications, New York, 2000)

# Adding other values to colors besides fashion

Dr André Luiz Battaiola
Federal University of Parana
Brazil

**Abstract:**
Fashion is related to a current style associated to garments, furniture, electronic equipments, vehicles, etc. In general, designers spend effort to figure out this style and incorporate it to their projects. The goal is incorporate an emotional component to the designed objects which will add an extra value to them, besides technical and usability aspects. Usually, this emotional component respects cultural, sociological and religious aspects. Under this point of view, fashion considers emotional component as only a consumer attraction factor but it is possible to add other values to it.

Color palettes are commonly used to distinguish one fashion from the other because colors are strongly related to emotions. Normally, designers associate the colors emotional impact only to the consumer attraction but colors can cause a range of emotions (calm, anger, excitability, etc). For instance, it is possible to use color to calm people in different environments, such as vehicles (plane, ship, train, etc) and buildings (hospital, stores, etc). In these cases, color palettes can assume important applications, besides fashion.

Based in the scientific literature, it is possible to choose colors to promote specific emotions. Thus, if there is a well defined co-relation between color and emotions, it is possible to define a computational method to promote one or several emotions in an environment. Notice that emotions transitions require well defined color transitions. Besides, an interesting method should allow applying restrictions, which can be associated to fashion or other aspects.

This paper describes the current status of a research work to develop a process that helps designers to: 1) analyze a target situation and associate to it the correct emotions and 2) find out the colors that drive the users to these emotions.

# Communicating Colour Research Results: Two Recent Swedish Examples

Karin Fridell Anter and Monica Billger
Chalmers University of Technology
Se 412 96 Göteborg (SWEDEN)
corresponding author: M. Billger mpb@chalmers.se

**Abstract**
How can colour knowledge and colour understanding be conveyed to architects? To colour researchers it is obvious that many of our findings could be interesting and useful in architectural practice, and practising architects often sense the need for a more solid ground when working with colour issues. This paper presents two recent efforts to bridge the gap between colour research and the architectural profession, including students of architecture. The first one is an anthology with the title *Researchers and practitioners about Colour, Light, Space,* and the second one is an attempt to use Virtual Reality to illustrate research results about colour on and inside buildings.

**A book: "Researchers and practitioners about Colour, Light, Space"**
Sweden has a long and successful tradition of research concerning colour issues, but the ongoing research about colour on light in interiors has not previously been published in an easily accessible form. A new book now presents both recent research results and reflections from practical work with colour, light and space. So far it is only published in Swedish. The participating researchers have formulated their questions and findings from their various professional points of departure; as an architect, interior designer, art historian, psychologist, nurse, building conservation expert or art teacher. Some of the articles in the book are written by practising architects and interior designers, starting off from their own projects and the experiences these have given.

*Why is there colour together with us humans in this world?* BJÖRNER TORSSON asks this question in his introductory essay. He leads us to great thinkers like Wittgenstein, Homer, and Goethe and artists like Paul Klee and Frida Kahlo, and he reminds us that colour and light can never be fully described. However much we try, there are always dimensions that reach beyond language and analysis. Colour and light are sensory qualities that have to be experienced.

But what do we really mean with the concept of *light?* Physics define light as electromagnetic radiation within a certain wave-length interval. RIKARD KÜLLER starts from this definition when he, in his article, describes the importance of light for man as a biological being. ANDERS LILJEFORS argues for another use of the concept of *light*. For him, it primarily denotes a visual phenomenon; that which we see as light. In his article he explains the function of the human visual system. He also provides tools for planning and evaluating light environments visually, instead of starting from measurable physical entities.

Also the concept of *colour* has several meanings. In Swedish, the same word ("färg") is used for experiences like red, blue or white and for what in English is called paint. Also, just like *light, colour* can be used in a physically-based sense, denoting radiation of certain wavelengths. KARIN FRIDELL ANTER in her article discusses the colour concepts and gives a short presentation of the *Natural Colour System* (NCS).

Colour is, like few other architectural issues, loaded with moral and ideological connotations. Every era has its norms for what is appropriate or not, and strikingly often the argumentation has been based on value-loaded concepts like *purity* and *authenticity.* This strong connection between ideology and the concrete use of colour is discussed in several of the articles. MARGARETA TILLBERG relates about those artists and architects who, around 1920, wanted to use colour and light for the creation of a new world for a new epoch. *Bauhaus* and *de Stijl* are known representatives of this movement, whereas their contemporaries in the young Soviet Union have been long kept outside our view.

MARI FERRING takes us to Sweden and the early build up of a welfare state. Around 1950 the 'concretist' murals at Årsta community centre provoked a debate showing great moral indignation over

the alleged superficial venture of painting buildings in "masquerade clothes" (Fig.1). One decade later a new "colourless" architecture, using steel and glass, attained positive judgement for its "clarity".


*Figure1. Wall paintings on cinema facade,*
*Årsta Community Centre, Stockholm (1947-54)*
*Photo: L. Lander.*

JAN M. BERG has been working as an architect since the 1960s. With examples from his own production he shows how colour ideologies have come and gone – from the self-determining colours of materials in the 1960s, via the playful and colourful era around 1970 and onwards towards an attitude where both the colours of materials and painted surfaces are legitimate alternatives.

Today the choice seems to be rather free, without pressing moral values about the superiority of one or the other. Still it can be difficult to vindicate colour's importance for architectural totality. And still the question remains: how come, that colour has been specifically loaded with all these moral judgements? It is never claimed that a period can be – or cannot be – *permitting* towards a material like stone. In this case *authentic* and *inauthentic* are no relevant categories – that is, of course, if the stone is not painted! There seems to be something special with colour as a phenomenon, as essence that creates a wish to tame it. Might it be because colour, irrespective of our wishes, is so important for human experiences and feelings, for better or for worse?

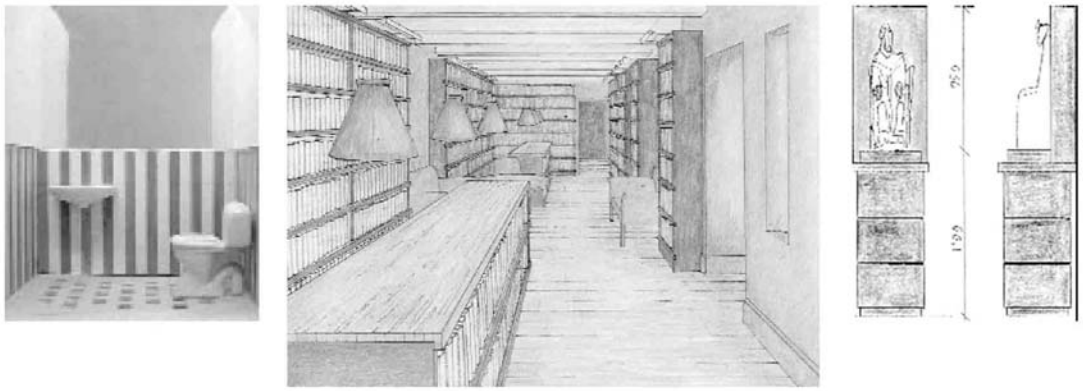


*Figure 2. Architect's working materal: Test model of guest toilet in Royal castle (Jan Berg). Painted perspective of library (Rodel & Ingalill Stintzing). Sketch of exhibition podium (Gertrud Olsson)*

Colour and light seldom have any prominent place in architectural education. Questions concerning colour and light are often seen as being subordinate to *form*, *volume* and *function*, and are therefore introduced only at a late stage of the design process. Nevertheless many architects see colour and light as important, maybe decisive means for the forming of spaces. Three articles in this book are written by such architects, conveying experiences from their practices. RODEL AND INGALILL STINTZING write about their work with public and semi-public premises, GERTRUD OLSSON writes about permanent or temporary exhibition architecture and JAN M. BERG, already mentioned, writes mainly about private homes. In spite of the difference between the projects presented and the different architects' methods, there is an important common denominator: every project starts from a basic idea where colour and light are important ingredients. The idea can be nourished from different aspects: surrounding nature, valuable components in already existing rooms or the character of the intended function. The important thing about the idea is that it exists and offers a sounding board for all those small and big choices that constitute design work. (Fig.2)

Current Swedish colour research has proceeded from the study of *colour as such* to surveys on colour perception and colour experiences in spatial contexts. How is the colour experience altered when the room is lit in a different way? How does colour influence the experience of spatiality? And how are we humans and our activities affected by the colours of our rooms? In her article MONICA BILLGER relates about her and her students' experiments with simultaneous contrast and other colour effects in three-dimensional reality. At the same time she describes the exiting expedition of research – to start from one set of questions and eventually find that other things are much more important. (Fig. 3) Also MAUD HÅRLEMAN has explored colour in rooms, but her focus has been on the light situation. How is the experience of colour and space affected if the room gets its daylight from north or south? (Fig. 4)

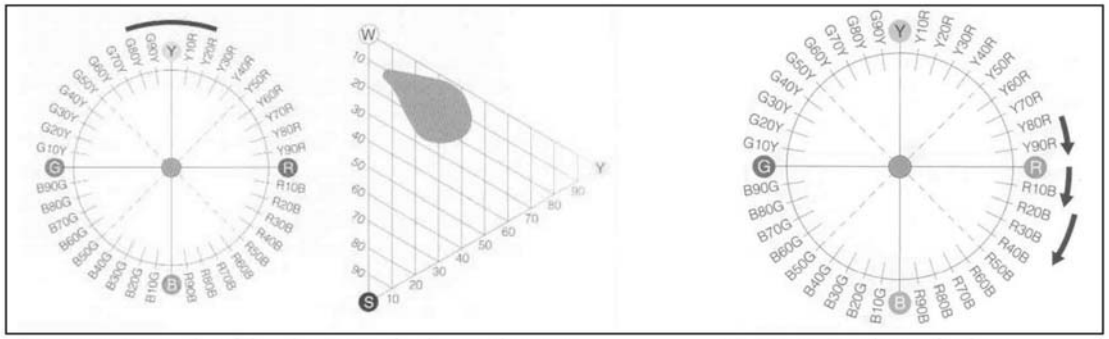



*Figure 3: Example of the elasticity of colours, shown in NCS symbols. A yellow material can vary within a rather large nuance area (left) and between greenish and reddish yellow (middle), depending on the illumination. (Monica Billger)*

*Figure 4: Tendency for hue shift of pink colours in north facing rooms, shown in NCS colour circle (Maud Hårleman)*

JAN JANSSENS and RIKARD KÜLLER conduct their research within the tradition of environmental psychology and convey controlled experiments concerning human biological and psychological reactions in different colour and light environments. Starting from the general conclusions presented by Rikard Küller in the article already mentioned, Jan Janssens discusses a concrete question: how does colour and light in office premises affect the people there? How important are the illumination

and coloration of the rooms for the well-being, comfort and performance of human-beings? Are there any universal rules for good interior illumination and colour design? HELLE WIJK is a nurse and has approached the colour issues from her own experience of patients' needs. In her article she presents research findings and practical experiences from a conscious use of colour and light in hospitals.

The final essays in the book discuss the different connotations of the ambiguous concept of *space*. BJÖRNER TORSSON gives a personal view about its nature. JADWIGA KRUPINSKA starts off from different scientific interpretations of the concept and analyses the changing attitude to spatial issues in those intellectual premises that are jointly called architectural theory. ULF KLARÉN in his essay starts off from the fact that our visual sense is developed for understanding the spatial context that surrounds us. He discusses what it is that makes us recognise, understand and evaluate what we see, and he analyses how artists in different periods have attempted to use detectable codes in their flat depictions of the three dimensional, *spatial*, world in which we exist.

**A VR-presentation: "The virtual colour laboratory"**

A more experimental project is called *The virtual colour laboratory*. It uses Virtual Reality (VR) to illustrate research results about colour on and inside buildings and is intended for architectural students, practising architects and others professionally interested in architectural colour. This project is still in progress. The *Virtual colour laboratory* (in short *DVFL*, derived from the Swedish name) will have the form of a web-page or a CD-ROM possible to open and use even without access to any separate 3D-visualisation program. When opening the web-page or CD-ROM you are welcomed to a VR-created building. It is placed in a rather realistically reproduced landscape, which gives the possibility of demonstrating different characteristic colour aspects of nature and its components. The exterior of the building is used to demonstrate the impact of distance on the perceived facade colours and their interaction. Inside the building there are a number of rooms illustrating the effects of different choices regarding colour, pattern and material. (Fig 5) It also includes a "library" with literature references and Internet links. In the virtual environment there are "signs" and "posters" referring to the user interface, where information texts, pictures and interactive choice alternatives are presented.

When moving around in the virtual environment, at certain spots the visitor can choose between different colour alternatives. In the exterior there will be a handful of facade colours and as many colours for facade details, window frames etc. In the interior, each of the rooms will offer the possibility to change one or a few factors, whereas the rest will remain constant. In one room the choice will be between different illumination alternatives, in another room you can change the colour of some of the walls and in a third one you can choose where to place surfaces with given colours. For achieving this directed interaction the program does not create new models from the user's choice but selects from a limited number of already defined models.

The work with DVFL is still in progress, and the immediate aim is to complete the programming and arrive at a stable program and interface. In a possible next step we plan to include more rooms, more choice alternatives and more references to old and new research findings, to make DVFL a useful and enjoyable source of knowledge and understanding of colour in spatial situations.

*Figure 5: We move towards the Virtual Colour Laboratory, enter a corridor and find a number of rooms, showing different colour effects and highlighting different aspects of colour in architectural design.*

**References:**

Karin Fridell Anter (ed.) *Forskare och praktiker om FÄRG LJUS RUM*. Formas, Stockholm 2006.
Monica Billger: *The Virtual Colour Laboratory*. Still not published.

# Chromatic Studies For Urban Space: Case Study: High School Campus, Lamentin (Guadeloupe, French West Indies)

Michel CLER, France CLER, Verena M. SCHINDLER
Atelier F&M Cler Etudes Chromatiques
64 rue Vergniaud, 75013 Paris, France
atmfcler@wanadoo.fr, vmschindler@yahoo.com

The sense of the chromatic aspect of any settlement is constituted, above all, by the limits and nature of human perception, but also through the composition of a broad range of distinguishing elements, such as topography, minerals, geography and the climate; the rhythm of autonomously developing human factors, such as urban infrastructure, architecture, advertisements, and, as well as collective habit, political policies, historical styles and colour trends. This sense and appearance of colour are further compounded by transient natural factors, such as light, weather or seasons, and vegetation. Considered together, these enduring and elusive qualities are essential agents in determining the specificity of the chromatic aspect in any particular setting and context. Herein, colour both lends and derives its meaning, which is not simply an appearance in itself, but also is always signifying and being signified through cultural, historic, political, religious, social, and symbolic agents and filters.
How can such a rich complexity be addressed?

*CHROMATICTOWNSCAPE.* Chromatic study is a method or systematic way of addressing the complexity of "colour" in the built environment. The Atelier F&M Cler calls its own particular kind of approach *Chromatictownscape*.

PROCESS. The Atelier's way of chromatic studies entails a number of stages. In short, these basically involve a) analysis; and b) synthesis.

Through the *analysis* the Atelier considers the appearance of colour as determined by elements which characterize space, such as sky, water, minerals, vegetation, seasonal changes and natural light. The results of this phase are translated into an initial *Chromatic Chart* (*Charte chromatique*), which is composed of three major segments: 1) *Palette* (*Le nuancier*); and, 2) *Chromatic Orientation Scheme* (*Schéma d'orientation chromatique*), which also includes 3) *Chromatic Reference Plan* (*Plan de références chromatiques*).

Through the synthesis, the Atelier integrates the results of the initial *in situ analysis* with further results determined through a careful consideration of the master plan for urban development. Working in collaboration with the concept team (in particular, with landscape architects) the Atelier refines the initial *Chromatic Chart* to make it an integrated part of the master plan. As part of the core guidelines for future development, the results of the chromatic studies can provide inspiration for further associative interpretation and can serve to assure continuity over the years. In effect this means that *Chromatictownscape* can serve to underscore and reinforce sustainable urban planning and development of communities. In the best of the cases, it can create a memory of colour on site and the beginning of a new colour tradition with its own dynamic.

REALIZATION. Using the chromatic studies of the Regional Professional High School Campus in Lamentin as a case study, the method and results of *Chromatictownscape* can be concretely demonstrated. Located at the outskirts of the community near the Caribbean seaside in a developing area the project not only required a careful consideration of colour ranges for existing buildings, but also colour schemes for new buildings.

With respect to the tropical climate, special consideration was also given to creating a chromatic harmony between interior and exterior spaces, to enhance a sense of fluidity between open and closed spaces. The aims of *Chromatictownscape* to promote and protect immediate, as well as long-term chromatic values is marked by the successful way in which the study integrated the different colour cultures coexisting in the Antilles, as well as the way in which colour was used as a means of establishing a visual comfort and an identity specific to the site and cultural context.

REFERENCE:

Schindler, V. 2005. Estudio cromático para el Liceo Profesional Regional. *30-60 cuaderno latinoamericano de arquitectura* 7 (Córdoba, RA): 6.

# Simultaneous Contrast In Visual Culture And In Fashion

Gertrud Olsson
School of Architecture, Royal Institute of Technology
KTH, SE-100 44 Stockholm (SWEDEN)
E-mail: (gertrud@arch.kth.se)

**Abstract.** The common account of simultaneous contrast is that the contrast phenomena occurs between two or more colour surfaces seen together, and thus affecting each other. Contrast effects enhance the difference between the colours involved; e.g. when a colour, as an inlay, is placed on two larger areas. This paper focuses on Sonia Delaunay's and the early modernist's application of the concept of simultaneous contrast. In the 1910s, Sonia Delaunay used simultaneous contrast to produce specific effects in paintings, fashion, ballet costumes, and textiles. For Sonia Delaunay, and also for Robert Delaunay, Apollinaire and Cendrars, simultaneous contrast could help express the new era's speed, velocity, and movement. At the same time, Moholy-Nagy worked out how a new world shows itself in the growing visual culture, a world that had changed from a static to a kinetic mode.

**Chevreul.** An obvious base of a study simultaneous contrast is the work of the French chemist M.E. Chevreul (1786–1889). His book *De la loi du contraste simultané des couleurs* (1839) is a thorough scientific examination of different contrast phenomena. Between 1824 and 1864, Chevreul was Director of the dye laboratory of *the Royal Manufactures at the Gobelins* in Paris. At the Gobelins tapestry, Chevreul noticed that the wool threads in the tapestry did not look like a skein (a wound length of yarn) of the same colour. The combinations of wool threads in the tapestry resulted in a new colour mixture on the retina of the eye. With the utmost precision, he began to examine the colour phenomena of wool. He juxtaposed different colours to observe how they changed the way they were perceived. He also discovered that the wool's *softness* in the tapestry made the boundaries indistinct, an appearance unlike the painted original. This indistinctness made the phenomenon of simultaneous contrast possible. From Chevreul's findings, the dye laboratory reduced by half the number of dyes that the weaver needed.

In his laws of colour contrasts, Chevreul concludes that to our eyes the colours will appear as *different* or *dissimilar* as possible, both in value and hue (§ 16). The *hues* and *values* of the colours change. The *hue* includes colours such as red, yellow, green. The *value* is the lightness or darkness of a colour. For example, a dark grey juxtaposed with a light grey will appear still darker. Red seen next to orange moves towards violet, and orange moves towards yellow. Furthermore, as Faber Birren notes, when "complements (red and blue-green) are seen in isolated areas of fair size, they add power to each other and appear all the more chromatic because of simultaneous contrast" (American edition of Chevreuls's *The Principles of Harmony and Contrast of Colors*, p.161).

**Impressionist painting.** Taking their cues from Chevreul's work, the Impressionists, and even more the Neo-Impressionist painters, developed a technique "mixing" colours on the retina of the eye. They arranged the colours so the surfaces melted together, making them indistinguishable to the observer, departing from distinct boundaries created by mixed pigments on canvas found in earlier forms of painting. The Neo-Impressionists wanted to catch the impression of verve, to recreate an effect of the immediate impression. They applied colour in small dots, spots, swirls or lines, moves that demand visual blending and the use of pure spectral hues. They mixed their tones optically. The juxtaposed small dots make possible the optical mixture when observed from a distance. Their paintings were characterised as atmospheric openness. The artist created this openness by forsaking the use of contours and by loosely defining the boundaries as an interplay of colours, shakes, and fields.

At the beginning of the 20th century, many artists found that the pointillist technique used by the Neo-Impressionists produced an achromatic greyed effect (Gage, s. 249). Some artists, such as Matisse, applied new colouristic technique on the contrast of large areas of the colour hue. As early as 1912, Sonia Delaunay created one of the first painting techniques in an abstract form with colours applied to large areas (Damase, p. 6). She took up the concept of simultaneous contrast from Chevreul and called her style of painting *simultanée*. Principally, she worked with colour contrast to add power and chromatic strength to the tints.

**Sonia Delaunay.** The Russian-French artist Sonia Delaunay (1885–1979) was born in the small Ukrainian village of Gradizhsk and grew up in St. Petersburg, Russia. At the age of twenty, she moved to France and lived all her life in Paris. In her early expressionist painting period, around 1906, she worked with strong contrasts of colour *(Sonia Delaunay,* s. 18). In the 1910s, Sonia Delaunay started to work with simultaneous contrast in a non-figurative way in several projects: paintings, fashions, ballet costumes, textiles, prints, books, and interior designs.

**Simultaneous contrasts in patterns.** Sonia's patterns in pure colours and in new colour relationships are varied in abstract forms. She uses arcs and circles, rectangles and triangles. (Perhaps it is worth pointing out that the form of circles was a symbol of the sun and of the simultaneous action.) The patterns change in rhythmic movements corresponding with their movements in value and hue. Her dresses and costumes are also inspired by the natural movement of the body. She began from the four basic colours – red, yellow, green, and blue – and black and white. The red hue is often mixed with yellow to form an orange-red. The green is mixed with yellow to form a hue similar to the colour of a mimosa flower. Her blue is a middle-blue and the yellow is strong. In addition, she uses grey. In her patterns, she often excludes some of the colours. When working with textiles, Sonia chose a limited number of closely related hues, allowing the vibrancy of the colour contrasts to extend their influence.

Sonia worked with print on textile as well as applications and embroidery. Around 1912, standard fabrics usually showed large flowers against black or strong coloured backgrounds (Damase, p. 62). Sonia's simultaneous fabrics changed this custom; she manufactured the same elements as used in her paintings. Her abstract patterns are simple and have clear motifs in composition and colour – actually quite similar to some African patterns. The colours are often vivid, but they harmonize most agreeably. In connection with this, she began to work with book covers, posters, textiles, dresses, and with the first "simultaneous automobile", a *Citoën B12* (from 1925) painted in the colours of the rainbow. "Simultaneity is her trademark", as Robert Delaunay put it (p. 66).

**The Eiffel Tower.** When talking about Sonia, one cannot escape to mention her husband the painter Robert Delaunay (1885–1941). The couple's attitudes were engaged with modern life, to the new emerging society shaped by technology and progress. They worked side by side, but in two different ways with simultaneous contrast. Sonia in one-dimension, at the surface, using rhythm and movement, Robert Delaunay in three-dimensions using light and space.

*The Eiffel Tower* in Paris became a symbol of simultaneity for the Delaunays and for the new art and literature as well *(Sonia Delaunay*, p. 33). The tower is clearly visible all over the city. This tower, named for the constructor Gustave Eiffel, was erected in the year of 1889 (on the centenary of the French revolution) for the world exhibition in Paris. The 300-meter high construction of cast iron was put together using 15,000 pieces that weigh a total of 7,500 metric tonnes. Robert Delaunay painted over fifty pictures of the Eiffel Tower. In one of his paintings from 1910, divergent planes are put over each other. The perspective multiplies and opens up. The colours are built from confrontations of colours in strong contrasts. With *Simultaneous Windows* (1911– 12), a study of the prismatic, Robert Delaunay left the reproduction of reality and obliterated all objects in his pictures. *Simultaneous Windows* consist of a transparent non-figurative object, a glazed opening with "elusively reflective qualities" (Rowe & Slutzky, p. 28). For Robert Delaunay forms are "nothing but reflections and refractions of light" (p. 29). The phenomenon of *lustre* of the surface flicker or glimmer is seen as transparent: "we seem to see into it and below it", as the physicist Ogden Rood describes lustre (p. 280).

The poet Guillaume Apollinaire (1880–1918) used the word *Orphism* to describe Robert Delaunay's paintings. He represents, according to Apollinaire, a new art movement proclaiming the signification of pure colour. Only by simultaneous contrast art could reach the pure expression and preserve the dynamic force of the colours. For the Orphist, simultaneous colours and forms reached an effect only when observed simultaneously. Robert Delaunay links with Seurat's and the Neo-Impressionist's experiments with simultaneous contrast. He appropriated the group's colour theory and their discoveries of light and colour. In 1912, Apollinaire published the first *literary* account of simultaneity. In *Zone*, he described a walking tour of Paris with no punctuation in the text to halt its progress. The poem slips from past to present, from images of antiquity to automobiles, aeroplanes and, naturally, the Eiffel Tower *(Sonia Delaunay*, p. 29). It is an homage to the new world of the 20th century and, at the same time, a farewell to the old world.

**A simultaneous language.** Sonia Delaunay integrated poetry and painting, letter and colour, into a simultaneous whole. The word simultaneity referred to the excitement and dynamism of the modern era *(Sonia Delaunay,* p. 103f). Sonia looked for the activity of colours in combination and transformed the colours from separate entities into pulsating unities of visual energy. Her techniques revealed the concept of simultaneity to the viewer (p. 104).

In Apollinaire's apartment, Sonia Delaunay met the poet Blaise Cendrars (1887–1961). His pen name (Cendrars) was created from the French word for ashes, *cendré*. Fire was important to Cendrars and so was colour. Like the express trains, the automobiles, and the aeroplanes Cendrars pays tribute to life in 120 kilometres per hour. His poetry is built on the oppositions of fire and ashes, hardness and softness, noise and silence – and colour contrasts *(Fransk poesi*, p. 26f).

In 1912 and 1913, he collaborated with Sonia Delaunay on *Prose du Transsibérien et de la Petite Jehanne de France,* a *poème simultanée* a collaboration of words and imagery. In this great poem Cendrars and Delaunay "exploited the structure of travelling as a model for the modernist experience" (von Moos & Rüegg, p. 39). Time and space form the ground structure of the voyage. The poem was designed by Sonia in colourful contrasting colours as the first "simultaneous book". The simultaneous poem is written by Cendrars in "free verse", disrupting the rhytmic flow of sounds revealing the Russian railway line as a visual map all the way from Saint Petersburg to Wladiwostock (ibid.). The adventure of travelling is brought to life in the poem. It establishes links between the places seen along the way and those remembered. It also tells "the thoughts, memories, reflections and fantasies that pass through the mind of a young poet", who is accompanied by a young girl. The travel ends with a rousing ode to Paris *(Sonia Delaunay*, p. 30). Everything is in the present, the here and now as well as the past and the future and the whole world. The key word is simultaneity – seeing simultaneously from different directions.

The book cover was a vertical paper two meters long with twenty connected sections. The total edition of 150 books reached up to the top of the Eiffel Tower, as mentioned the symbol of the new age. The text was set up in twelve different typefaces printed in several colours. The format and the design of the poem are made so the viewer simultaneously pictures the art and the text (Harding, p. 36). It varies in hues, tones, and contrasts of colour. The text mirrors the colour and form; the colour and form mirror the text.

In a short essay on Sonia Delaunay, Cendrars writes:

> Our eyes reach up to the sun. A colour is not a colour in itself. It becomes a colour only in contrast to one or more colours. A blue colour is only blue in contrast to a red, a green, an orange, a grey and every other colour. (ibid., p. 34)

**Simultaneous contrast in costume and in fashion.** During the summer of 1913, Sonia Delaunay began to design simultaneous dresses. She made them and mounted them in collages made of textile. These simultaneous dresses were a new wave in fashion corresponding with the latest popular dances of that time, the foxtrot and the tango. "The rhythms made us want to make the color dance, too", she said *(Sonia Delaunay,* p. 37). In her abstract forms of arcs, circles, rectangles and triangles Sonia created a movement of colour. But the forms and the contrasting colours also enhancd the natural movement of the forms of the body, corresponding with the rhythms of Latin music. In the dancehall the Bal Bullier in Montparnasse, one could see the action of the dancers united with the action of colour and light.

Sonia was commissioned to design the costume for the ballet *Cléopâtre* (1918). Working for the theatre, she could experiment with successive designs for lengths of fabric: textiles wrapped around the human form, the body set into action in dance, visual movements of the costume. Cleopatra's costume was built up of discs in pure colours decorated with sequins and pearls. The ballet established Sonia's name as an innovator in both costume and fashion *(Sonia Delaunay,* p. 51). In the following two years, after *Cléopâtre*, she did the costume for *Aida,* performed by an opera company in Barcelona. Here she combined simultaneous colours with floral folk patterns. And later in a new ballet, *Les Quatre Saisons* (1928), she designed background scenes and dresses for each season in the play. Once again she used the rhythm of colour contrasts and the rythhm between forms.

In 1922, a textile manufacturer in Lyon in France asked Sonia for a set of fabric designs. They ordered fifty designs for silk. She introduced abstract geometrical designs in printed silk. For the commission, she began to study colour relations. The subject of textile studies refined her control of the interaction of colours *(Sonia Delaunay,* p. 65). A few years later, on Boulevard Malesherbes in Paris 1925, she opened her own shop, the *Boutique Simultanée*. Here she offered simultaneous design in the form of coats, dresses, handbags, and even interior furnishings.

Sonia's modern cut supported the display of her geometric forms. The cut of the dress was conceived by its creator simultaneously with its decoration. Sometimes Sonia weaved a verse in large letters inside a cape, or embroidered a quotation from a poet on the outside. One can put it in two ways: this dress is a poem or this poem is a dress. The depression in Europe in 1929 ended the great age of Delaunay's fashion *(Sonia Delaunay,* p. 68f).

**Moholy-Nagy.** At the same time, in the 1920s in Germany, the Hungarian artist László Moholy-Nagy (1895–1946) taught at the Bauhaus School in Dessau. Similar to Sonia Delaunay, Moholy-Nagy worked with pure colours and with colour contrasts in compositions. He made collages with coloured paper strips "to clarify how different colours behave when organized in relation with each other" (2005, p. 216). The most interesting phenomena, he thought at the time, are the after-images and the subjective changes in the neighbouring colours (p. 88). However, Moholy-Nagy changed his used technique and the medium from pigment on canvas to "painting-with-light" directly in space. Instead of canvas, Moholy-Nagy painted transparencies, coloured lights one behind the other, like coloured light on a screen. His desire was, he writes, "to work with the peculiar characteristics of colours, with their pure relationships" (p. 219).

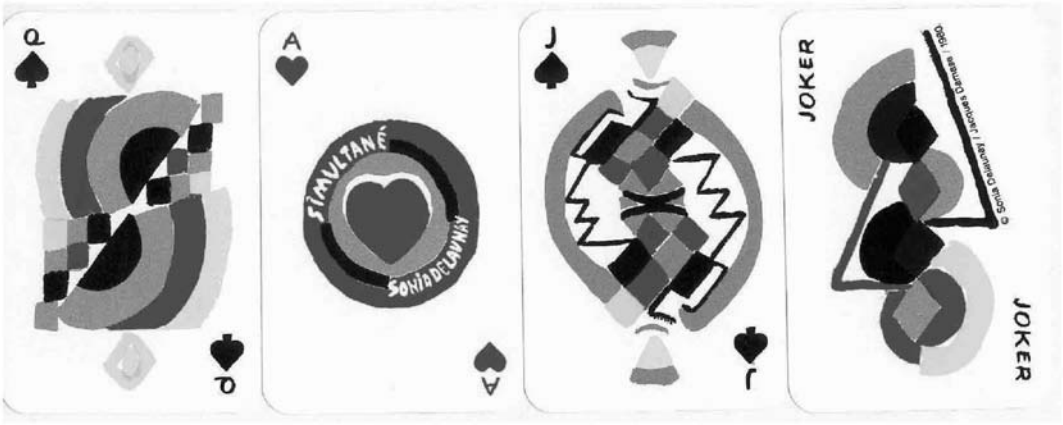
Moholy-Nagy examined the tension and relation between light and movement, between materiality and visuality in an optical way. In addition, he introduced the word *transparency* in architectural context. In architecture "transparency means a simultaneous perception of different spatial locations", to use an established definition of today (Rowe & Slutzky, p. 23). In *Von Material zu Architektur* (1929), Moholy-Nagy analyses how a new world shows itself in the growing visual culture. Architecture changes from restricted closed spaces into a free fluctuation of forces. In painting, coloured pigment is replaced by a display of coloured light. And in spatial creation on stage, Moholy-Nagy experimented with "the problem of creating space from light and shadow" (2005, p. 197). During eight years (1922–30), he worked with a light-space-modulator trying to create a stage design only by light and shadows, generating an architecture that seemed completly immaterial. In the production *Tales of Hoffman* (the State Opera in Berlin 1928) everything on stage was transparent. Moholy-Nagy let the transparent surfaces work together in order "to make an organized and well perceptible space arrangement" (ibid.). The transparent material collected, scattered, and reflected the light. The manifold reflection by mirrors created an illusion of swaying.

For Moholy-Nagy, the concept of *simultaneous* is synonymous with the word *transparency*. In his abstract pictures in motion, he paints with light. He applied colours with flowing, prismatic light that oscillated instead of using pigments. In Moholy-Nagy's light display machines, his kinetic sculptures, automatic projections, created effects of changing luminous. Discs of polished metal, sheets of glass, and celluloid produced a "range of shadow interpenetrations and simultaneously intercepting patterns in a sequence of slow flickering rhythm", Moholy-Nagy writes (2005, p. 141). In simultaneity, one can see everything at the same time, and in addition to this, one can see movement.

In *Von Material zu Architektur,* Moholy-Nagy brings out the new world expressed by the optical culture. His thesis is that modern perception does not separate, but includes, in a play, the relation between object and events. Light and perception rub out the limit between different rooms. Traffic, industry, modern architecture, and big events belong in the same room, perceived as an integral whole. Also for Moholy-Nagy, the Eiffel Tower is a symbol. With its broken-through perforated volume, the significance of the tower is to become an object experienced simultaneously "on the border line between architecture and sculpture" (2005, p. 183).

**Field of vision.** Chevreul's observations about colour contrasts and colour phenomena were the points of departure for *a new visual culture*. His discoveries about the laws of visual mixture opened up a new vision. In painting, the single moment received attention. It manifested the importance of the eye's impression. Thanks to Chevreul, the late 19th century artists were able to introduce a technique of *mixing*

*coloured light*. By painting a great number of small dots juxtaposed, the colours melted together in the eye of the beholder. When seen from the proper distance, the motif of the canvas appeared. Sonia Delaunay and Robert Delaunay took the simultaneous contrast further, working with abstract large areas to give the pure colours a vivid and chromatic hue. In addition, the Delaunays developed the concept of simultaneous contrast in the fields of fashion and costume. In the 1920s, Moholy-Nagy began to paint-with-light directly in space, and formulate in words how the new world shows in the growing visual culture. – Today, eighty years later, we live in a colourful visual world of movies, televisions, and big scale advertisements. Plexiglas and many other glass materials, light projections, light shows, and colour light installations all act together constructing a culture *for your eyes only*.




**References:**

F. Birren, Principles of Color. [1969] (Van Nostrand Reinhold Company, New York, 1987)

M.E. Chevreul, The Principles of Harmony and Contrast of Colors. [De la loi du contraste simultané des couleurs, 1839] Ed. F. Birren (Van Nostrand Reinhold Company, New York, 1967)

J. Damase, Sonia Delaunay. Fashion and Fabrics. (Thames and Hudson, London, 1991)

Fransk poesi 1910–1970. [French poetry including Apollinaire, Cendrars] (Fibs Lyrikklubb, Stockholm, 1974)

J. Gage, Colour and Meaning. (Thames and Hudson, London, 2000)

G. Harding, O Paris. (Fibs Lyrikklubb, Tidens förlag, Stockholm, 1978)

L. Moholy-Nagy, Von Material zu Architektur. [1929] (Gebr. Mann Verlag, Berlin, 2001)

— The New Vision [1938] and Abstract of an Artist [1947]. (Dover Publications, New York, 2005)

S. von Moos & A. Ruëgg, Le Corbusier before Le Corbusier. (Yale University Press, New Haven and London, 2002)

O. Rood, Modern Chromatics. Students' Text-Book of Color with Applications to Art and Industry. [1878] (Van Nostrand Reinhold Company, New York, 1973)

C. Rowe & R. Slutzky, Transparency. (Birkhäuser, Basel, 1997)

Sonia Delaunay: A Retrospective. (Albright-Knox Art Gallery, New York, 1980)

# Colour Knowledge And Its Application As A Reflection Of One's Culture

Priscilla Botha
Professor Emeritus
Formerly from the University of Pretoria, Dept. Consumer Science
Tel: (+27 84) 245 1456
priscillab@iburst.co.za

**Abstract**
The interrelatedness of the concepts culture, colour and knowledge are explicated. Colour as a phenomenon and the meaning of colour as arising from our associations embedded in a wide range of fields like the arts, culture including as idiosyncratic personal encounters are explicated. The pervasiveness, complexity, and at times contradictions from the various perspectives, ensure that no one meaning is correct, normative or representative or typical. Suggestions are included how this viewpoint can be applied in a colour curriculum.

**Introduction**
The title of the paper suggests that I should reflect on the three main concepts of **colour**, **culture** and **knowledge** and their interrelatedness. Colour knowledge and its application in everyday life constitute an aspect of culture. Therefore I shall introduce my paper explicating firstly the concept culture and afterwards the concept of colour and of knowledge.

**Culture**
Culture denotes all *'human-made material items and patterns of thought, feeling and behaviour shared by members of a group who regularly interact with each other*[1]**.** Culture includes a range of material and nonmaterial phenomena, which are interrelated. Material items (material culture/artefacts) are made in line with the group's ideas, beliefs and values (nonmaterial culture/mentefacts) and the way the members think how these should be made, what is aesthetically pleasing and how the items should function. Many objects are designed primarily for utilitarian or ritual use. These also reflect the materials available to the people and the level of technological advancement (Brown, 1963:67-70)[2]**2**. The acceptance of a specific form of art/craft and therefore the specific form of expression is a learned response as the people of a society develop a heritage of common experiences.

The notions of history and fashion stress the constantly changing nature of culture. Since the previous century, we are experiencing **globalisation**, which implies more similar ways of behaving as a result of the interconnectedness of people around the world. As cultures come into contact with each other, innovative items emerge, which have an appeal to people across boundaries. In this vein we have had punk, hip-hop and rock music that have been popular across many cultural groups. Contrary to this, there seems to be another tendency of individuals starting to interpret and reinvent their practices from the past to meet a new challenge, i.e. to define themselves and to announce their affiliations, such as ethnicity, as fulfil several roles, and wish to move through several cultural milieus as the context may change (Eicher *et al,* 2000:48)1. (Illustration).

Throughout the world, it has been felt that '*beauty is its own excuse for being and the search for beauty is a universal human experience'* (Brown, 1963:63)2. Aesthetic expression and enjoyment are in themselves rewarding experiences that compensate for much of the routine and humdrum activities of daily life. Seldom has man been satisfied with the strictly utilitarian. Man has used the resources of his habitat and technology available to make the things needed for comfort and welfare, but we have also chosen to make these beautiful, and at times created objects solely for the aesthetic pleasure of the maker and the consumer of these objects. Therefore, there can be no arbitrary standards applicable everywhere for one's response to any aesthetic expression. Aesthetic expression is a function of one's own cultural experience (Brown, 1963:64).2

In any object, design is implied and therefore also the design elements and design principles. Colour as a design element is of particular importance for those attending this conference. It is not only the artist or designer who deal with colour; all people have to make colour decisions almost every day. Therefore I shall turn to colour as the next concept of importance.

**Colour**

Colour is an essential part of everyone's life. Our world is marked by bold uses of colour. All of us make colour decisions almost every day in ordinary living. We constantly have to choose items to buy where colour is a major factor determining the outcome of one's decision - from different colours in home appliances, interior finishes, cars, clothing, etc. From an artists or designers point of view, colour is arguably the most important design element. Fashion design, interior design, architecture, industrial design, visual merchandising, are a few of the fields of expertise that are increasingly concerned with colour.

Colour is a property of light, not an object itself [3](Lauer & Pentak, 2005:236). This fact is illustrated when white light is put through a prism and broken into the familiar rainbow of hues. Objects have no colour of their own, only the ability to reflect a colour. The significance of this is that as light chances, the colour of objects will change. Related to this is the fact that our perception of colours changes according to their surroundings. Rarely do we see colour by itself. The nuances of a colour created by medium, surface and material should always be considered. Colour preferences may be product specific and is not necessarily an indication of personality traits [4](Lind, 1993:57).3

The guidelines for colour mixing and usage differ depending on whether the colour source is light or pigments and dyes. The former is direct light and the latter is reflected light. Colour from light combines and forms new visual sensations called an *additive system*, whilst pigments combine according to a *subtractive system* because when light hits the surface, pigments absorb (or subtract) all of the colour components except the one that is the colour of the object. The outcome when primary and secondary colours of different light sources are mixed will be a white light, whereas mixing the same colours in paint, would produce a dark neutral 'mud'. The two colours act like two filters to combine to reflect less light. A paint mixture is always weaker than at least one of the parent colours (Lauer& Pentak, 2001:236).4

**Colour systems**

Colour as such, is the only design element that can be studied, (and taught or applied) from a (natural) science and the social sciences (e.g. psychology, anthropology (cultural) and an arts/aesthetic) perspectives. Each of these perspectives contributes to a wider understanding of this particular phenomenon. The former is exemplified in numerous colour systems, of which the Ostwald, Munsell and Natural Colour System (NCS) are perhaps the best known or most often used when working with pigments or coloured paper. These systems aid our understanding of (some) of the complexities of the fields of colour by reference to a fixed set of descriptive qualities and numerical coding. This is summarised as a hue circle, a vertical value/nuance scale and a horizontal intensity/chromatic scale. These different scales are combined in a 3D model/tree/solid, which is said to summarise all possible variations of a colour. Therefore when dealing with colour, it is important to realise that (colour) knowledge is constructed within different systems of representation and no system is adequate to explain the complexity of the phenomenon of colour.

**Knowledge**

To know and understand more of our living world is an essential part of being alive. According to Aristotle, knowledge or scientific inquiry started off as and is driven by wonderment about the nature and origin of the universe (Babbie & Mouton, 2001:4)[5]5. Hawking [6](1988:14)6 also maintains the same when he says: *'Man has a deep desire to have knowledge and our goal is nothing less than a complete description of the universe we live in'.*

**What is knowledge and how do we come to have it?**

0ne has knowledge when one has certainty about some information and / or an understanding thereof [7](Graig, 1999:198).7 There are at least two types / worlds of knowledge applicable for this paper of which each has a language game of its own. The first type of knowledge is scientific

knowledge and the second type is 'lay' knowledge, also called common sense or everyday knowledge (Babbie & Mouton, 2001:13-15).5

Knowledge as *verified* beliefs implies that it is a product or outcome of scientific research, the process by which **scientific knowledge** is generated and structured as concepts, definitions, theories, etc[8]. (Mouton, 1996:13, 180).8 The aim of science is to produce a certain kind of knowledge, which forms the foundations of science (Mouton, 1996:14).8 To be able to claim and conclude that scientific knowledge is 'true', the evidence should be justified or substantiated through empirical evidence and logical argumentation and inferences should in fact be true or accurate representations of reality

The above view of knowledge draws a sharp line between scientific and **common-sense or everyday knowledge**, which is firstly based on the (sometimes) uncritical acceptance of unsubstantiated beliefs or opinions about the lived world, often passed down from generation to generation, and secondly, it is coloured by personal values and laden with moral or political judgements[9] (O'Connell, Davidson & Layder, 1994:21).9 This stands in sharp contrast to the objective, value-free facts, neutral stance of scientific knowledge based on rigorous, empirical observations and hypothesis testing.

However, ordinary knowledge of which not all is inferior, has a number of positive features. Because it is based on personal experience and observation, it is rich in meaning and symbolism. Much of our understanding of people and phenomena that we encounter in our daily living is based on the accumulated experiences, observations, and reflections over the years. Despite the fact that our common knowledge may be based on inaccuracies, we gain an understanding of how things work and are able to solve problems of everyday living.

The above explication means that we can construe reality in two ways. Following Van den Berg (in[10] Kruger, 1979) 10 we speak of first and second orders of reality, or that scientific observations are at a different level from ordinary experience and therefore (according to some scientists) privileged and thus the only form to enjoy scientific status. (Natural) scientists are interested in what is tangible and measurable and are able to *explain* phenomena. They do not necessarily claim that their hold on reality is total, but suggest that science is cumulative and therefore systematically expands our knowledge. It thus claims that what is known through a rigid methodology, is at least verifiable. (This viewpoint implies a positivistic metatheory and mostly a quantitative methodology). The question arises whether the methodology of the (natural) sciences can grapple with human experience and his reality? Without arguing this point, one can make a general statement that, to understand human nature, a natural scientific oriented measurement is not suitable. The social scientist maintains that to *understand* man as man rather than as an object, he must have an understanding of what it really *means* to be (e.g.) a mother or father in relation to being a piece of furniture or to be parents to their children or husband and wife. To understand people, people are conceived, not primarily as biological organisms, but foremost as conscious, self-directing symbolic human beings (Babbie & Mouton, 2001:28). A comprehensive understanding of human behaviour is sought in contrast to the central role of variables in describing and analysing human behaviour. In the words of Van Kaam (in Dreyer, 1978:143) *'it manifests itself with the least possible imposition of theory or method, personal and cultural prejudice or need …'*. A different method of inquiry from the natural sciences is thus necessary, because these qualities and nuances of meaning cannot be quantified, perhaps only in an arbitrary way. A '*thick description'* coined by Clifford Geertz (in Babbie & Mouton, 2001:272)5 referring to a rich detailed description as opposed to summarised, standardised descriptions of quantitatively measured variables. [This viewpoint implies a phenomenological metatheory and a qualitative methodology. (Kruger, 1988:21, 58; Babbie & Mouton, 200:xxiii-xxiv)].10,5

To be a professional one needs not only to have a scientific understanding of one's subject matter, but also a scientific way of solving problems, which is closely related to a scientific research process or design process. The design process can be summarised in three very simple activities, namely 'Thinking, Looking and Doing' (Lauer & Pentak, 2005:6-21)4 or one can use a model to structure the process. [Illustration using Grete Smedal's work in Longyearbyen where she had to plan and develop a colour scheme for the town. She faced challenges such as the ever changing

light, the inherent colour scheme of the landscape and the negative impact the built and external environment had on the inhabitants of an isolated settlement[11] (Smedal, 2001)]11

Scientists or professionals are both members of society and are scientists and they presumably have knowledge of their subject matter as well as everyday commonsense or experiential knowledge. Furthermore, knowledge of their subject matter can be constructed within different systems of representation. In both cases, the other powerfully shapes each type of knowledge. Therefore phenomena investigated by social and for that matter also natural scientists, cannot be researched/taught without any reference to this everyday common-sense knowledge. Both types of scientists therefore conduct research, which "*does nothing more than elaborate and codify such-taken-for granted knowledge" and "...the fact that (social) scientists are formed and informed by their subject matter (society), does not force them to uncritically regurgitate existing beliefs ".* (O'Connell *et al,* 1994:27)9. As ordinary members of society, not occupying the role of scientist, we also try to understand and question life in non-scientific ways. The two types of information / knowledge gained by very different avenues, does not make the last mentioned, less informative and enlightening. According to Taylor (quoted in Graig, 2000:3, 5) 7mechanistic explanations of behaviour restricts its own explanatory power and that "*...any acceptable account must in fact be coordinated with our everyday account so as to save the phenomena'* or exhibits '*a respect for the phenomena*' (Kruger, 1988:143.10

**Integration and application**

I want to conclude with an integration and application of the above in terms of my life long experience as university lecturer, teaching courses in design and research methodology and the insights of Olivia Gude (coordinator of art education and assistant professor in the School of Art and Design, University of Illinois, Chicago). According to Gude [12](1999)12 the main aim of a colour curriculum, should be to enhance learners' sophistication when using colour. They should learn to trust their own perceptual skills and life experiences with colour and should not uncritically regurgitate existing information. Their experience with colour should also be widened by examining the role of the visual artist and the other cultural groups in generating meaning and value in changing times. The following is a few ideas:

- Firstly introduce learners to ***a natural science paradigm*** by exposing them e.g. to Johannes Itten's colour sphere and let them paint hue, value and chroma scales to see how colour perceptions are structured and let them get hand on experience on colour mixing. Introduce other colour systems e.g. Munsell, and NCS to see how basically the same information is presented in different systems of presentation. . Also introduce colour systems for different media, e.g. CMYK, (Cyan, Magenta, Yellow, and Black) the colour breakdown for four colour process printing. The learners are encouraged to discuss which features, are best explained by each model and medium.
- ***Knowledge is constructed within systems of presentation.*** Expand the previous exercise and bring in different materials, media and surfaces of the same colour (as far as possible). Learners are confronted with the fact that colour perception and choices cannot be decontextualised and stripped of material and historical associations. No system is adequate to represent the complexity of reality. Learners have to realise and continue to see *'the thing itself' and not its depiction within a single representational system' (Gude, 1999:22).*
- ***Using ''imperfect' pigment to achieve the theoretically predictable results*** by mixing three primaries to get a complete range of hues or mixing complements to get a mid-value grey. These experiments, inevitably leads to murky and dull colours. Learners frustrated with this exercise, should realise that theoretical predictions is not duped by incorrect theory, but is '*struggling with the inevitable gap between the complexity of the visual world and the limitations of the systems we use* (Gude, 1999:22)12
- 
- ***Knowledge is based on the best evidence available at a given time*** (Babbie & Mouton, 2001:8). Technological advancement in colour chemistry made it possible to include colours that long had been seen but could not be produced in pigment colours, e.g. the bright blue seen on butterfly wings and consequently added to the Munsell colour system. The expansion of the NCS colour atlas lately is another example.

- ***The meaning of status and devotional symbols can shift with the advent that the symbol looses its economic value*** e.g. when the brilliant blue pigments were replaced circa 1824 with the much cheaper Ultra Marine Blue
- ***Affirming existing colour theory (e.g. simultaneous contrast) and not allowing students to first give their own reactions,*** reinforces the idea that all information conveyed is objectively true. Teaching solely this tradition is problematic. It is suggested that colour exercises be contextualised in history of modern art and culture and that the perpetuated values and meanings are re-examined.
- ***Etc***
-

**One should understand the interconnectedness of technical, economic, and socio-cultural information to appreciate the wonder of colour**

**References**


1 J. B. Eicher, S. L. Evenson and H.A. Lutz, The visible self, 2nd ed., Fairchild, New York, 2000.

2 I. C. Brown, Understanding other cultures, Prentice Hall, Englewood Cliffs, N.J.

3 C. Lind, Psychology of Color: similarities between abstract and clothing color preferences, Clothing and Textile research Journal 12(1):57-65.

4 D. A. Lauer and S. Pentak, Design Basics, 6th ed., Thomson Wadsworth, 2005.

5 E. Babbie and J. Mouton, The practice of social research, South African ed., Oxford University Press, 2001.

6 S. Hawking, A brief history of time. From the Big Bang to Black Holes, Bantam Books, London, 1988

7 A. P. Graig, What is it that one knows when one knows 'psychology'? Theory and Psychology 9(2):197-227.

8 J. Mouton, Understanding social research, J. L. van Schaik, academia, Pretoria, 1996

9 P. O'Connell, J. Davidson and D. Layder, Methods, sex and madness, Routledge, London, 1994.

10 D. Kruger, An introduction to phenomenological psychology, 2nd revised ed., Juta, Cape Town, 1979.

11 G. Smedal, Lonyearbyen in colour – status and challenges, Kunsthogskolen, I Bergen, 2001.

12 O. Gude, Color coding, Art Journal 58(1): 21-24.

# Color Harmony Study on Object-Background Patterns

Xiao-Ping Gao and John H. Xin
Institute of Textiles and Clothing,
The Hong Kong Polytechnic University, Hong Kong, China
Corresponding author: Xiao-Ping Gao (xp.gao@polyu.edu.hk)

**Abstract**
Color harmony refers to the pleasing feeling in visual experience produced by color combinations. The harmony of 810 of CB color patterns, in which a center color was placed on a background color, was evaluated by 20 subjects. The influence of relationship between two component colors and single color preference on color harmony was analysed. Lightness difference and average lightness are the two most important factors, which accounts for 38.9% and 18.3% of variance, respectively. The harmony of the color pattern reached its top level when the lightness interval equal to 24. As a high positive correlation was observed between lightness and single color preference, a high harmonious level of color patterns with high lightness may partially attribute to color preference. Hue difference, accounting for 9.1% of total variance, was also a very important factor on color harmony.

## 1. Introduction

When two or more colors seen in neighboring areas produce a pleasing effect, they are said to produce a color harmony[1]. The concept of color harmony has been widely adopted in product design. It can provide an accurate and objective tool for color arrangement in applications such as textile fabric design, interior design, and advertisement design. Especially, the efficiency of product design can be significantly enhanced when the color harmony model is cooperated into computer-aided design (CAD) system. Many of early philosophers and artists have formulated their own color harmony rules[2]. Some of which are still be used today, such as, monochromatic scheme, analogous colors, and complementary colors, etc. These traditional color harmony rules, however, may have limitations since they were based on personal experience and represented personal desires rather than from systematic observation of color phenomena[2, 3].Therefore it is very important and meaningful to investigate what combinations of colors can produce harmonious effects by using psychophysical experiment. In the textile pattern design, patterns with two component colors in object-background relationship (CB pattern) are most frequently used and were studied in this experiment.

## 2. Methods

Fig. 1 shows the color pattern investigated in this study. In this pattern, the two colors are in center-background relationship. For abbreviation, it was named as CB pattern.

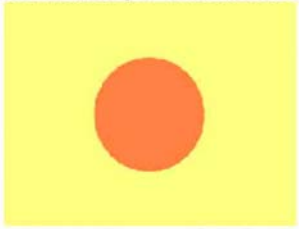


Fig. 1 The color pattern used in the experiment.

The design of color stimuli was based on the previous studies[4-10]. It was known that hue related, lightness related, and chroma related variables, are three categories of factors should be involved in color pattern design. For the variation along the hue related dimension, it is known that hue difference is the most important factor and the influence of hue itself is unimportant[6-8]. Therefore we fixed the hue of one component color and changed that of the other component color so that various level of hue difference could be covered. In the experiment, we selected Munsell hue 5G as one hue and ten 5-series Munsell hue as the other ones. Hence ten kinds of hue pairs were included in

the color patterns. In view of the asymmetry of the two component colors, hue pairs with 5G as background color and as center color were both used. Consequently there are totally 19 hue pairs.

The interval and average value are both deemed to be very important in the lightness related variables and chroma related variables[4-8]. The design of color pairs along the lightness and chroma dimensions is described as follows. The lightness and chroma of each color are respectively classified into three levels: high, median, or low. Hence for the two component colors in a pattern, 6 following combinations of lightness dimension or chroma dimension are possible: high and high, high and median, high and low, median and low, and low and low. With different lightness combinations and chroma combinations, different color schemes can be constructed for each hue pair. Thus, totally 810 of different color patterns were designed and then were evaluated in this experiment.

The subjects are college students aged from 25 to 35. Twenty subjects, half male and half female, participated in the visual assessments. Each subject was asked to take the Isihara Color Blindness Test before the experiment to ensure they all possess normal color vision. The experiment was conducted on a CRT display in a complete dark room. Rating scales method was used to evaluate color patterns. The seven point rating scales, "unharmonious-harmonious", from -3 to 3, were used to evaluate harmonious levels of color combinations, while "unpreferred-preferred", from -3 to 3, were adopted to evaluate single color preference when it was displayed in small size and large size to represent center color and background color, respectively.

## 3. Experimental results

### 3.1 Single color preference

To evaluate the influence of color perception attributes (hue, lightness, and chroma) on single color preference, the average single color preference for each color as object or background was calculated across 20 subjects. Their relationship was examined by correlation analysis. The results show that lightness is the most important factor, while the effects of hue as a secondary factor seems not so prominent as the results of most of previous studies[11-14]. Light colors were more favored. For constant lightness and chroma, the colors containing green or blue were more preferred, while those containing yellow or purple were less preferred.

### 3.2. Observer repeatability and agreement

Observer repeatability and agreement were examined in the experiment to ensure that the measured characteristic is stable and meaningful. In this experiment, 80 duplicated patterns were used to test the repeatability of each subject. It was found that, among 20 subjects, 1 subject had correlation coefficient less than 0.7 ($p < 0.05$). The evaluation results of the 19 subjects were considered reliable, and were adopted for further statistical analysis. The observer agreement was tested by the correlation between one's evaluation and their average evaluation. It was found that the mean correlation coefficient is 0.69, with the minimum being 0.57.

The observer repeatability and agreement indicate that color harmony is an unequivocal and stable feeling for most people. The average color harmony was calculated across the most reliable 19 subjects.

### 3.3 Color harmony modeling

We used the multiple regression analysis[15] for mathematic color harmony modeling. Two steps were employed to obtain the best regression equation for color harmony.

***Step 1: specifying the maximum model to be considered***

As mentioned in experiment method section, the component color relationships can be grouped into three categories: hue related (hue interval), lightness related (lightness interval, average lightness), and chroma related (chroma interval, average chroma). Let $\Delta h_{ab}$ be the CIELAB hue difference between two component colors, $P$ be the single color preference, $L$ and $C$ represent lightness and chroma, subscript $c$ and $b$ represent center and background color, we have 7 basic variables as listed in Table 3. In addition, we considered high-order terms ($x_1^2$, $x_2^2$, $x_3^2$, $x_4^2$, $x_5^2$), interaction terms ($x_1x_2$, $x_1x_3$, $x_1x_4$, $x_2x_3$, $x_2x_4$, $x_2x_5$, $x_3x_4$, $x_3x_5$, $x_4x_5$) and ($L_b$-$L_c$) ($C_b$-$C_c$). High correlations were observed between basic predictors and the high-order and interaction terms. To avoid the problem of near collinearity, which may lead to unstable and uninterpretable results[15], the variables $x_i$ ($i = 1 \ldots 5$) were centered before the calculation of high-order and interaction terms.

Table 1 Variables and their meanings used for color harmony modeling

| Variable | Meaning | Variable | Meaning |
|---|---|---|---|
| $x_1$ | $\|L_b\text{-}L_c\|$ | $x_5$ | $\|\Delta h_{ab}\|$ |
| x2 | $(L_b+L_c)/2$ | $x_6$ | $P_b$ |
| $x_3$ | $\|C_b\text{-}C_c\|$ | $x_7$ | $P_c$ |
| $x_4$ | $(C_b+C_c)/2$ | | |

***Step 2: Specifying a strategy for selecting variables***

Stepwise regression method was used in finding the best model. Using SPSS® and MINTAB®, the largest model is obtained, as shown in Table 2.

Table 2 Variables Entered/Removed with the criteria: probability of F to enter is less than 0.001 and the probability of F to remove is larger than 0.01.

| Model | Variables Entered | Variables Removed | R Square | R Square increased |
|---|---|---|---|---|
| 1 | $x_1$ | | 30.2% | 30.2% |
| 2 | $x_2$ | | 48.5% | 18.3% |
| 3 | $x_5$ | | 57.6% | 9.1% |
| 4 | $x_1^2$ | | 66.3% | 8.7% |
| 5 | $x_6$ | | 69.1% | 2.8% |
| 6 | $x_8$ | | 71.2% | 2.1% |
| 7 | $x_1x_5$ | | 73.1% | 1.9% |
| 8 | $x_7$ | | 74.8% | 1.7% |

From Table 2, eight variables were entered step by step with the criteria of $p<0.001$. The total variance explained by the largest model is 74.8% with $x_1$, $x_2$ are the most important factors, which contribute 30.2% and 18.3% of total variance, respectively. $x_5$, accounting for 9.1% of total variance, and$x_1^2$, accounting for 8.7%, is of considerable influence. $x_6$, $x_8$, $x_1x_5$, $x_7$, also have statistically significant influence on color harmony, but contribute very little to total variance. As practically unimportant but statistically significant predictors can greatly confuse the interpretation of regression results, we focused on a few important variables in a small model. It is reasonable to assume that the variable increasing $R^2$ less than 5% offers unimportant improvement in predictive power. Consequently, the model with first four variables ($x_1$, $x_2$, $x_5$, and $x_1^2$) was the best one according to $R^2$ increasing and model simplicity. Table 3 lists the ANOVA results of the small model.

Table 3 The ANOVA results of the selected model in CB pattern

| Source | d.f. | SS | MS | $F$ | Significance | $R^2$ |
|---|---|---|---|---|---|---|
| $x_1$ | 1 | 146.7 | 146.7 | 722.9 | $p < 0.001$ | 66.3% |
| $x_2$ | 1 | 89.0 | 89.0 | 438.37 | | |
| $x_5$ | 1 | 44.3 | 44.3 | 218.29 | | |
| $x_1^2$ | 1 | 41.4 | 41.4 | 203.74 | | |
| Residual Error | 805 | 163.7 | 0.2 | | | |
| Total | 809 | 485.1 | | | | |

The regression equation is

$$y = 0.404 + 0.047x_1 + 0.038x_2 + 0.005x_5 - 0.002x_1^2 \quad (1)$$

or,

$$HARMONY = -1.246 - 0.002(|L_b - L_c| - 24)^2 + 0.019(L_b + L_c) + 0.005|\Delta h_{ab}| \quad (2)$$

Using this model, 66.3% of total variance of color harmony can be explained. Lightness interval and average lightness are the most influential factors on color harmony. According to Eq.(2), when the

lightness interval between two component colors equals to 24, the harmony of the color pattern reaches its maximum. In addition, increasing the total lightness of color pattern also improves harmonious level. Because of the relationship between color preference and lightness, a high harmonious level of color patterns with high lightness may partially attribute to color preference. In fact, it was observed that totally 23.2% of variance could be explained by the effects of single color preference of center color and background color when total lightness was excluded in the linear regression. For the influence of hue difference, it was observed that complementary hue was more favored, while similar hue was evaluated to be more unharmonious.

**4. Discussion and conclusion**

According the results of analysis, it can be conclude that both component color relationships and single color preference may influence the harmonious levels of CB color patterns. Lightness interval was observed to be the most important determinant on harmony of this kind of color pattern. This result is quite similar with the findings of most of previous studies[9,10]. While we observed that lightness interval close to 24 is most harmonious, they stated that the larger was the brightness contrast (or lightness interval), the more harmonious was a color combination. As the largest lightness difference in this study is 30, we also can say that the patterns with large lightness interval are more harmonious than those with low lightness interval. Large lightness interval means high legibility. It means that when the objects are more distinguishable from backgrounds, the patterns will be evaluated more harmonious. This result has been proved in interior design. It was observed that if the color of furniture were similar to that of walls and floor, the effect would not be aesthetically pleasing as the three dimensional figure-ground concept would be destroyed[16].

**Reference**


1. D. B. Judden and G. Wyszecki, Colour in Business, Science and Industry (John Wiley & Sons, Inc., 1975).
2. T. W. A. Whitfield and P. E. Slatter, "Color harmony: an evaluation," Br. J. Psychol. **18**, 199-208 (1978).
3. D. T. Sharpe, The Psychology of Color and Design (Nelson-Hall Co., Chicago, 1974).
4. G. W. Granger, "Aesthetic measure applied to color harmony: an experimental test," Journal of general psychology **52**, 205-212 (1955).
5. J. M. Pieters, "A conjoint measurement approach to color harmony," Perception & Psychophysics **26**, 281-286 (1979).
6. L. C. Ou and M. R. Luo, "A Colour Harmony Model for Two-Colour Combinations," Color Research and Application **31**, 191-204 (2006).
7. N. M. Nayatani, A. Tsujimoto, J. Ikeda, and S. Namba, "An appraisal of two- color harmony by paired comparison method (part 2)," Acta Chromatica **2**, 1-15 (1969).
8. N. M. Nayatani, A. Tsujimoto, J. Ikeda, and S. Namba, "An appraisal of two- color harmony by paired comparison method (part 1)," Acta Chromatica **1**, 221-235 (1967).
9. H. Helson and T. Lansford, "The role of spectral energy of source and background color in the pleasantness of object colors," Applied Optics **9**, 1513-1562 (1970).
10. M. F. Washburn, D. Haigh, and J. Regensburg, "The relation of the pleasantness of color combinations to that of the colors seen singly," American Journal of Psychology **32**, 145-146 (1921).
11. J. P. Guilford and P. C. Smith, "A System of Color-preference," American Journal of Psychology **72**, 487-502 (1959).
12. G. W. Granger, "An experimental study of color preferences," The Journal of General Psychology **52**, 3-20 (1955).
13. G. Smets, "A Tool for Measuring Relative Effects of Hue, Brightness and Saturation in Color Pleasantness," Perceptual and Motor Skills, 1159-1164 (1982).
14. N. Camgoz, C. Yener, and D. and Guvenc, "Effect of hue, saturation, and brightness on preference," Color Research and Application **27**, 199-207 (2002).
15. D. G. Kleinbaum, L. L. Kupper, K. E. Muller, and A. Nizam, Applied Regression Analysis and Other Multivariable Methods (Duxbury Press, Pacific Grove, Calif., 1998).
16. D. T. Sharpe, *The Psychology of Color and Design* (Nelson-Hall Co., Chicago, 1974).

# Improvement PCA Performance In Recovery Of Spectral Reflectance, Considering The Lightness Mean Of Samples

**S. Gorji Kandi** [1] **, M. Amani Tehran** [1] **, M. Rahmati** [2]
[1] Textile Engineering Department, Amirkabir University of Technology, Tehran, Iran
[2] Computer Engineering Department, Amirkabir University of Technology, Tehran, Iran
E-mails: gorji_s@aut.ac.ir , amani@aut.ac.ir , rahmati@ce.aut.ac.ir

**Abstract**
Principal component analysis (PCA) has been used in color technology over 50 years. Along these years many researches have been done to find out new usages or improve it's shortcomings in different applications in color technology. One of the most difficulties is to find suitable basis vectors, which are able to reconstruct data accurately by the least number. In this article the influence of the lightness of the data set ($\overline{L^*}$) on the color difference error in dimensionality reduction of the spectral reflectance by PCA was studied. All the experiments were done by 3 basis vectors. The results show that, by increasing the $\overline{L^*}$ of the test data set that is compressed and also the train data set that the basis vectors obtained from it, the color difference error of representing is decreased even for a dark color set.

**Introduction**
Principal component analysis (PCA) is a well-known method for identifying more effective features in a data set [1]. The central goal of this technique is to represent the data in a reduced dimensionality space while preserving as much information as possible. Since spectral curves are band limited and have smooth shape, it seems that linear models are able to represent them. The principal components of a reflectance data set are the eigenvectors of the covariance matrix of it. A few basis vectors instead of 16 or 31 bands can represent the spectral reflectance curves. To perform PCA for dimensionality reduction, the desirable numbers of eigenvectors of the covariance matrix are chosen as *FV* vectors in equation (1) and then the new reflectance curves can be obtained by this equation. The dimension of the new space is based on the number of selected *FV*. It is clear that by increasing the number of basis vectors the accuracy increases, although 3 to 6 PCAs are usually sufficient.

$$\hat{R}_{(m\times p)} = FV'_{(m\times n)}.R_{(n\times p)} \qquad (1)$$

Where FV is a vector contains of m of n feature vectors in an n-dimensional space, $R$ is the original reflectance curves and $\hat{R}$ is the compressed one.
The suggested term to evaluate the value of each basis vector is the ratio of eigenvalue to the summation of all eigenvalues that expresses the percentage of mean square error introduced by eliminating the corresponding eigenvector [1]. So the equation (2) may use as a criterion for deleting the ith eigenvector.

$$\mu_i = \frac{\lambda_i}{\sum_{j=1}^{n}\lambda_j} \qquad (2)$$

Where $\lambda_i$ s are eigenvalues correspond to that eigenvectors which are not used.

It is more than half a century that principal component analysis used as an efficient mathematical tool in color technology. Cohen who was one of the first performer in this case, published the first three principal component or basis vector of 150 reflectance spectra in 1964 [2]. In resent years, PCA has found different application in color technology and many researches have been published [3]. From the most important applications of it, compression and recovery of spectral reflectance have been investigated [4-10]. Some similar techniques such as Independent component analysis (ICA), Non-Negative matrix factorization (NNMF) and etc, are also investigated in comparison to PCA [5,10].
In compression and recovery of spectral reflectance, it is always desirable to obtain the basis vectors that minimize the representation error. For instance, in one of the research, the effect of categorizing data set based on the hue characteristic was investigated and it indicated that by hue grouping, the representation error could be reduced [4]. In this paper, it is shown that how the lightness of the data

set affects the representation error in dimensionality reduction of reflectance curves and by considering the effect it is improved the performance of PCA.

**Methods**

In this paper the influence of the mean of lightness or abbreviated $\overline{L^*}$ of the data set that are used as test data to apply PCA method on them or train data to derive basis vectors for PCA, on color difference error between original spectral reflectance and that represented after compressed by PCA is investigated. The Munsell data set of 1269 matt color samples has been used. The spectral data were used between 400 and 700 nm by 20nm interval, so the data have been presented into 16 dimensionally space. The 1269 Munsell data set was divided into three groups based on the lightness of the samples. To be able to perform it, the data was sorted by lightness value and then divided into three sets, which contained of 423 samples. The lightness characteristic of each group is shown in table (1). All of the experiments were performed by 3 basis vectors, so the reflectance data were converted into 3 PCA dimensional space, from 16 dimensional spectral. At first, by the first three basis vectors obtained from 1269 Munsell data set, PCA method was applied to compress or reduce the dimension of each group (set1 ,set2 and set3). Figure (1) shows the first three basis vectors of Munsell data set. Hence, the complete Munsell set was performed as train data and each of data set with various $\overline{L^*}$ values was used as test data to research the influence of the $\overline{L^*}$ of the test samples on the color difference error. Then the first three basis vectors that obtained from each of three sets compress each set. So each of these data was used as train data to show how the $\overline{L^*}$ of the data used to derive PCA vectors, affects the representation error.

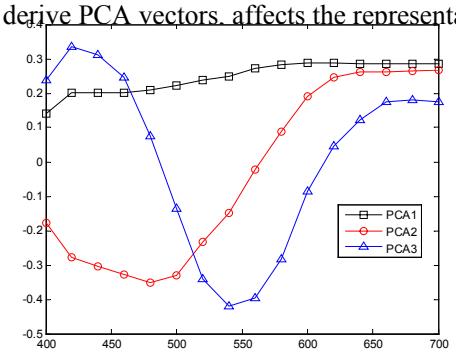



***Figure (1): the first three basis vectors obtained from 1269 Munsell data set***

| | Mean L* | Min L* | Max L* |
|---|---|---|---|
| Set1 | 36.1275 | 24.8349 | 48.2620 |
| Set2 | 55.8589 | 48.2792 | 66.6103 |
| Set3 | 75.4413 | 66.6154 | 87.6322 |

*Table (1): the lightness characteristics of three data set obtained from Munsell data set*

**Results:**

To compare the representation error, the color difference between each of the original color sample and represented one after applying PCA method was calculated. For this purpose the CIELAB color difference equation under $D_{65}$ and equal energy illuminants using the 1964 (10º) CIE observer data was used. To give an identification of the difference, the mean and median of ΔE and the number of samples that provide color difference more than 10 unit of CIELAB were presented.

In order to evaluate the effect of the $\overline{L^*}$ of the test data set on the color difference error between original reflectance curves and those represented after applying PCA, each of the three data sets was represented by the three basis vectors of complete Munsell data set. The results of color difference errors are shown in table (2). It is illustrated in table (2), in comparison between these data sets, the first set that contains the more dark samples has the most color difference error and vice versa. As it

shows, the ΔE error decreases by increasing $\overline{L^*}$. This effect may be justified by considering that in PCA method, the data are mapped on the first important eigenvectors. As is shown in figure (1) and mentioned in some literature [5], for 1269 Munsell data set the first PCA that is the most important one can approximately be similar to the lightness axis in a reflectance dimensional (here 16) space. Considering the fact that for a light sample, the portion of lightness into the color of sample is more than a dark one. Therefore, as it was described before, when the spectral reflectance is mapped on the first PCA of such a set as Munsell may be the lightness characteristic is preserved better. Hence, for a light sample the color difference error is less.

***Table (2): The color difference error of representation three data sets after dimensionality reduction by the first three basis vectors obtained from complete munsell data set.***

| Test Sample | *Train Sample | $\Delta E(CIELAB)$ [equal energy] | | | $\Delta E(CIELAB)$ [$D_{65}$] | | |
|---|---|---|---|---|---|---|---|
| | | Mean | Median | $No.\Delta E\rangle 10$ | Mean | Median | $No.\Delta E\rangle 10$ |
| Set 1 | Munsell | 4.4790 | 3.7204 | 28 | 4.7622 | 3.8345 | 32 |
| Set 2 | Munsell | 3.3361 | 2.6154 | 15 | 3.5620 | 2.7765 | 19 |
| Set 3 | Munsell | 2.2323 | 1.6972 | 1 | 2.3644 | 1.8806 | 1 |

* The data set that was used to derive PCA vectors

To be able to show the influence of $\overline{L^*}$ of the train data set that is used to derive basis vectors, each of three data sets was used to dimensionality reduction by the first three basis vectors of each of these sets. Table (3) shows results of color difference error of their representation.

To indicate the efficiency of the three first basis vectors of each of the three sets, by applying equation (3) the total mean square error introduced by eliminating the 13 eigenvector from number 4 to 16 was calculated as follows and showed in table (4).

$$\mu_{(4-16)} = \sum_{j=4}^{16} \mu_j \qquad (3)$$

As it illustrates in table (4), by increasing the value of $\overline{L^*}$ of the data set, the errors of deleting basis vectors from 4 to 16 is decreased. As the most $\overline{L^*}$ has %36 decreased error in comparison with the first set that is the darkest one.

Table (3) shows that for the set1 with the lowest $\overline{L^*}$ value, by increasing the $\overline{L^*}$ of the train set, the mean and median of color difference error is decreased. Whereas in the first row the test and train data are the same, it was expected that in this condition the error would be minimum. But as it is illustrated table (3), the mean of color difference is 1 unit ΔE(CIELAB) more than the use of set2 as train data (with intermediate $\overline{L^*}$ value) and 2 unit ΔE(CIELAB) more than the use of set3 that has the highest $\overline{L^*}$ value. By considering set2 and set3 in table (3), the similar results are obtained obviously. However for these light set this effect is more highlight, as changing the train data from set1 to set2, the mean of color difference reduced 4 unit ΔE(CIELAB) and this decreasing situation is continued by using set3 as train data instead of set2. Figure (2) shows decreasing the mean of color difference error by increasing the $\overline{L^*}$ value for each of three data sets. It is indicated that by increasing the $\overline{L^*}$ of the test set, the sensitivity of it to the $\overline{L^*}$ value of the train data increases. To describe the reason, table (4) might be verified. As it illustrates in this table by increasing the $\overline{L^*}$ of the data set, it is decreased the efficiencies of the basis vectors from 4 to end obtained from it. Therefore, for a set with high $\overline{L^*}$ value, the first three basis vectors obtained from it could be more accurate to find out the directions or axes of the samples distribution in the spectral space in comparison with a dark set.

**Conclusion**

In this study, the influence of the lightness of the data set that is used to obtain basis vectors in PCA method for dimensional reduction of spectral reflectance was investigated. For this purpose, the 1269 Munsell data set were used. The Munsell data set was divided into three data set based on the lightness value of samples in a way that the first set contained of the darkest one and vice versa.

Each of the three data sets was compressed by the first three basis vectors of complete Munsell set. The results showed that, the color difference error was decreased by increasing the $\overline{L^*}$. This effect may be because of that the first PCA obtained from complete Munsell data set that is the most important one can approximately be similar to the lightness axis in a reflectance dimensional (here 16) space. Therefore, when the spectral reflectance is mapped on the first PCA of such a set, as Munsell may be

the lightness characteristic is preserved better and for a light sample that the influence of lightness into the color difference error is more than a dark one, the color difference error is less. To be able to show the influence of the $\overline{L^*}$ value of the train data set that was used to derive basis vectors, each of the three data sets was represented after compression by three basis vectors of each set. The results indicated that the first three basis vectors of a lighter data set can be more accurate to find out the directions or axes of the samples distribution in the spectral space in comparison with a dark set and the error of eliminating the basis vectors from number 4 to 16 is less. So by increasing the $\overline{L^*}$ of the train data set, the color difference error is decreased even for a dark data set as test data.

***Table (3): The color difference error of representation three data sets after dimensionality reduction by the first three basis vectors obtained from each of these data sets.***

| **Test Sample** | ***Train Sample** | $\Delta E(CIELAB)$ [equal energy] | | | $\Delta E(CIELAB)$ [$D_{65}$] | | |
|---|---|---|---|---|---|---|---|
| | | Mean | Median | $No.\ \Delta E\rangle 10$ | Mean | Median | $No.\ \Delta E\rangle 10$ |
| Set 1 | Set 1 | 5.6152 | 4.3432 | 56 | 5.8692 | 4.4836 | 64 |
| Set 1 | Set 2 | 4.4372 | 3.4955 | 34 | 4.7107 | 3.6506 | 37 |
| Set 1 | Set 3 | 4.1810 | 3.5597 | 24 | 4.4158 | 3.7613 | 26 |
| Set 2 | Set 1 | 7.3662 | 5.5820 | 110 | 7.6531 | 5.8491 | 122 |
| Set 2 | Set 2 | 3.4895 | 2.9060 | 20 | 3.7280 | 3.0709 | 23 |
| Set 2 | Set 3 | 2.6452 | 2.0654 | 9 | 2.8570 | 2.2318 | 15 |
| Set 3 | Set 1 | 6.2212 | 4.7884 | 97 | 6.4689 | 5.0276 | 101 |
| Set 3 | Set 2 | 2.5846 | 2.0814 | 3 | 2.7431 | 2.2266 | 3 |
| Set 3 | Set 3 | 1.4589 | 1.1507 | 2 | 1.5530 | 1.1938 | 2 |

* The data set that was used to derive PCA vectors

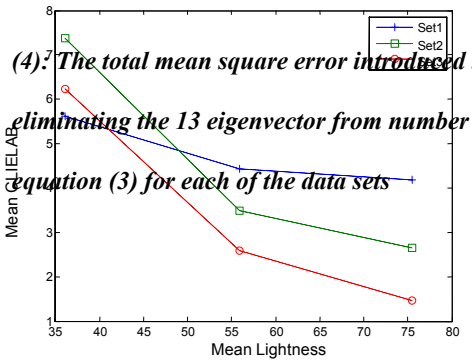



***Figure (2): The mean of ΔE in representation of each data set versu $\overline{L^*}$ value of the train data set***

***Table (4): The total mean square error introduced by eliminating the 13 eigenvector from number 4 to 16 by equation (3) for each of the data sets***

| | **Error** |
|---|---|
| Set1 | 5.7111 |
| Set2 | 4.0827 |
| Set3 | 2.0451 |

## References


1. K. Fukunaga, "Introduction to Statistical Pattern Recognition", W.Rheinboldt,Ed.,2th Edn , (Academic Press,INC, 1990), pp. 399-440.
2. Cohen JB.,"Dependency of the spectral reflectance curves of the Munsell color chips", Psychon Sci., 1, 369-370, (1964).
3. Tzang D., Berns R., "A Review of Principal Component Analysis and Its Application to Color Technology", Color Res. And Appl., 30(2), 84-98, (2005).
4. Garcıa-Beltran A., Nieves J.L., Hernandez-Andres J., Romero J., "Linear Bases for Spectral Reflectance Functions of Acrylic Paints", Color Res. And Appl., 23 (1), 39-45, (1998).
5. RamanathR.,KuehniR.,SnyderW.E.,HinksD.,"Spectral Spaces and Color Spaces",ColorRes.AndAppl.29(1),29-37, (2004).
6. Connah D., Westland S. , Thomson M.G.A., "Recovery spectral information using digital camera systems", Color.Technol., 117, 309-312 (2001).
7.Marimont D.H.,Wandell B.A.,"Linear models of surface and illuminant spectra",J.Opt.Soc.Am,9(11),1905-1913, (1992).
8. Fairman H.S., Brill M.H., "The Principal Components of Reflectances", Color Res. And Appl., 29(2), 104-110, (2004).

9. Cheung V., Westland S., “Characterization of trichromatic color cameras by using a new multispectral imaging technique”, J.Opt. Soc. Am, 22(7), 1231-1239, (2005).
10. Xiong W., Funt B., “Independent Component Analysis and Nonnegative Linear Model Analysis of Illuminant and Reflectance Spectra”, Tenth Congress of the International Colour Association AIC Colour , Granada, Spain, (2005).

# Fabric Printing Of Colours Measured In Nature And The Field Evaluation There-of

J Baumbach
CSIR, DPSS, Optronic Sensor Systems
POBox 395, Pretoria, 0001, South Africa
e-mail: jbaumbac@csir.co.za

## Introduction

Camouflage technology exists since 1979 at the CSIR. Spectral measurements of natural phenomena (leaves, bark, soil, rocks) were very difficult during the early days, and spectral measurements were performed on samples brought back from the field. Special care had to be taken to ensure integrity of measurements, especially on plant material. From these measurements the current camouflage colours used on vehicles were defined.

In the 1990's field measurements became a bit easier, when portable instrumentation became more readily available. Since 2001 CSIR used a Spectrascan PR715 radiometer for field measurements (Figure 1). The advantage of this instrument was that it is able to operate completely autonomously, and the data is stored on 3 1/2" floppy disc, which enables easy data transfer to computer. The spectral data, once on computer, was manipulated to reflect CIELAB values, which are the most useful to work with.

**Figure 1: Measurements in the field, using the PR715**

## Colour data

For three years colour data was collected along the South-African border areas. The majority of the data was collected along the Botswana-, Zimbabwe- and Mozambique borders. The vegetation types on the northernmost borders are grassland, savannah and mixed thorn bush. The border with Mozambique ahs Mopanie-field and savannah, while the coastal region with Mozambique has more dense tropical vegetation. Therefore, the dominant colours were browns and beiges.

Abovementioned colour data was compared to the colours currently used on the South African National Defence Force's (SANDF) equipment. It was concluded that these camouflage colours were a very good representation of the colours found amongst the border areas [1].

The measured data is stored in a database, together with location, photographs and a general description of the area around each data point. During 2004 all the CIELAB values was combined in one dataset. A colour prediction algorithm was developed, using custom Matlab code. This algorithm

calculated eight “average colours”, based on the available colour data. These colours were two light browns, two dark browns, two light greens and two dark greens (Figure 2).

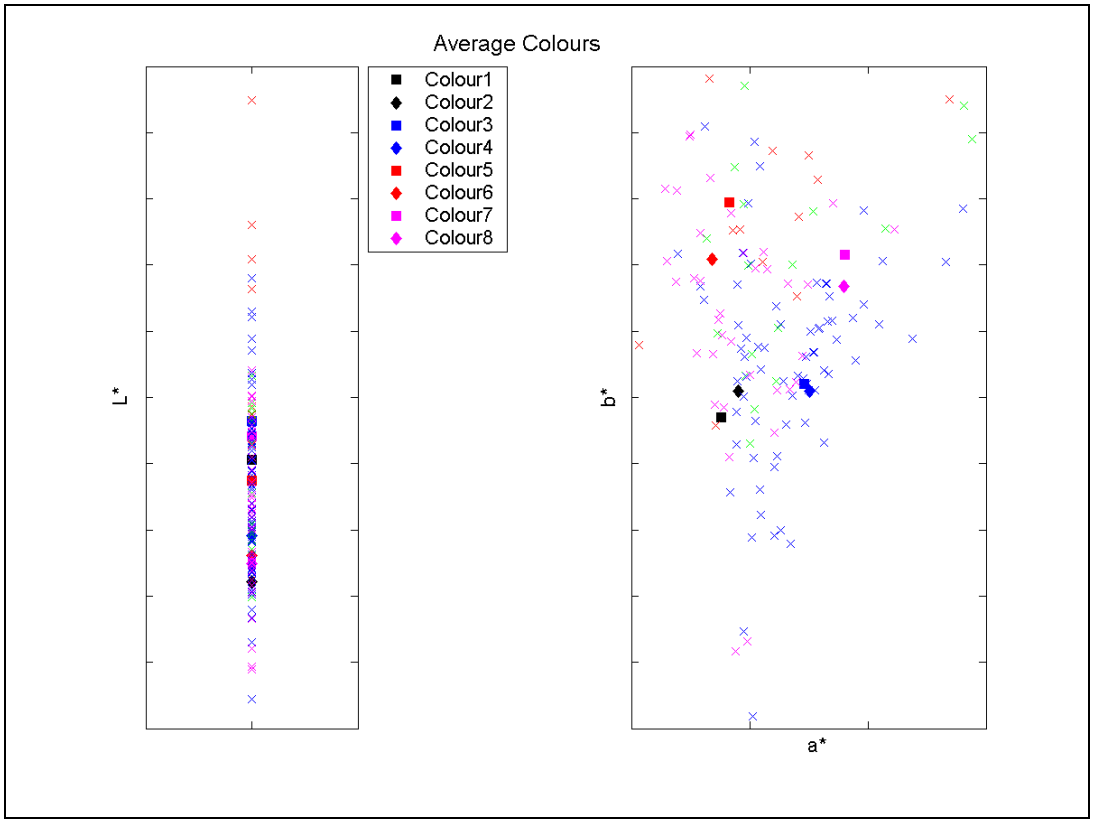



**Figure 2: Eight Predicted Colours**

It was then postulated that, given enough data points, these “average colours” could be used as customised colours on camouflage uniforms, designated for a specific area. For example, if a peace mission to the Democratic Republic of the Congo (DRC) is planned, colour measurements of the area is performed, and these data then used to calculate which colours to be used on the equipment (specifically camouflage uniforms).

## Colours onto fabric

The colour coordinates of the eight “average colours” were supplied to a company that manufactures the SANDF’s camouflage clothing. Using the current SANDF camouflage pattern, but different combinations of the calculated colours, sixteen different colour schemes were achieved, using standard screen-printing technique. These combinations were, amongst others, different dark- and light green, as well as dark- and light brown patterns. Camouflage shirts were then manufactured (Figure 3).

## Evaluation of colours

Thirteen of the camouflage shirts were then evaluated in the field. The procedure was as follows: each uniform was propped (separately) at the same location in the field, and digital photographs were taken of each uniform. Care was taken to ensure that each photograph covered the same area, and have the same camera settings (aperture and shutter speed). The RAW-format images were also used, in order to minimise the image processing that take place in the camera software. No compression was also done on the imagery, to ensure minimum loss of information.

**Figure 3: Two of the Uniforms Manufactured and Evaluated**

These digital photographs were then evaluated, using MATLAB's image processing toolbox and custom code. The raw digital data was imported into MATLAB. The RGB-values (red, green, blue) of the uniform were selected, and matched to the rest of the image. A tolerance of +-2 on each of the RGB-channels was allowed, to compensate for pixel-noise. The number of matching pixels was recorded, and the percentage matching pixels were calculated as follows:

$$\%MatchingPixels(MP) = \frac{NP}{TP} * 100$$

where NP = Number of Matching Pixels in Image
TP = Total Number of Pixels of the Image

Above relationship gave an indication of the colour match of the uniform to the environment. An example of the matching pixels is shown in Figure 4. The results for all the uniforms are shown in Table 1. The highest values are marked in green, and the lowest values in orange.

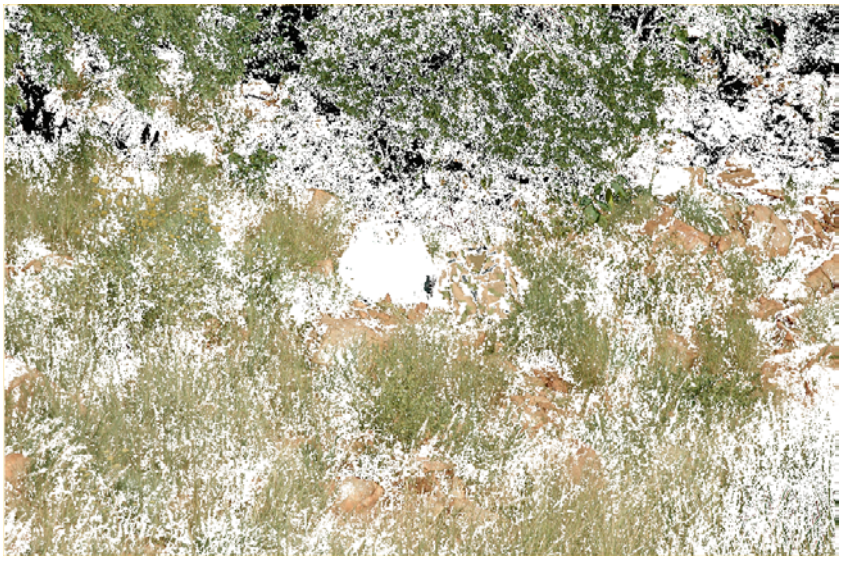


**Figure 4: Calculation of MP**

**Table 1: MP values for the different designs**

| Design no | % Matching Pixels (MP) |
|---|---|
| NO1 | 28.9 |
| NO2 | **46.0** |
| NO3 | 31.1 |
| NO4 | ***21.9*** |
| NO5 | ***18.7*** |
| NO6 | ***16.0*** |
| NO7 | 31.5 |
| NO8 | **45.7** |
| NO12 | 29.3 |
| NO13 | 32.0 |
| NO14 | **48.1** |
| NO15 | **46.8** |
| NO16 | 38.1 |

## Conclusions

Thirteen different colour designs have been evaluated in one scene, with the uniforms deployed both in full sunshine and broken shade. After image analyses the findings are as follows:

The patterns containing only greens did not perform very well. The reason for this is that the greens on the uniforms did not match the greens in the scene very well.

The patterns that have a mixture of brown and green (predominantly brown appearance) matched the scene's colours very well. The browns matched the soil and rocks much better than is the case for the match between the greens and the foliage.

It can therefore be concluded that design NO14 matched the scene's colours the best.

## Future work

The first question that arises when colours comparisons, using digital cameras, is undertaken, is how accurate these colour are represented by these cameras. He author is currently busy with an uncertainty model, in order to quantify and qualify the colour reproduction of these sensors.

The second question is: how do these digital comparisons, using only the RGB camera values, compare with the human eye's perception of the same scene? More specifically, the author is interested in the question: "Which of the abovementioned uniforms will fit a certain environment the best?" A comparison between the uniforms, using human subjects, will be undertaken in the near future.

## References

[1] Baumbach J, "*The SANDF's Camouflage Colours: Comparison with the Colours found in Nature*", International Colour and Lighting Conference, Cape Town, November 2003.

# Optical Characteristic Of Ink Jet Prints Conditioned By Substrate Ageing

I. Bolanca, I. Majnaric and Z. Bolanca
University of Zagreb, Faculty of Graphic Arts
Getaldiceva 2, 10000 Zagreb (Croatia)
Corresponding author: Z. Bolanca (zbolanca@yahoo.com)

## 1. Abstract

The investigation results of optical characteristics and the relevant values essential for the quality of reproduction of the Ink Jet impressions in relation to the defined conditions of the accelerated ageing are presented in this paper.
The results show that the ageing process influences the optical properties of the printing substrate in the following sequence; recycled paper, fine art paper and offset paper. By analysis of FT-IR spectrum smaller increase intensity of the carboxyl peak can be noticed and the changes in the area, for which C=O vibrations are responsible, which is the result of the oxidation changes on aged paper in relation to the non aged paper. With prints on aged paper the greatest aberration in yellow and cyan happens on the fine art paper. Quick closing of screen in the printing is performed on the aged paper in relation to other sample series can be noticed.

## 2. Introduction

Papers, i.e. prints are subjected to many degradation processes during ageing. The ageing of paper could be in fact defined as a sum of all irreversible physical and chemical processes which happen in the material during time.
Deterioration in quality of an aged paper can manifest itself in chemical permanence and the decrease in mechanical durability [1, 2]. The permanence of paper or prints depends on the chemical resistance of its components and of the influence of external factors [3]. It includes lightfastness and points at resistance of the printing ink against fading and colour change after exposition to light [4, 5].
The durability of paper depends mainly on the physical and mechanical characteristics of the raw materials, impact of microclimatic factors such as heat, humidity or radiation and on contamination by ions and gas from the environment and action of microorganisms [6, 7].
Natural ageing process of paper and prints causes the degradation of cellulose .The presence of moisture, oxidative agents and microorganisms are important in this process and especially the presence of acidic substances. The results in this case are the hydrolysis of cellulose that appears in shortening its chain along with changes in content of crystalline form [8].
Acid catalyzed hydrolysis of cellulose was recognized to be the primary reaction of the accelerated deterioration of paper. For study of accelerated ageing of paper new methods are being developed and recently a mathematical model was presented for temperatures from Rychlyet at al [9].
Colorimetric characteristics of the non aged and aged paper printed by Ink Jet technology are presented in this work. The droplets of ink are sprayed through the nozzles on the substrate to obtain the image. The non aged and aged impressions have been analyzed as well. Relevant sizes essential for the reproduction quality as well as the results obtained by FT-IR spectroscopy have been discussed, in relation to the kind of the printing substrate.

## 3. Experimental

Digital printing machine Epson 1200 photo was used for printing. The test form contained different printing elements: coloured halftone photos, patches for determining the colour density, halftone value and relative printing contrast, trapping fields, patches for determining dimensional stability and colour register control, surfaces for determining grey balance and standard wedge.
The printing was performed on different substrates: fine art paper (Symbol Freelife Gloss, Fedrigoni), woodfree natural paper (Acroprint EW, Fedrigoni) and on recycled paper (PAN). Some paper characteristics are presented in table 1.

Table 1. Some characteristic of the used printing substrates

| Sample | Composition | Grammage g/m$^2$ | Thickness mm | Brightness |
|---|---|---|---|---|
| Fine art | Woodfree pulp 50%<br>Recycled fibres 50%<br>Both sides coated paper | 110 | 0,098 | 95 |
| Woodfree natural | Woodfree pulp, Noncoated | 100 | 0,120 | 94 |
| Recycled | Recycled fibres | 80 | 0,110 | 86 |

For accelerated ageing substrate and print the climatic chamber was used, under the following conditions: temperature 80$^0$C, relative humidity 65% and ageing time of 24 days without the radiation influence. In the experimental part, three series of samples were processed: prints on non-aged paper, prints on aged paper and aged prints. Optical parameters for the described samples series were performed by X-Rite spectrophotometer with the support of ColorShop program. The measuring results were processed by means of Data Analysis program and technical Graphic Origin Professional. Except that the spectrophotometer Datacolor Elrepho 450 was used for measurements.
For monitoring and characterization the paper degradation caused by ageing the FT-IR spectroscopy was used (Spectrometer Spectrum One Perkin Elmer).

## 4. Results and discussion

It is possible to monitor the reproduction quality by the relation of the screen value of prints and original as presented for the impression on aged and non aged paper and aged impression in figure 1.

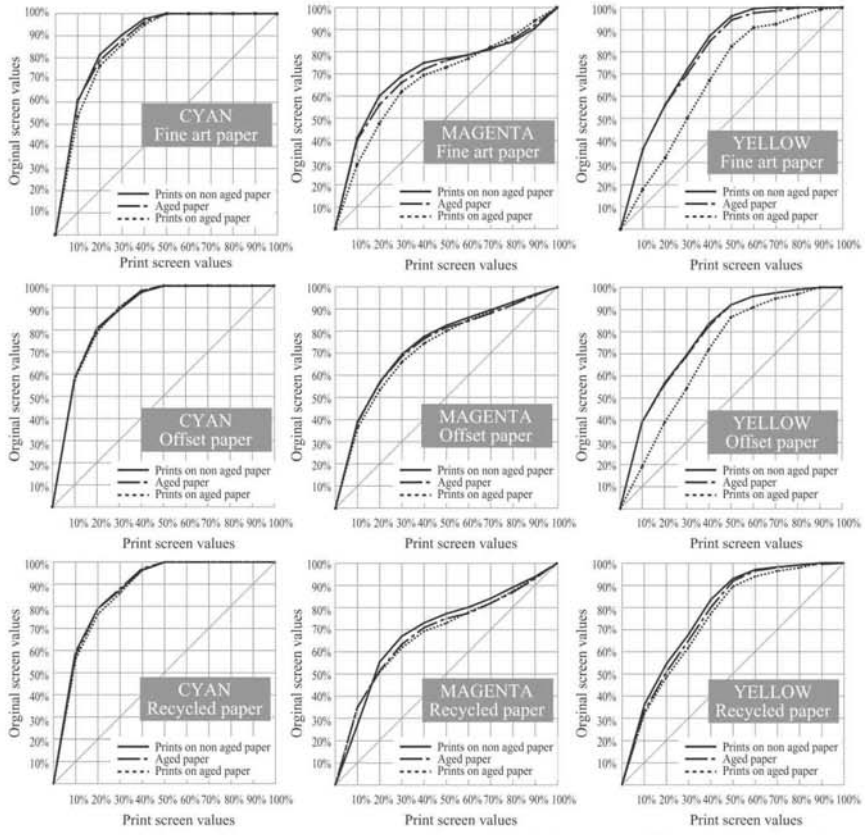



Figure 1. Relation of screen value of print and original for different types of paper

The research results show that in all the prints the positive error appears. Cyan is especially distinguished, in which the complete closing of screen appears at 50% of the screen value. Yellow colour behaves similar to that but it is less stressed and the closing of screen appears at 80% of the screen value. On prints on aged paper the MYK inks have the decrease of the screen value in relation to the non aged paper. On prints made on fine art paper, the decrease of the screen value ranges in the

area from 10 and 50% in the values between 20 and 15%, which essentially changes the print characteristics with the screen closing. The aged prints on offset paper do not show greater aberration in relation to the non aged prints. Prints on aged offset paper, particularly with yellow, show considerable decrease of the screen value along the whole reproduction curve with the greatest negative increase in the area of 20% screen value -16%. Prints on aged recycled paper have considerably expressed decrease of the screen value for CMYK in the area 20 and 60 % of the screen value in relation to the aged prints. Colorimetric values of all the print series in the whole ink layer are presented in figure 2 and the calculated colour differences ΔE are presented in table 2.

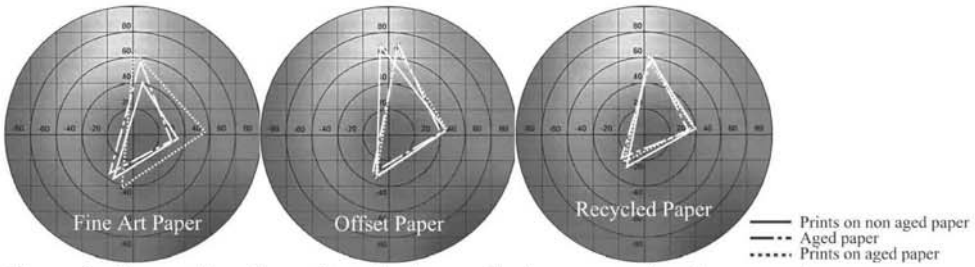


Figure 2. Chromatic values of aged prints and prints on aged and non aged paper

Table 2. Colour differences ΔE for CMY Ink Jet impressions

| Sample | $C_{1,2}$ | $C_{1,3}$ | $C_{2,3}$ | $M_{1,2}$ | $M_{1,3}$ | $M_{2,3}$ | $Y_{1,2}$ | $Y_{2,3}$ | $Y_{2,3}$ |
|---|---|---|---|---|---|---|---|---|---|
| Fine art | 8,9 | 14,6 | 10,1 | 6,4 | 27,4 | 22,4 | 3,4 | 9,3 | 9,4 |
| Offset | 4,4 | 4,6 | 1,1 | 5,0 | 6,2 | 2,3 | 0,9 | 4,1 | 3,2 |
| Recycled | 8,2 | 4,1 | 4,7 | 6,0 | 6,4 | 3,1 | 3,5 | 4,7 | 4,3 |

$\Delta E_{1,2}=E_{\text{non aged prints}} - E_{\text{aged prints}}$, $\Delta E_{1,3} = E_{\text{non aged prints}} - E_{\text{prints on aged paper}}$, $\Delta E_{2,3}= E_{\text{aged prints}} - E_{\text{prints on aged paper}}$

It is visible from the results that the brightness of the Ink Jet prints changes very little in relation to the type of the printing substrate. The values of the chromatic parameters depend on the ageing process and the paper type.

In order to determine the possible influence of the ageing process of the printing substrate on total colour, which can be especially, expressed in brighter CMY tones, their optical properties have been monitored and the research results are presented in table 3.

Table 3. Colorimetric characteristics of the non aged and the aged paper

| Sample | L*non aged | a*non aged | b*non aged | L* aged | a* aged | b* aged | Δ E |
|---|---|---|---|---|---|---|---|
| Fine art | 95.97 | 1,51 | -2,25 | 94,37 | 0,42 | 4,02 | 6,6 |
| Offset | 94,56 | 3,96 | -8,83 | 93,88 | 2,89 | -4,73 | 4,3 |
| Recycled | 86,73 | -0,23 | 6,63 | 83,90 | 0,26 | 13,44 | 7,4 |

In ageing the printing substrate small changes in lighter – darker area can be seen, as well as the shift in red -green and in yellow -blue coordinate. Generally speaking the increase of b* value is attributed to the chromophores which appear by the degradation of the paper components such as cellulose, hemicelluloses and lignin.

In figure 3 FT-IR spectrum has been presented in the area of the wavelength numbers from 4000,0 do 400,0 $cm^{-1}$ only for the non aged and accelerated aged fine art paper with the aim of determining the size of the influence in the changes of the observed optical properties which can originate from the degradation in the ageing conditions.

As it is visible from the results on the aged paper, the increase of the absorbency in FT-IR spectrum near 1600 $cm^{-1}$ can be seen, which corresponds to the increase of the carboxyl peak and it is the result of the oxidation processes by ageing. Carboxyl groups have somewhat smaller effect on the decrease of the optical properties of the aged paper in relation to the carbonyl ones, but they increase their effect. In oxidative degradation of the low molecular part of the carbohydrates the carbonyl groups appear which effects the decrease of brightness and increase of yellowness of paper and the complex changes can be noticed in the area of the wavelength number of 1734 $cm^{-1}$, for which the vibrations C=O are responsible. The described changes are caused by the increase of temperature and relative humidity which corresponds to the microclimatic conditions of the accelerated ageing.

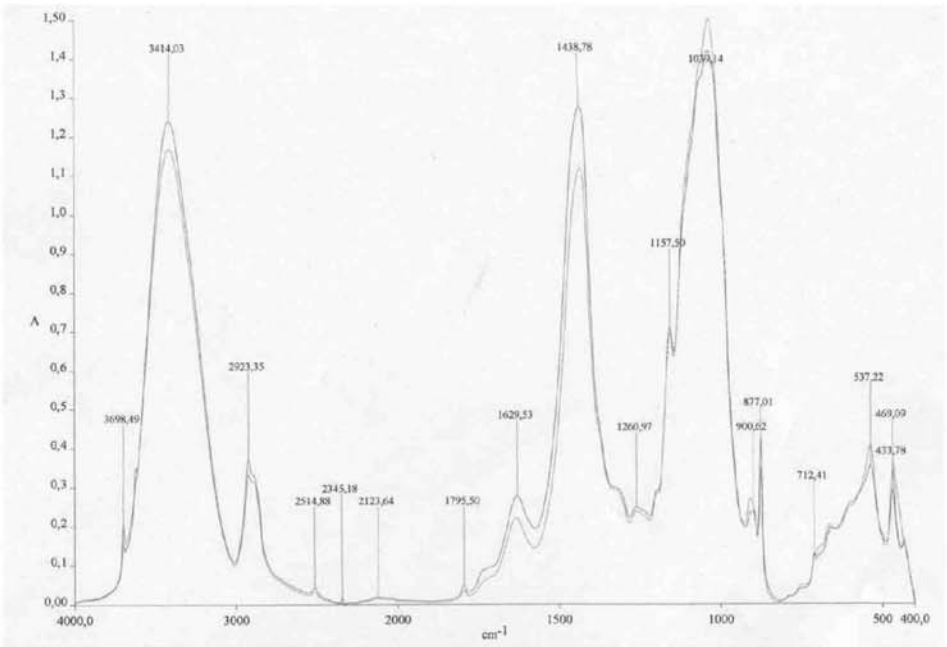


Figure 3. FTIR spectra of non aged and aged substrate

## 5. Conclusion

On the basis of the research results, it can be concluded that the ageing process influences the optical properties of the printing substrates in the sequence; recycled paper, fine art paper and offset paper. By the analysis of FT-IR spectrum smaller increase of the carboxyl peak intensity can be noticed as well as the changes in the area for which the C=O vibrations are responsible, which is the result of oxidation changes on the aged paper in relation to the non aged one.

Medium values of the colour differences for all the observed inks deviate somewhat greater for fine art paper (ΔE 12.4), and less for offset paper (ΔE 3.5) and recycled paper (ΔE 4.9). With prints on aged paper the greatest deviation appears in yellow and cyan on fine art paper. Quick screen closing can be noticed when printing is done on aged paper, in relation to other sample series.

In the scientific sense, this work is the contribution in explanation of the problems of reproduction ageing in Ink Jet technology including the relevant parameters of the reproduction process from the point of view of the formal characteristics of the printing form. The result application can contribute to the reproduction objectivity improvement.

## 6. References

1. Van der Reyden, D., Recent Scientific Research in Paper Conservation, JAIC. 31 (1), 117-138, (1992)
2. M. Strlic, B. Kolar, G. Novak, B. Pihar, Ageing and Stabilization of Alkaline Paper, J. Pulp Pap. Sci. 24, 89-94, (1998)
3. H. El-Saied, A.H. Basta, M.M. Burns, Permanence of paper, Restaurator, 21, 89-99 (2000)
4. A. Proksch, H. H. Hofer, P.C.Le, W. Knopp, Alterungbeständigkeit gestrchener Papiere, PTS Symposium, Vortragsband, München, 17-22, (1999)
5. A. Johansson A., Air pollution and paper deterioration, causes and remedies. Dissertation. Göteborg University. (2000)
6. J. Malesic, J. Kolar, M. Strlic, Effect of pH and carbonyls on the degradation of alkaline paper: factors affecting ageing of alkaline paper. Restaurator, 23, 145-153, (2002)
7. V. Bukovsky, The influence of light on ageing of newsprint paper, Restaurator, 21, 55-76, (2000)
8. V. Bukovski, Natural ageing of paper after daylight irradiation, Restaurator, 21, 229-237 (2000)
9. Rychly J., Pedersoli J., Matisova-Rychla L., Strlic M., Kolar J., Chemiluminiscence from paper, Kinetic analysis of thermal oxidation of cellulose, Polm. Degrad. Stab.78, 357-367, (2002)

# Perceptions, preferences and fashion trends with regard to the colour of mobile phone key pad and LCD display backlighting in South Africa

Elsie Coetzee
Radiometry and Photometry Group, National Metrology Laboratory (NML), CSIR
PO Box 395, Pretoria, 0001 (SOUTH AFRICA)
Corresponding author: Elsie Coetzee (emcoetzee@csir.co.za)

## Abstract

Mobile phones play a critical role in communication in South Africa. Interesting questions regarding the colour of the keypad and LCD display backlighting of the mobile phones arose during luminance measurements done in the CSIR NML laboratory on the keypads and displays for the local market. It was decided to perform a survey to establish the following:

- What colours are preferred by the end user and does culture, age or any other factor like perception play a role? What colours are preferred by the mobile companies and why?
- Are there fashion trends with regard to the backlighting and is it expected to change soon?
- Does the manufacturer have requirements for the colour specified by the customer? Are there international or national specifications specifying requirements for the colour of the backlighting and is there a need to standardise on the colour requirements?

## 1. Introduction

Mobile phones play a very important role in South Africa and have developed to the extent that they are used for music downloads, text messaging, video games and video calls. It is now also performing the function of personal piggy banking. Mobile phone banking systems have been introduced and it is hoped that it will bring millions of poor South Africans into the official economy for the first time. It is a high-tech solution designed to help poor people in remote areas who have never had access to banks, cash machines or credit cards.[1]

Statistics given on the internet indicate that the potential market size for mobile phones in South Africa by 2006 is 19 million users. Over 9 000 users sign up per day. GSM network bases cover more than 60 % of the geographical area of South Africa and more than 70 % of the population.[2]

With this information as background it is important to establish what role the features, in particular the colour of the backlighting, of the mobile phone plays for the South African user.

## 2. CSIR NML Survey

Since colour is regarded to be a psychophysical concept[3] and it is known to be influenced by factors like suggestion, knowledge, emotion, etc.[4] it was decided to send out a questionnaire to various users. The questionnaire included questions on age group, gender, make of mobile phone, colour of backlighting, future choices, contrast, culture, fashion trends and standardisation.

A total of 206 questionnaires were returned and the statistical data of the respondents is given in Figure 1.

It is interesting to note that the highest percentage of response was received from the 40 – 50 year male group. Low percentages of feedback were obtained from the < 20 years and > 65 years due to the main target market reached.

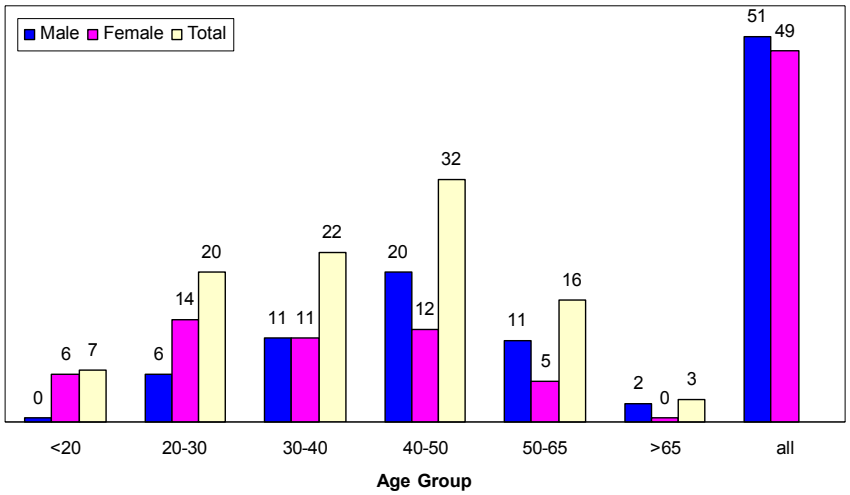



**Figure 1 – Statistical data of respondents**

## 3. Results of the survey

Colour of the current mobile phone keypad and display backlighting

86 % of the respondents said that the colour of the backlighting did not play any role at all when they selected their mobile phone. Other features like the camera, radio, walkman, battery life, functionality, size and calendar functions were indicated to be more important. 14 % has indicated that the colour played a role and gave reasons for their choice such as the following: colour choice and preference, clarity, visibility, colour screen for cameras and videos, modern, calming, latest fashion trends and appealing look. The colours of the current mobile phones are given in Figure 2.

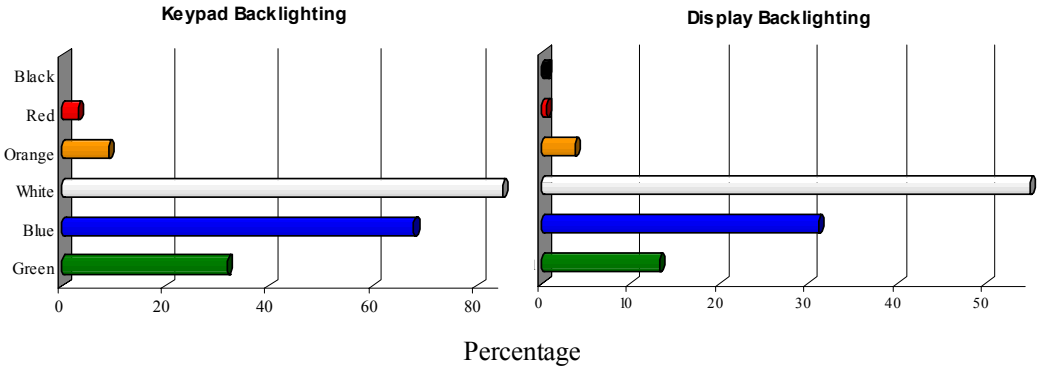



**Figure 2 – Colours of keypad and display backlighting**

3.2 Colour choices for future mobile phone keypad and display backlighting

The question was asked whether they think the colour matters now and what colour would they prefer now. The picture changed quite significantly. Could that be due to suggestion?

65 % still said that is of no importance to them and 35 % indicated that it will be important now when selecting a mobile phone. A variety of colours were given as the preferred colour, but the colour **blue** was by far the most popular choice. The reasons given for choosing blue included the following: Attractive, visibility, same colour used before, discreet colour (does not attract much attention from other people), favourite colour and easier to read in low illuminance conditions.

Results of measurements done on a couple of mobile phones in the laboratory showed that the luminance of the backlighting of the blue ones selected for measurements was significantly higher than the others.

A number of persons complained about the visibility of the display when illuminated by the sun and some thought that a display with white backlighting could be the solution, but others disagreed.

The colour choices of the respondents are given in Figure 3.

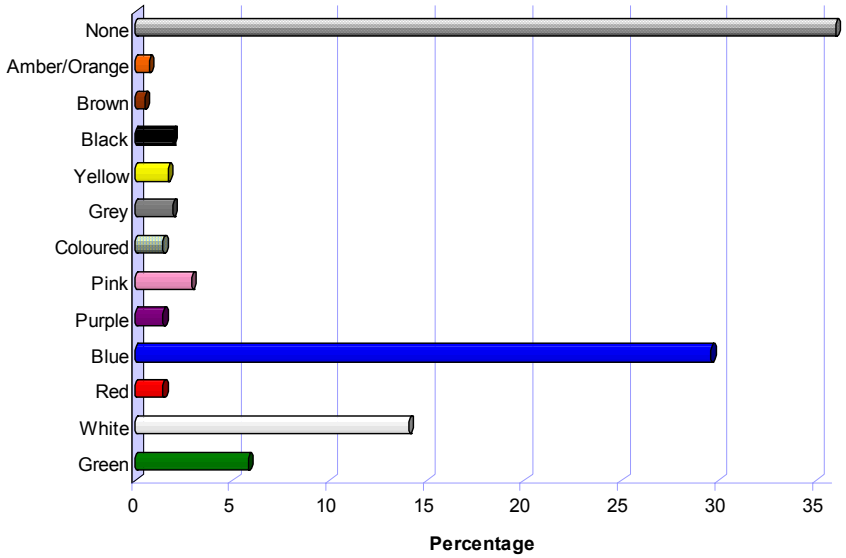



**Figure 3 – Colour choices**

3.3 Contrast between lettering and backlighting of display

The results showed that contrast is more important to the mobile phone user. 65 % indicated that they consider it to be important as it ensures readability. As expected the majority vote came from the 40 -50 years, 50 – 65 years and > 65 years age groups. It was, however, very interesting to see that only 30 % of people made adjustments to their phone settings to obtain better contrast.

Do culture, image and fashion trends play a role?

Only 11 % of the respondents thought that culture could play a role. Some of them were of the opinion that it will be part of the culture of the younger generation. There was no indication that the colour choices were influenced by racial preferences. Some of our respondents pointed out that some colours have specific meanings and messages in their culture, but will not be involved at all when the colour of the backlighting is chosen.

As expected 93 % of the youngsters in the age group < 20 years said that the latest fashion trends will most definitely influence their colour choice in future while 30 % of the total population voted yes. The response to the question whether the colour is an important part of your image gave 16 % of the total number of positive votes on the total number of questionnaires and a surprisingly 15 % of the male respondents in the age group 40 – 50 years.

## 4. Standardisation on the colour requirements of mobile phones

During a search done using the ANSI NSSN search engine for standards the results showed that 21 standards exist world wide on mobile phones, but none of these include requirements for colour. Emphasis is placed on requirements for radio interference, EMC, vehicle interface, etc. Apparently the private standards, as far as it could be established, also do not include requirements. The mobile companies select the colour to enhance their image.

Our survey showed that a majority of 99,5 % of the respondents voted that there should not be standardisation. The common reason stated was that it is a personal choice that should not be regulated. A small number of people was concerned about readability and thought standardisation could ensure this.

## 5. The opinion of local mobile phone distributors

Some of the major companies were contacted by phone or visited to get their opinion. Their experience agreed with the results of our survey and could be summarised as follows:

- Most people will go for the latest models of phones and will not be concerned about the colour of backlighting. They are more concerned about the special features like cameras and video calling at the moment. As a result of this the number of Mega Pixels of the camera and in some cases, whether the screen could provide the 'magical number' of 256 k colours are of greater importance.[5] For obvious reasons the memory size and battery life are the most important considerations .
- It is only with older people (40 years and older) and people with eyesight problems that contrast and colour of the display and the size of the keys are considered to be important.

## 6. Conclusion

The results of the survey showed that the colour of backlighting of the keypad and display of the mobile phone are not regarded as critical as some of the other fashionable features of the phones. It should not be regulated since it is regarded as personal choice and preference. However, the colour and in particular the contrast become more important for the older generation and people experiencing problems with their eyes.

During the survey information was obtained about the latest development in displays. It is a high-contrast (ensures visibility in sunlight), low-power display called the Nano Chromics Display (NCD) and according to the manufacturers this is the display of the future that will replace the LCD displays.[6] Will this lead to another survey in future?

## 7. References


1. Nicole Itano, "Africa's cellphone boom creates a base for low-cost banking", Christian Science Monitor, August 26, 2005 edition, http://www.csmonitor.com (2006-09-05)
2. Ads by Google, "Statistics of Cellular in South Africa", Google, http://www.mobileoffice.co.za (2006-09-05)
3. Committee on Colorimetry, Optical Society of America, "The science of color", New York: Thomas Y. Crowell Company, 1953, pp. 220 -222
4. Tom N Cornsweet, "Visual perception", Academic Press, New York & London, 1971, pp. 365 -371
5. Bruce Fraser, Chris Murphy and Fred Bunting, "Color management", Peachpit Press, Berkeley, Canada, pp. 59-62
6. Tekla S. Perry, "Winner: black, white, and readable", IEEE Spectrum, http://www.spectrum.ieee.org (2006-08-02)


## 8. Acknowledgements


1. To all my colleagues of the Photometry and Radiometry laboratory at the CSIR NationalMetrology Laboratory for your contributions and support: Ms Natasha van Tonder, Ms Margaret Budzinski, Dr Meena Lysko, Mr Indru Olivier and Mr Berto Monard.
2. To Flextronics SA (Pty) Ltd for the assistance and information provided.

# Color In Fashion And In The Artistic Vanguard

Rubén Gramón
FADU UBA
Argentina

**Abstract:**
History is an inexhaustible source of ideas for designers, particularly the first decades of the 20th Century where a close relation between fashion and artistic vanguard can be found. The analysis of from the Theory of Color allows us to recognize similitude's and differences to deepen our knowledge of them and enable us for teaching design.

The Belle Époque with its intense colors find its correlate in the brilliant tones of the Fauvists. The Art Deco and its expressions in black and white where influenced by the neutral colors of Cubism. Surrealism and the return to intense colors with the introduction of cyclamen by Elsa Schiapparelli. The Second World War and the return to a de-saturated key came together with Abstract Art. Fashion and the artistic vanguard, since usually never described from a formalized knowledge like the Theory of Color, has been used historically as models to be copied by hiding their characteristic rules.

Through a comparative analysis of fashion and the artistic vanguard of the first decades of the 20th Century this rules can be recognized and though operate with them in the design practice.

# The World of Colours in Hairdressing

Ms. Charmaine Joubert
National technical co-ordinator
Goldwell RSA
South Africa

**The Meaning of Color**

Colors transmit messages and generate emotion relating to cultural influences and personal experiences, but also to purely biological facts. By using various colors, we make use of the messages and emotions they represent to help us achieve our goals.

You may have noticed that fashion designers, for example, use bright and lively colors on their models in spring time, whereas during winter, more sombre, conservative colors dominate the catwalk. Fashion designers are very deliberate in their use of color, just as a lady will chose a red dress to make herself more seductive.

**Light and Shine**

Why do some objects shine and others do not?

The surface texture of an object such as the hair will influence the shine of the object.

- Only a smooth, even surface can completely reflect incoming light rays. Such surfaces, a new car for example, are therefore perceived shiny to the human eye.
- In the same way, for hair to appear naturally shiny, light needs to be reflected off a smooth surface. This requires healthy hair, i.e. the cuticle layer lies smooth and close to the hair shaft representing a flat even surface.
- Due to the fact that hair, especially lighter hair, has a tendency to be transparent, a kind of reverse reflection takes place. This occurs at the underside of the hair facing the light.
- If the light penetrating the hair is refracted or diffused by an uneven inner structure, the hair will appear less shiny and the perceived depth of color will be impaired.

**What persuades people to change their hair color?**

Their reasons will be as diverse as your clientele: they may include the simple desire for change, a new fashion trend, a special occasion – each and every client will have their own personal motivation, and it is for this reason that a color treatment is so much more than simply a chemical process – it involves emotions such as expectation, anticipation, trust, but also mistrust and anxiety.

# The Study on Development of Device Independent Color Analysis Program in the Field of Fashion

Yeon sook Noh
Chung-Ang University
Korea

**Abstract**
This study describes the development process of a program which enables the analysis of colors using digital cameras. The analysis of colors heretofore in use employs either professional color measuring instruments such as a colorimeter or a spectrophotometer, or colorimetric method with human eyes (macrographic measurement). Using professional instruments, the results of color measuring are accurate and objective. However, the machines are expensive and intricate to use.

The program developed in this study is one means to measure correct and objective colors without a professional instrument. The results of the study suggest color measuring using a universal device, digital cameras. That kind of devices operate on device- dependent color system, a color of an object could vary from camera to camera, because of the characteristics of color processing. Therefore, digital cameras were not adequate to measure colors up to now. In this study, a concept of color management system (CMS) is introduced to overcome the limits.

In this article, detailed progress of developing the program is described, centering on the development of the camera profile generating program. Moreover, the accuracy and applicability of the profiles generated by the program is examined by comparing and analyzing profiles of other profile generating programs.

# The Teaching Materials of Dyeing by using Fresh Leaves of the Natural Indigo Plant: The Learning about Various Blue

***Ikuko Okamoto*** [*] ***and Masashi Kobayashi*** [†]

[*] *Osaka Kyoiku University, Faculty of Education, 4-698-1 Asahigaoka, Kashiwara, Osaka (Japan)*

[†] *Osaka-Shoin University, Faculty of Arts and Sciences, 4-2-26 Hishiya Nishi, Higashi-Osaka, Osaka (Japan)*

Corresponding author: I. Okamoto (okamoto@cc.osaka-kyoiku.ac.jp)

## ABSTRACT

We dyed 11 kinds of fabrics with only fresh leaves of the Japanese indigo plant. The dyeing methods are the printing and the dip dyeing. The printing, the hue range was from 5B to 5PB. But the nylon fabric was dyed in the color of the purple. The dip dyeing, the hue range was from 10B to 5PB. The acetate rayon could show higher value of the chroma than the natural fibers. We can dye the fabrics such as wool, silk, acetate rayon, nylon and vinylon uniformly by the dip dyeing which extracts indican from the fresh leaves of the Indigo plant.

It became clear in this study that the fresh leaves of the indigo plant can dye various kinds of fabrics to the each different blue color. These dyeing methods were moreover safe, and we do not have to worry therefore about environmental pollution.

## 1. INTRODUCTION

There are a lot of colors in the environmental area where we live. People liked beautiful colors from the ancient time and used natural dye and pigment for their life. Speaking of dye, it is a synthetic dye now. However, people are still interested in the dyeing with the vegetable dyes that uses the leaves of the plant, the flower, the bark and the root. Main plant dye for dyeing is the indigo plant and the madder from the ancient times to the first half of the 19$^{th}$ century. As the place of origin of a natural indigo plant is called Bengal or Madras in India. The indigo plant is cultivated widely now in many areas of the world. There are many kinds of natural indigo plant: *Polygonum tinctorium L.*, which lives from the subtropical zone to the temperate zone, *Indigofera tinctoria L.*: the tropical to the subtropical zone, *Strobilanthes flaccidifolius D.C.* in the subtropical zone, and *Isatis oblongata D.C.* in the temperate Zone. In Japan, two kinds of indigo plants such as *Polygonum tinctorium L.* and *Strobilanthes flaccidifolius D.C.* are used for dyeing. Though the method of indigo dyeing with the fresh leaves of *Polygonum tinctorium L.* was not general, we chose this method in this study. We do not use chemicals for dyeing, because we intend to use this study as the teaching materials of an elementary school. In this study, we dyed the fabric by two methods with the fresh leaves of the Japanese indigo plant. We measured by the spectrophotometer the fabric which we dyed with the indigo plant. We suggested that our study was effective for the teaching materials of an elementary school.

**Table 1** The experimental fabrics

| Fabric | Symbol | Weight | Muncell notation | | |
|---|---|---|---|---|---|
| | | (g/50cm$^2$) | H | V | C |
| Wool | W | 0.7 | 6.84Y | 8.81 | 0.90 |
| Silk | S | 0.4 | 4.11Y | 9.13 | 0.76 |
| Cotton | C | 0.6 | N | 9.39 | - |
| Cupurammonium Rayon | CR | 0.5 | 3.11Y | 8.77 | 0.76 |
| Rayon | R | 0.4 | N | 9.28 | - |
| Acetate Rayon | AR | 0.4 | 7.36Y | 9.14 | 0.29 |
| Promix | PM | 0.7 | 4.19Y | 9.19 | 0.67 |
| Polyester | P | 0.3 | 3.92PB | 8.65 | 0.65 |
| Nylon | N | 1.0 | 2.05GY | 8.77 | 0.34 |
| Modacrylic | A | 0.3 | 6.75Y | 9.13 | 0.94 |
| Vinylon | V | 0.5 | N | 9.32 | - |

## 2. METHOD

We sowed the seeds of the Japanese indigo plant in this spring and got the fresh leaves which we could dye in the summer after about 3 months. By the way, the average temperature of April was 13 degrees celsius, and it was in July 26.5 degrees celsius in the summer. We dyed various fabrics with only fresh leaves of the indigo plant in these experiments.

Table 1 shows the summary of the test fabrics which we used for experiments. As for one piece of fabrics size; the width is 10cm at 5cm length. We tried two kinds of dyeing methods.

Figure 1 shows the method of the printing. In other words we put one piece of fresh leaf on the fabric and dyed it by striking it with a hammer.

Figure 2 shows the method of the dip dyeing. We poured at first heated water in a beaker, in which we had put fresh leaves and then we kneaded the leaves. We added then the juice of the newer fresh leaves to the solution and thus we made the dye solution. In both dyeing methods, we rinsed the dyed fabrics in the water carefully.

We measured the dyed fabrics with the spectrophotometer. The measuring instrument is SZ-Σ90 which is made in Nippon Denshoku Industries Co., Ltd. of Japan. We analyzed the colors with the color management software that was attached to the spectrophotometer. The name of the software is Color Mate 5. We chose 2 degrees in the field of vision angle as a measurement condition in the C source of light. Because the condition of this field of vision angle is necessary so that measurement data can be converted into Munsell notation.

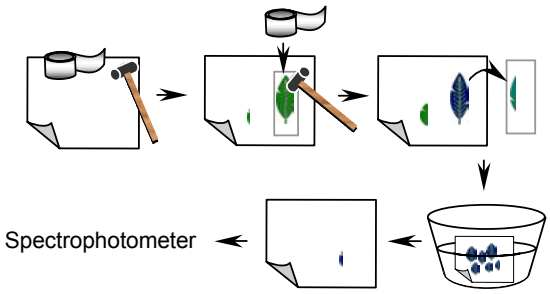



**Figure 1** The method of the printing with a hammer

## 3. RESULTS

The leaf of *Polygonum tinctorium L.* which is the Japanese indigo plant includes the colorless, water-soluble indican. When the leaf tissue is destroyed, the indican is hydrolyzed into the indoxyl and the glucose by the indicanase included in the leaf.

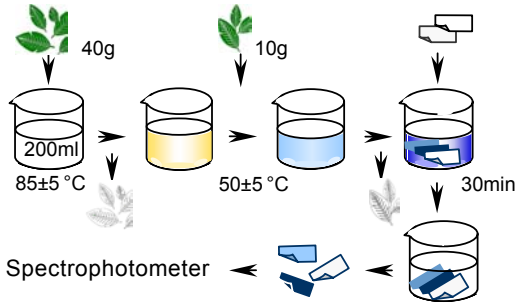



**Figure 2** The method of the dip dyeing in a beaker[1]

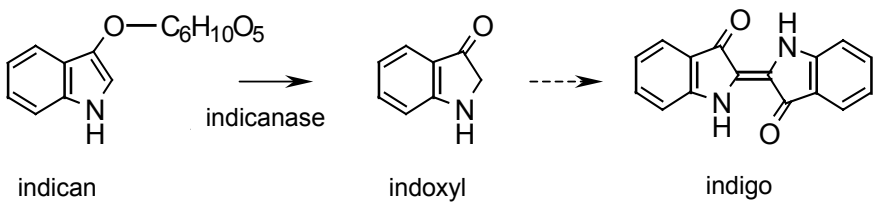



**Figure 3** Scheme of the production of indigo

The indigo generates by the oxidation after two molecules of the indoxyl did polymerism (Figure 3). First of all we measured the color of 11 kinds of the fabrics which we did printing.

Figure 4 shows the Munsell hue of each fabric which we dyed. In the case of the printing, the hue range of the indigo blue of the most fabrics was from 5B to 5PB. However, as for acetate rayon, polyester and nylon, the hue ranges were wide in comparison with the other dyed fabrics. Above all, the dyed nylon fabric was reddish, and the hue range was from 7.6B to 6.5P.

Figure 5 shows the relation between value and chroma when we did printing. The wool showed the highest property of the printing among 11 kinds of fabrics, value was 4.1 and chroma was 3.2.

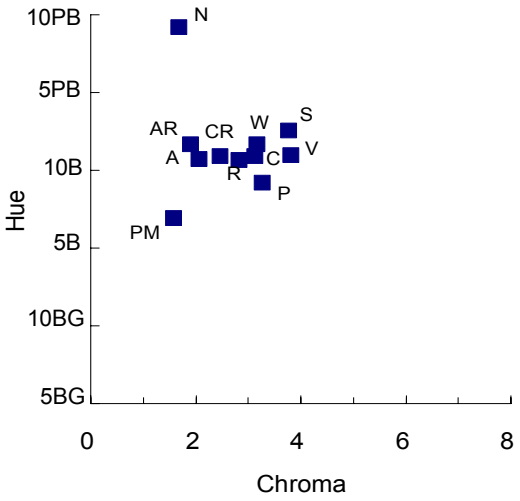



**Figure 4** Relationship between hue and chroma by the printing

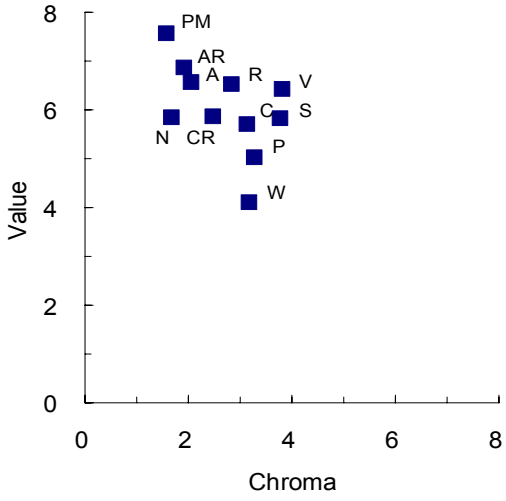



**Figure 5** Relationship between value and chroma by the printing

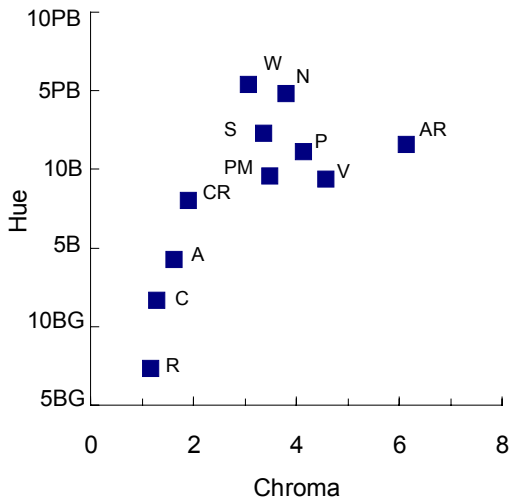



**Figure 6** Relationship between hue and chroma by the dip dyeing

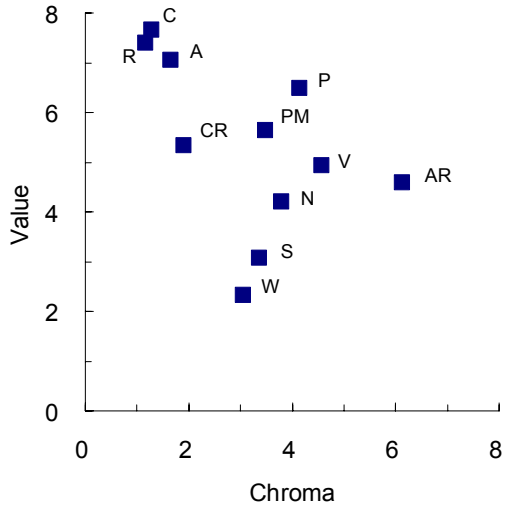



**Figure 7** Relationship between value and chroma by the dip dyeing

The chroma of the dyed polyester and the dyed vinylon was approximately similar to natural fiber such as wool, silk and cotton.

We measured then the color of 11 kinds of fabrics which we did dip dyeing.

Figure 6 shows the Munsell hue of each fabric which we dyed. In the case of dip dyeing, the hue range of the indigo blue of the most fabrics was from 10B to 5PB. The hue of such as cotton, rayon and modacrylic is from 7.5BG to 5B, but dye property of those fabrics is low.

Figure 7 shows the relations between value and chroma when we did dip dyeing. The wool and the silk showed both low value in value and chroma. These fabrics were dyed with dark blue. The acetate rayon which is semi-synthetic fiber was dyed in bright blue. And the chroma showed the highest value in 11 kinds of fabrics. Even if it was a synthetic fiber, nylon and vinylon were dyed under the same condition of dip dyeing.

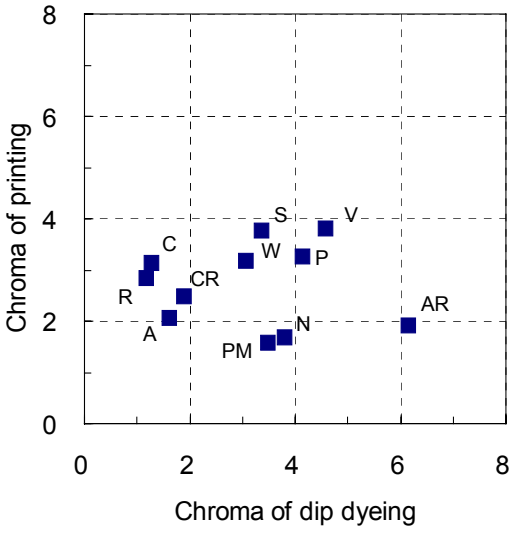



**Figure 8** Relation between chroma of the dyeing fabrics in printing and dip dyeing

Figure 8 shows relation between chroma of dyeing fabrics in printing and dip dyeing. The value of the chroma of fabrics such as cotton, rayon, silk, wool, cuprammonium rayon and modacrylic is high in the case of printing. Above all, the value of the chroma is high in the printing of cotton and rayon. The value of the chroma of fabrics such as acetate rayon, nylon, promix, polyester and vinylon is high in the case of dip dyeing. The acetate rayon could show higher value of the chroma than the natural fibers.

## 4. CONCLUSIONS

The printing by the fresh leaves of the Japanese indigo plant is effective because there is dyeing-affinity for the chemical fibers too. The nylon fabric is dyed in the color of the purple in printing by the fresh leaves. The reason is because indirubin of the red pigment which is included in the natural indigo plant is generated in the dyeing process[2]. We can use this dyeing method as the good teaching materials in an elementary school, because the forms of the leaves themselves of the indigo plant are copied on fabrics. Anyone can print easily if they prepare the fresh leaves, fabrics, an adhesive tape and a hammer. We used nothing than the fresh leaves in the dip dyeing as in the printing.

We can dye the fabrics such as wool, silk, acetate rayon, nylon and vinylon uniformly by the dip dyeing which extracts indican from the fresh leaves with hot water. It became clear in this study that these teaching materials were safe, and therefore we do not have to worry about environmental pollution.

## References

1. Yutaka Tkagi, “The New Dyeing Method with the Fresh Leaves of the Indigo plants (in Japanease),” Society for Life Culture of Osaka Kyoiku University, Journal of Life Culture 28, 81-86(1985)

2. Satoshi Ushida, Yka Tanigami and Maki Ohta, “Conditions for the Production of Indirubin in the Process of the Dyeing with Fresh Leaves of Indigo Plants (in Japanease),” Journal of Home Economics of Japan 49,389-395(1998)

# Color As A Specific Feature And Cojoint With Other Features In Experiments On The Appearance Of Complex Test Objects

Lucia R. Ronchi
Via Suor Maria Celeste, 50125
Florence
Italy
n.rositani@flashnet.it

**Abstract**
Aim of the work. The present POSTER aims at describing a method, object of our research, we started developing a few years ago, capable of quantifying, on the basis of visual appearance, the amount of information conveyed by a complex sample (e.g. a textile), relatively to a reference. It seems susceptible of some applications: a), to classify the textiles according to their degree of visual complexity; b), as a guide for combining a pair of complex samples, according to a given criterion, c), for educational purposes, because of the underlying plethora of notions of advanced flavour.

The experimental method
The display presented to the observer is rectangular, and consists of two juxtaposed samples, the test and the reference, sharing the same height (10°). The width (S) of the display ranges from 4° to 30°
For a given test sample and for a given reference, the ratio of their areas is varied, by shifting horizontally, in discrete steps, a horizontal mask through which the display is seen, until a match is obtained, by the use of the constant stimuli procedure.
Now, the peculiarity of the method is the kind of match requested to the observer. There are various possibilities: either the match of the intrapair information contents, or the match of visual saliencies or the "symmetry", in the broader sense of the term, that is, beyond the purely geometrical one) , or the aspect ratio, as referred to that magic deviation from the geometrical symmetry, named Divine Proportion of Golden Ratio.
The results of a number of sessions are visualized by displaying the ratio of the areas at the intra-pair match versus the intrapair luminance contrast. The shape of these plots exhibits a clear dependence on the degree of spatial complexity of the test objects used.
The reference sample used in each trial may consist either of a step of a grey scale, of variable reflectance factor from trial to trial, or of a patterned sample the spatial structure of which is somehow related to that of the test sample. For instance, it seems of interest the case where the two paired samples are gratings, and their differences in spatial frequency are such as to pass from assimilation to simultaneous contrast.

The underlying visual mechanisms
In the "captivity" of the visual laboratories, color appearance is widely investigated by the use of isolated uniform samplers, or for various color combinations, and the general trend consists in investigating and model of "local" response to color regarded as a specific feature. A wide literature describes the influences of various environmental factors on the appearance and discrimination of a local color, generally one at a time, while the others are "frosted".
Now, the simple situations are rarely met in the real world, which is complex by definition, so that the local response is replaced a global response, resulting from the coexistence of various stimulus features which interact, and act cojointly, in a multidimensional space. It escapes from the constraints of the traditional metrology, and a new metrological approach is to be sought for.
Note that our experiment, above described is a first step towards this new metrology, since the psychophysical responses we used at the match differ from the traditional ones, and might be referred to those used since long: in the matter of color harmony. in Munsell's experiments, dated 1905 the cojoined stimulus features were Area, Value and Chroma, while, from the seventies on, Heggelung considered the chroma dependencies on the luminance level as referred to the coming into play of

greyness and blackness. We have been gathering several data by including also texture, flat or rough, regular or quasi-random, and there is yet much to work in this area.
The situation is conceptually well presented by computational modelling, based on a sequence of internal representations, from early vision to higher centers, including cognition and even reaching the "mindsight", abstract vision and symbolism.

In conclusion, the responses to the various features remain segregated up to an early features map, beyond which they lose their specificity, interact and operate in conjunction, even by compensating each other, to allow the optimal "tuning" with the appropriate central units. In the cojoint regimen, only the global response is of interest for the experimenter, as if the appearance of the single features were a "hidden" ingredient.. However, because of the visual multiplexing, the various features result in their appearance, even in a complex situation, although through a coarse mode, and with a partial failure of discrimination. For instance, for the color features the appearance is dominated by color categorization, and the discrimination partially fails because of (even if incomplete) perceptual constancy, which, contrary to what is requested in the laboratory, in the real world is only devoted to recognition (without specifying which, among the several cues, is the "winner that takes all" at the site of the final decision).

# Estimation of a Dyed Textile's Original Color based on Model of Discoloring Process

Nozomi Sasaki, Yoshitsugu Manabe, Mika Naganawa, and Kunihiro Chihara
Image Processing Laboratory, Nara Institute of Science and Technology
8916-5, Takayama, Ikoma, Nara (JAPAN)
Corresponding author: Nozomi Sasaki (sasaki.nozomi01@is.naist.jp)

## Abstract

Many of dyed textile as cultural properties have discolored, so its original color is unknown. It is important to know original color. However now, estimating original color relies on empirical knowledge of a curator. This paper proposes a method of estimating original color numerically. In this method, dyed textile samples are discolored, then spectral reflectance is measured on discoloring process. A discoloring model is made from the data, and the original color is estimated using the model. In our experiments, original colors of 10 samples were estimated, and average of calculated color difference for cotton clothes was about 1.3.

## 1. Introduction

Many of dyed textiles as cultural property have discolored, and it is important to know original color in understanding design of textile and making the digital archive of cultural properties. However now, estimating original color relies on empirical knowledge of a curator and it is not numerical.

A fiber, dye, and dye mordant constitute the dyed textile, and these are called constituent factor of a dyed textile in this research. If the information on all the constituent factors is got, the original colors of a dyed textile can be known. A kind of dye can be estimated by the easy chemical analysis, but chemical analysis must cut away a portion of a dyed textile. Moreover, if a dye mordant changes, a color will change a lot granted that fiber and dye are the same. Even if we can know only the information on dye, original color of a dyed textile cannot be known. It is also important to get to know a discoloring phenomenon to know original color. Matsuda had checked that spectral reflectance changes in a discoloring experiment process[1]. However, he didn't analyze numerically.

This research proposes the model showing spectral reflectance change of a discoloring process, and the estimating method of original color using this model.

## 2. Estimation Method of Original Color

### 2.1 Modeling of Discoloring Process

Fig. 1 shows the flow of modeling method. To make a model of a discoloring process, dyed textiles are discolored by light, especially ultraviolet rays. Ultraviolet rays are one of the biggest causes that discolor dyed textiles. A lamp used in this research is metal halide lamp. The main wavelength of the lamp is UV-A that is reaching on the ground all the year round. The discoloration of a dyed textile is performed in the darkroom. The temperature in the room is about 29 degrees C, and the humidity is about 37%.

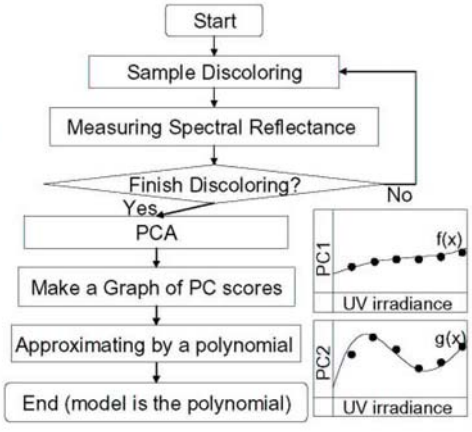



Fig. 1 The flow of model creation

Spectral reflectance is measured repeatedly while discoloring a dyed textile. The measuring range is for 380 to 780nm at 1nm, so the dimension of one data is 401. When measurement is performed n times, there are n points with 401 dimensions. These n points are considered to be n variable, and Principal component analysis (PCA) is performed to these n variables.

PCA is one of the multivariate analysis. The result of PCA can be expressed with a small number of synthetic indexes. These indexes are called principal component vector. On each principal component, the value given to each variable is called principal component score. In this research, measured spectral reflectance can express at a smaller dimension than 401 dimensions using PCA.

To make a discoloration model, it is important to confirm the relation between the increase amount of ultraviolet radiation and the alteration of a color. In this research, considering change of principal component score as the alteration of the color, the relationship between the principal component scores and the amount of ultraviolet radiation is approximated by a polynomial. Approximate evaluation is performed by R-square. This discoloration model is made according to the kind of constituent factor of the dyed textile described in section 1.

### 2.2 Estimating Original Color

Original color is estimated from the color of the discolored dyed textile using two or more discoloration models. The discoloration model is based on spectral reflectance. The spectral reflectance of the sample that wants to estimate original color is measured. The model to which this spectral reflectance belongs is determined out of two or more models. PCA is performed to the spectral reflectance of this sample and much spectral reflectance that were used for creation of a model. Each principal component score is plotted on the 2D plane of the 1st and 2nd principal component Distinction analysis is performed to principal component scores, and the group to which a sample belongs is determined. Original color is estimated using the model of the determined group.

To apply the model to the sample, the sample has to be on the same 2D plane as a model. The 1st principal component score of the sample in the 1st principal component of a model can compute from the spectral reflectance of the sample. The amount of ultraviolet radiation of the sample needs to be estimated. One discoloration model is made of two or more principal component models. In each principal component model, principal component scores and the amount of ultraviolet radiation are based on the amount of ultraviolet-rays irradiation of the model which has a proportionality relation. On the plane of other principal component models the point of expressing a sample is plotted using the amount of ultraviolet radiation made into the standard. The polynomial of a model is sifted in accordance with a vertical axis so that it may pass along this point.

The intercept of a polynomial to which it was made to move is estimated as scores of each principal component of original color, and spectral reflectance of original color is restored from each principal component scores.

## 3. Experiment

The experiment was conducted using three kinds of dyed textile. All the sizes are 4×4cm.

A. cotton dyed by dye stuff made from sophora flower using copper mordant.

B. cotton dyed by dye stuff made from sophora flower using aluminum mordant.

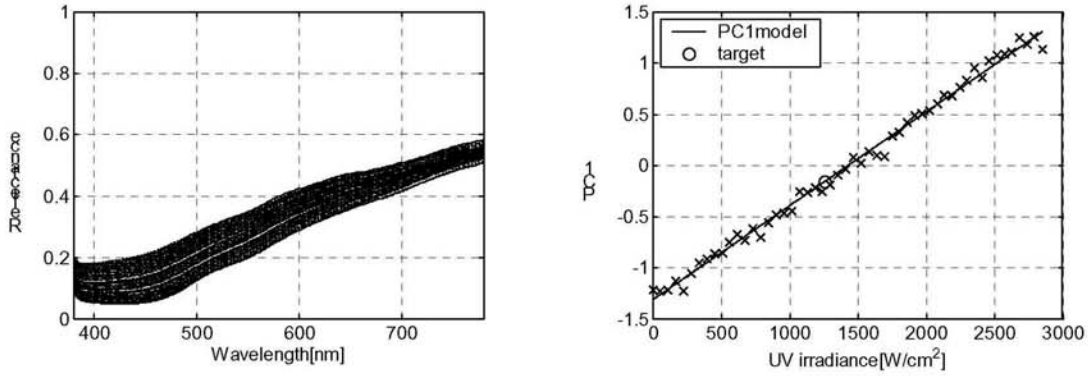
C. silk dyed by dye stuff made from Amur cork using aluminium mordant.

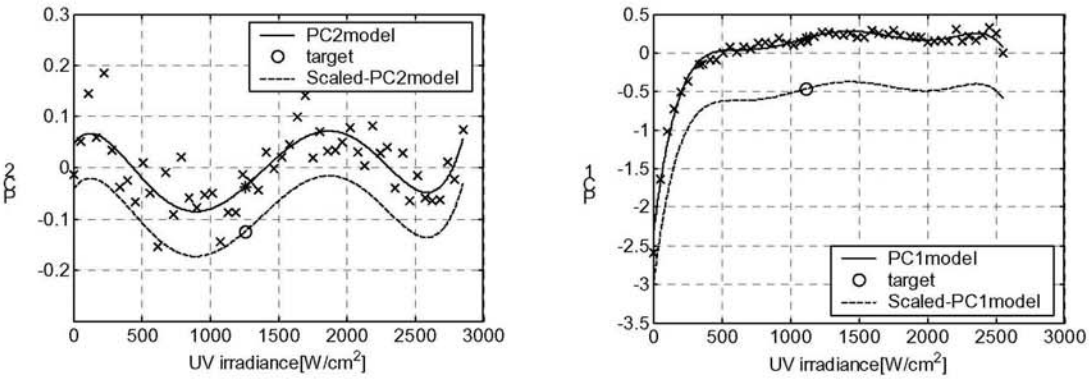
### 3.1 Modeling of Discoloring Process

Fig. 2 is the graph of the result of measured spectral reflectance. PCA is performed to these data. Fig. 3 shows the graph of scores of the 1st principal component, and carried out polynomial approximation. The 2nd principal component is processed similarly (Fig.4). Fig. 5, 6 and 7 are the results of (C). Since 1st principal component score was not proportional to the amount of ultraviolet radiation, 3rd principal component scores are plotted.

### 3.2 Estimating Original Color

The dyed textile which is known original color is used for original color estimation as a sample. The sample was discolored by putting to sunlight for a long period of time. Two samples were used for original color estimation. First, PCA was performed to the spectral reflectance of the first sample and



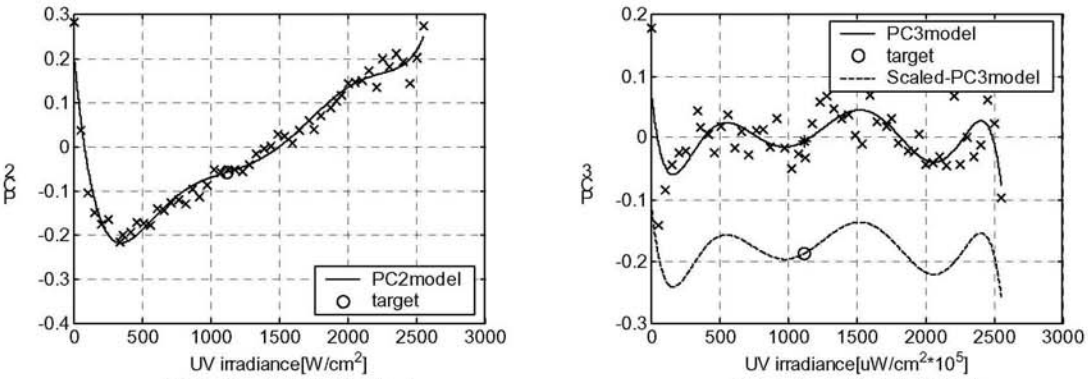
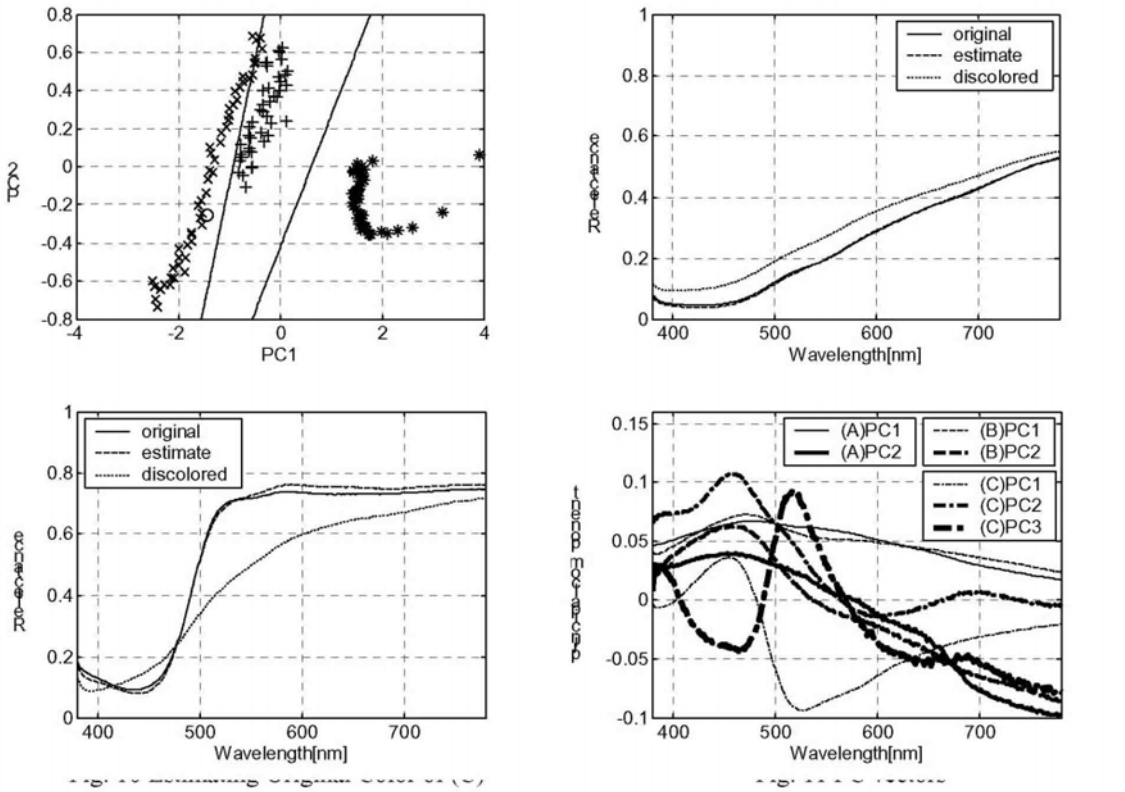




Fig. 6 PC2 Model of (C)

Fig. 7 PC3 Model of (C)

much spectral reflectance which were used for creation of three models. Fig. 8 is the result of plotting scores, and performing distinction analysis. The first sample was distinguished as it is the same kind as the dyed textile of (A). As shown in Fig. 3, the amount of ultraviolet-radiation is presumed from the 1st principal component model of (A). The amount of ultraviolet radiation was estimated to be 1259.27W/cm$^2$. The estimated spectral reflectance and the spectral reflectance of actual original color are shown in Fig. 9.

Next the second sample was distinguished as it is the same kind as (C). The 1st principal component model of (C) does not have a proportionality relation between the 1st principal component score and the amount of ultraviolet radiation. Moreover, change is not seen by 1st principal component scores, after being exposed to certain ultraviolet radiance. The model of the 2nd principal component is proportional to the amount of ultraviolet-rays irradiation, after being exposed to certain ultraviolet radiance. For this reason, as shown in Fig. 6, the amount of ultraviolet radiation was determined using the 2nd principal component model. The estimated spectral reflectance of the second sample and the spectral reflectance




of actual original color of the second sample are shown in Fig. 10.

Average color difference of the sample of the same kind as (A) and (B) was 1.3 on the L*a*b color coordinate system and 1.3 on the L*u*v color coordinate system. Average color difference of the sample of the same kind as (C) was 2.663 on the L*a*b color coordinate system and 3.425 on the L*u*v color coordinate system. There are these color difference within industrial color difference [2].

## 4 Discussion

The principal component vector of (A), (B) and (C) is shown in Fig. 11. Since 1st principal component vectors of (A) and (B) are flat, the increase in the 1st principal component score shows that a sample becomes white. The 1st principal component vector of (C) is not flat, and the discoloring process of (C) has something special.

The dyed original difference by the same constituent factor is mostly solvable by moving the 2nd principal component score (3rd for silk), so the 2nd principal component shows the dyed original difference.

## 5. Conclusion

The discoloring process of a dyed textile by UV radiation was made model and the original color was estimated using this model in this research. The dyed textile which did not perform management of temperature and humidity but was put to sunlight can also estimated original color by this method mostly. In the future, the experimental result using various causes of discoloring is expected.

## References

[1] Y. Matsuda, "Dyeing Behavior and Photofading of Berberine as a Dyestuff", Sci. Antiq, 31, pp. 24-31, 1986 (in Japanese)

[2] ASTM : Method E 97-53 T (1953)

# Evaluation of Colour Harmony of Thai Observers for CRT-Colour Samples

Suchitra Sueeprasan* and Tetsuya Sato†
* Department of Imaging and Printing Technology, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand
† Department of Design Engineering and Management, Faculty of Textile Science, Kyoto Institute of Technology, Kyoto 606-8585, Japan
Corresponding author: Suchitra Sueeprasan (suchitra.s@chula.ac.th)

**Abstract**

This study aimed to investigate the degree of colour harmony perceived by Thai observers for colour samples displayed on a CRT. Twelve single colours (comprised of 6 major colours: red, green, blue, cyan, magenta and yellow, with 2 levels) were selected and combined to generate 66 pairs of colour samples. Thirty Thai observers (15 males and 15 females) participated in the experiment. Each observer was asked to rate the degree of colour harmony for each colour pair using a scale ranging from 0 (disharmonious) to 100 (most harmonious). It was found that the results obtained from male and female observers were significantly different. Some correlation was found between colour harmony and hue difference ($\Delta H^*_{ab}$), and colour difference ($\Delta E^*_{ab}$). Colour pairs with a common colour denominator were more harmonious.

## 1. Introduction

In art, harmony is something that is pleasing to the eye and could be defined as a pleasing arrangement of parts. Harmony of colour refers to a combination of colours that possesses aesthetic appeal. This is of interest to researchers in various fields, as it is an important factor in design. The science of colour harmony has long been studied and this could trace as far back to the work by Chevreul[1] on the Principles of Harmony and Contrast of Colors and Their Applications to the Arts in 1839. Many experiments were conducted to investigate influential factors on the perception of colour harmony. This includes a study by Hård and Sivik[2], whereby three factors were identified: area sizes, perceptual similarities and order rhythms. Burchett[3] categorised attributes of colour harmony into eight factors: area, association, attitude, configuration, interaction, order, similarity and tone. This indicates the complexity in evaluation of colour harmony. Most studies were thus carried out under simplified conditions, usually with two-colour combinations. The results from experiments conducted by Granger[4], Pieters[5], Chuang and Ou[6], Ou and Luo[7] showed that colour harmony had some correlation with colour intervals (represented by uniformly spaced points in a colour system) between individual colours in a colour combination. However, some discrepancy was found amongst the studies. The earlier studies[8,9] showed that cultures had an effect on the visual results of colour emotion. The present study investigated colour harmony for two-colour combinations displayed on a CRT monitor. Visual assessments were carried out by Thai observers. Relationships between colour intervals in the CIELAB colour space of the two colours in a given pair and visual scores representing the degree of colour harmony were examined.

## 2. Experimental method

Colour harmony for two-colour combinations were visually assessed by Thai observers. The visual experiment was conducted in a darkened room where a series of colour pairs were displayed on a CRT monitor with its white point set to illuminant D65. The monitor was calibrated using GretagMacbeth Profile Maker 5.0 to ensure stability and repeatability of the CRT-colour samples. A set of 66 colour pairs was generated from 12 single colours. The set of single colours included six major colours, i.e. red, green, blue, cyan, magenta and yellow, with two levels (generated from appropriate combinations of either 0 and 255 or 0 and 127 digital inputs of RGB channels). Each of the single colour patch was 3" height by 1.5" width and was combined to generate colour pairs of 3"x3" in size. Each colour pair was presented on a uniform grey background (R=G=B=127) in the centre of the monitor. Each observer sat in front of the monitor with a distance of 12–15 inches away

from the monitor. A colorimeter GretagMacbeth Eye One was used to measure the colour samples in terms of colorimetric values - lightness (L*), a*, b*, chroma ($C^*_{ab}$) and hue ($h_{ab}$) - in CIELAB colour space. Colour difference ($\Delta E^*_{ab}$), lightness difference ($\Delta L^*$), chroma difference ($\Delta C^*_{ab}$) and hue difference ($\Delta H^*_{ab}$) were calculated for each colour pair. Figure 1 shows the distributions in CIELAB colour space of the 12 single colours used in the experiment.

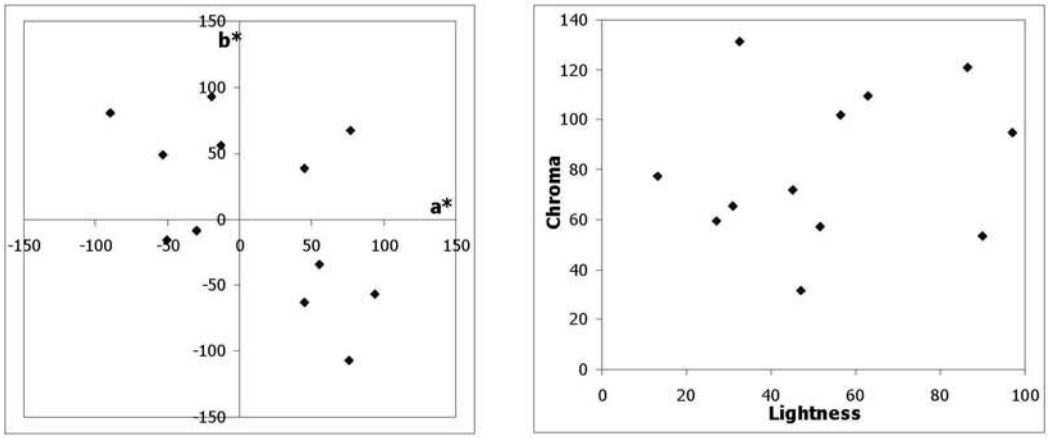



Figure 1 Experimental colour samples.

In the visual experiment, observers identified the magnitude of colour harmony using a scale ranging from 0 to 100 with intervals of 10, where 0 represents "disharmonious" and 100 represents "most harmonious". The observers were instructed to regard the term "harmony" as "pleasing". In other words, the colour pairs that were of high harmony were the pairs that looked pleasant. In addition, observers were given few trials before performing the actual experiment. The colour pairs were displayed in a random order to avoid systematic bias. The experiment lasted approximately 30 minutes for each observer.

Thirty Thai observers with normal colour vision included 15 males and 15 females, ranging in age from 18-30. The experimental raw data accumulated from 30 observers were averaged to obtain visual scores representing colour harmony for each of the colour pairs.

## 3. Results and discussions

The agreement between the results of individual observers and the mean results was examined using the Pearson product-moment correlation coefficient ($r$ value). For perfect agreement, an $r$ value should be one. It was found that the mean $r$ values for male and female results against the panel results were 0.48 and 0.56, respectively. This indicates that individual female data had better agreement with the panel results obtained by averaging the visual scores of all observers than those of male observers. However, when calculating the agreement between their own panel data, e.g. individual male against the panel results for male, the $r$ values were found to be 0.51 and 0.59 for male and female observers, respectively. This shows that the agreement between the same gender was not much different. The difference in the perception of colour harmony between male and female observers was further investigated using the paired $t$ test. This was to determine whether the visual scores of colour harmony obtained from male and female observers were significantly different. The hypothesis was tested at 95% confidence level and it was found that the null hypothesis was rejected, i.e. the mean colour-harmony scores of male and female observers were significantly different. The results also showed that female observers gave higher scores of colour harmony.

For each colour pair, the visual scores of colour harmony were averaged from all observers. The 95% confidence intervals for each colour pair were also calculated and the mean value obtained from 66 colour pairs was 8.02. The visual scores ranged from 24 to 74.

Analyses of correlation between colour attributes of each pair and the colour-harmony scores were carried out. Relationships between colorimetric differences ($\Delta L^*$, $\Delta C^*_{ab}$, $\Delta H^*_{ab}$ and $\Delta E^*_{ab}$) of

colours in a given pair and visual scores of colour harmony were investigated by means of Pearson product-moment correlation coefficient (Table 1). The results showed that there was very little correlation between colour harmony and lightness ($\Delta L^*$), and chroma difference ($\Delta C^*_{ab}$) with Pearson *r* values of -0.17 and 0.05, respectively. Some correlations were found between colour harmony and hue ($\Delta H^*_{ab}$), and total colour difference ($\Delta E^*_{ab}$) with the moderate correlation of -0.68 and -0.61, respectively. This reveals that colour pairs having low values of $\Delta H^*_{ab}$ or $\Delta E^*_{ab}$ tended to have high scores of perceived colour harmony, while colour pairs with high $\Delta H^*_{ab}$ or $\Delta E^*_{ab}$ values inclined to be less harmonious.

The earlier studies by Ou and Luo[7] found that colour-harmony scores correlated with the summation of lightness values ($L_{sum}$) of colours in a particular pair. On the other hand, Pieters[5] found that colour pairs tended to be more harmonious with an increase in chroma summation ($C_{sum}$). To verify their results, this study thus evaluated the correlation between colour-harmony scores and $L_{sum}$ and $C_{sum}$. As can be seen in Table 1, no correlation was found for both factors in this study.

Table 1. Correlation (Pearson *r*) between mean visual scores of colour harmony and colorimetric differences.

| *r* value | $\Delta L^*$ | $\Delta C^*_{ab}$ | $\Delta H^*_{ab}$ | $\Delta E^*_{ab}$ | $L_{sum}$ | $C_{sum}$ |
|---|---|---|---|---|---|---|
| Colour harmony | -0.17 | 0.05 | -0.68 | -0.61 | -0.02 | -0.19 |

Figure 2(a) shows the scatter plot of the 66 data points of $\Delta H^*_{ab}$ against the colour-harmony scores. It can be seen that colour harmony tended to increase with a decrease in hue difference between two colours. To observe the tendency of changes in colour harmony due to changes in hue differences more clearly, the plot between the visual scores and hue differences was simplified by classifying the data points having $\Delta H^*_{ab}$ within 10-unit interval into the same group. The mean values of $\Delta H^*_{ab}$ and visual scores that averaged from all data in the same group were used to represent the group's data. The 95% confidence intervals for the mean visual scores of each group were also calculated. The results are plotted in Figure 2(b). This plot clearly indicates the tendency of increasing perceived colour harmony when hue differences between the colour pairs decrease. This reveals that a combination of two colours that are not much different from each other would harmonise. This agreed with the results found by Chuang and Ou[6].

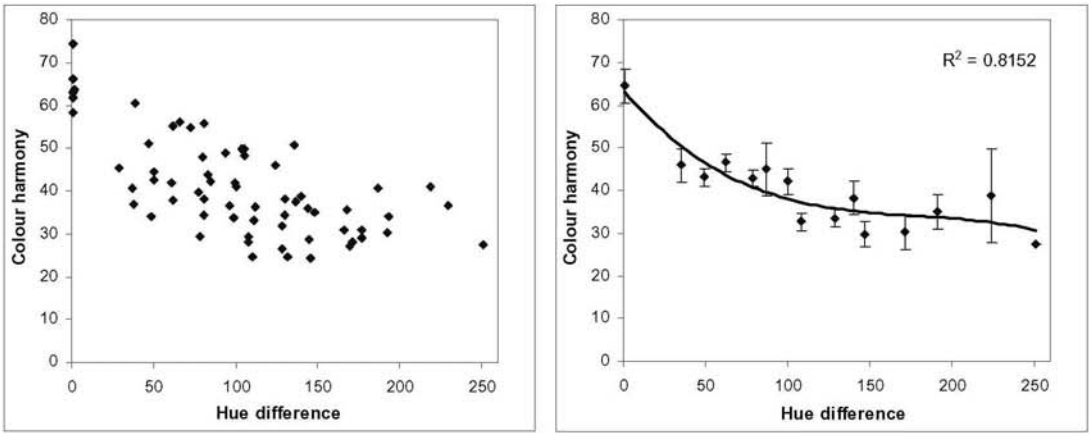



Figure 2 Relationships between colour harmony and hue differences (a) the plot of 66 data points (b) the plot of classified hue intervals.

Further investigation of hue effect on colour harmony was carried out by classifying the colour pairs into two group based on a common colour denominator, i.e. a group of colour combinations with a common colour denominator and the other group without a common colour denominator. The group of colour combinations with a common colour denominator contained samples that paired with the same hue but having different chroma, e.g. red (R=255) – red (R=127), and samples combined as follows: red-magenta, red-yellow, green-cyan, green-yellow, blue-cyan, blue-magenta. The mean colour-harmony scores were 49 and 34 for the group of a common colour

denominator and the other group, respectively. The *t* test were performed to determine whether the mean degree of colour harmony of the first group (a common denominator) was significantly higher than the mean of the second group at the significance level of 0.05. It was found that the null hypothesis was rejected, which means that the mean of the first group was significantly higher at the 95% confidence level. This reveals that colour pairs with similar hues tended to be harmonious. However, the previous studies[4,6,8,10] observed a significant influence of single colour preference on colour harmony. A high colour-harmony score was obtained for colour combinations that included favourite individual colours. This factor could also affect the results in this study. Note also that the experimental conditions such as the shape of colour samples, type of samples (e.g. CRT colours, textiles) are also the influential factors. The differences in the experimental set-up could therefore yield differences in the findings between this study and the others.

## 4. Conclusions

A set of 66 CRT-colour pairs was assessed by Thai observers to determine the degree of colour harmony. The results obtained from male and female observers were significantly different, in which female observers tended to give higher colour-harmony scores. The mean correlation coefficient indicating the agreement between individual observers' results and the panel results averaged from all observers was found to be 0.52. It was found that colorimetric differences between individual colours in the given colour pairs had no strong correlation with the colour-harmony scores. However, moderate correlation was found for hue difference and the visual scores ($r$ = -0.68). This result showed that colour pairs with low $\Delta H^*_{ab}$ value tended to have high colour-harmony scores. The results from the paired *t* test indicated that colour pairs with similar hues looked more harmonious than colour pairs with complementary hues.

## Acknowledgements

The authors would like to thank Warittha Rungruangpaisalsuk and Neungtip Tatirat for the collection of the experimental raw data. Thanks also go to all the observers who kindly participated in the experiment.

## References

1. M.E. Chevreul, The Principles of Harmony and Contrast of Colors and Their Applications to the Arts, translated from the first French edition of 1839 (Schiffer Publishing, Atglen PA, 1987).
2. A. Hård and L. Sivik, A Theory of Colors in Combination: A Descriptive Model Related to the NCS Color-Order System, *Color Research and Application* 26, 4-28 (2001).
3. K.E. Burchett, Color Harmony, *Color Research and Application* 27, 28-31 (2002).
4. G.W. Granger, An Experiment Study of Color Harmony, *The Journal of Gerneral Psychology* 52, 21-35 (1955).
5. J.M. Pieters, A Conjoint Measurement Approach to Colour Harmony, *Perception & Psychophysics* 26, 281-286 (1979).
6. M. Chuang and L. Ou, Influence of a Holistic Color Interval on Color Harmony, *Color Research and Application* 26, 29-39 (2001).
7. L. Ou and M.R. Luo, A Colour Harmony Model for Two-Colour Combinations, *Color Research and Application* 31, 191-204 (2006).
8. L. Ou, M.R. Luo, A. Woodcock, and A. Wright, A study of colour emotion and colour preference. Part II: Colour emotions for two-colour combinations, *Color Research and Application* 29, 292-298 (2004).
9. L. Ou, M.R. Luo, G. Cui, A. Woodcock, M. Billger, B. Stahre, R. Huertas, A. Tremeau, E. Dinet, K. Richter, and S. Guan, The Effect of Culture on Colour Emotion and Preference, *Proceedings of AIC Colour 05*, Granada Spain, 259-262 (2005).
10. J. Hogg, The Prediction of Semantic Differential Ratings of Color Combinations, *Journal of General Psychology* 80, 141-152 (1969).

# Colour Vision in Quality Assurance

Ms Heleen Temple
Fibre & Polymer Technology
South African Bureau of Standards (SABS)

**Abstract:**

Introduction

In the world about 12 - 20 percent (depending on whose figures you want to believe) of the white, male population and a tiny fraction of the female population are colour-blind (No accurate figures have been published on the Ishihara's test where used on a black / coloured population).

For the colour-blind, most of these circles are nothing but spots. Below are the correct answers to what a person with normal colour vision would see - and what a person see with Red-Green colour-blindness. When you see what they can't see, you may understand why it's so tough for them to find the right socks and why we they like bright colours, which are more easily identifiable.

What is Colour Vision Deficiencies?

Normal colour vision is described as trichromatic. This term originates from colour-matching studies. In colour matching experiments, trichromats can match any colour by a mixture of three primary colours. There is a considerable amount of variance in colour-matching abilities of normal trichromats.
One form of colour vision deficiency is referred to as anomalous trichromatic. Anomalous trichromats can match any colour by a mixture of three primary colours, but their matches are different from normal trichromats.
A second form of colour vision deficiency is described as dichromatic. In colour matching experiments, dichromats can match any colour by a mixture of only two primary colours.
A third, very rare form of colour vision deficiency is called monochromatic. Monochromats cannot discriminate colours and perceive only shades of grey. Individuals with monochromatic vision are truly colour-blind (achromatopsia).
Besides these congenital colour vision deficiencies, there are also acquired colour vision deficiencies. These may be caused by illness or injury. Colour discrimination also declines with age. The loss of discrimination is larger for blues-yellows than for reds-greens, partly because of increased absorption of short wavelength light in the lens.

Interesting Colour Tools:

An interesting site that purports to display colours in such a way as to see them with normal colour vision and to show to a person with normal colour vision what they would look like to someone who has different kinds of colour blindness. Interesting concept! It is something that any teacher or public communicator should no and it is important for the colour-blind to speak-up should they realize that they do not see all the facts!!
http://colorfilter.wickline.org/colorblind/filter/ This page allows you to enter a web page URL and brings it back supposedly as a colour-blind person would see it.

Colour vision testing

For children and non-learned individuals tests have been designed that use simple objects and symbols making colour vision testing fun, quick and easy for all age groups, including preschool children. The "Colour Vision Testing Made Easy" test contains 14 different cards and takes only a

minute to administer and score - making it invaluable for large vision screenings. The test is divided into two parts.
Part I has simple symbols (circle, star, square) to test the colour vision of the general public. These cards feature two objects, so a colour deficient person can see one of the objects. This way he or she sees something and does not get discouraged or self-conscious. It also validates that the person understands the test and is trying their best.

Part II has objects such as a dog, balloon and boat turning colour vision testing into a fun game of matching or tracing for young children, as well as individuals with learning disabilities or those who are non-communicative

Benefits of these tests

- Inexpensive pediatric pseudoisochromatic colour vision test that makes testing fun, quick and easy for "all" age groups, especially 3-6 year old pre-school children.
- Comprehensive, validated and 100% Ishihara compatible.
- Easily identified objects (circle, star, square, boat, dog and balloon) can be identified by children as young as 3 years old.
- Children do not need to know their numbers.
- Only takes a minute to administer and score making it invaluable for any size vision screening.
- Ideal for learning disabled, language barrier, non-verbal or non-communicative patients.
- Preferred colour vision test for "Prevent Blindness Vision Screening Programs" and "Special Olympic Athletes" worldwide because of its simplicity and recognizable international symbols.
- Proven to be more accurate than the Farnsworth Lantern and D-15 at detecting mild colour deficient patients.
- Response patterns of the normal and colour deficient child is very clear-cut so that a diagnosis is made with a high degree of confidence.

# Texture Effect on Visual Colour Difference Evaluation Using the Texture Pairs

S.J. Shao[1], J.H. Xin[1], K.F.Chung[2]
1. The Institute of Textile & Clothing, the Hong Kong Polytechnic University
2. Department of Computing, the Hong Kong Polytechnic University
Corresponding author: J. H. Xin (tcxinjh@inet.polyu.edu.hk)

**Abstract**

This study investigates texture effect on the visual color difference evaluation using simulated color texture pairs with the small color difference sizes in the three different directions of lightness, chroma, and hue components at the five CIE color centers. In an attempt of modeling the texture effect, two texture parametric factors, named as texture strength contrast and the product of texture strength, were designed to correlate the visual color difference results and texture features. High correlation was found between the visual color difference results and the two texture parametric factors. It was also found that the two factors have slightly stronger influence on lightness and chroma than on hue component.

## 1. Introduction

In instrumental color control process, the results of color difference calculations between standards and their matches often determine whether these matches are passes or fails. For accurate quantification of color difference, a reliable color difference formula is required. Currently, various advanced color-difference formulae such as BFD[1], CMC[2], CIE94[3], and the latest CIEDE2000[4] have been proposed since the recommendation of CIELAB formula by the CIE in 1976. To achieve the best results when using a color difference formula, a set of appropriate reference conditions should be adopted[3]. In some practice, however, the conditions may considerably deviate from the reference conditions. Consequently, there is a need to understand how the perceived color difference of sample pairs might be affected by the viewing parameters. The CIE Technical Committee 1-28 on *Parameters Affecting Color-Difference Evaluation* has identified and reported a set of parametric effects in an effort to coordinate research in this area. Among other parameters, the texture structures in the sample pairs also significantly influence color perception and thus has far-reaching industrial relevance. Some recent publications[5-6] have shown the strong effect of texture on perceived color difference. However, until now, a quantitative relationship between the texture parameters and the visual color difference has not yet been established. Therefore, no correction factor or guideline has been suggested by the CIE[7].

In the present study, the texture color samples were generated by the texture mapping method from the captured woven fabric samples and displayed on a characterized CRT monitor. These synthesized texture samples were used to investigate texture effect on the visual color difference evaluation.

## 2. Experimental

### 2.1 Preparation of Simulated Texture Samples

In this study, twenty-nine simulated texture samples were synthesized using dichromatic reflection model[8] at each of five CIE color centers.

### 2.2 Visual assessment using the synthesized texture sample pairs

In the visual experiments, a Sony Trinitron GD 500 CRT Monitor was used to display the synthesized color texture images. The characterization of the display was carried out using the gain, offset, and gamma (GOG) model with additive terms of for ambient flare and interreflection[9]. The gray scale method used for visual assessment in the experiments was similar to the visual assessment in previous studies[10]. In the experiment, five gray scale samples numbered with 1 through 5, a standard gray same as gray scale sample 5, and a texture pair were presented to the observers. The colorimetric specification of gray scale samples and background are given in Table 1.

Table 1: The colorimetric specification of gray scale samples and background

| Grade | $L^*$ | $a^*$ | $b^*$ | $C_{ab}^*$ | h | $\Delta L^*$ | $\Delta E_{ab}^*$ |
|---|---|---|---|---|---|---|---|
| 5.00 | 39.76 | -0.63 | -1.39 | 1.52 | 245.70 | | |
| 4.00 | 40.72 | -0.65 | -1.35 | 1.50 | 246.57 | 0.95 | 0.96 |
| 3.00 | 41.74 | -0.67 | -1.29 | 1.45 | 242.55 | 1.97 | 1.98 |
| 2.00 | 42.71 | -0.76 | -1.43 | 1.62 | 242.01 | 2.94 | 2.95 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.00 | 43.72 | -0.70 | -1.28 | 1.46 | 241.33 | 3.96 | 3.96 |
| background | 47.24 | -0.42 | -0.19 | 0.46 | 204.34 | | |

In this work, the sizes of the small color difference were explored in the experiments equivalent to 2 $\Delta E^*_{ab}$ units. For each pair, two samples had only exhibited lightness, chroma and hue difference, not their mixture. Two samples in each pair are divided by one pixel line with the same color coordinates as the background. The CIELAB values of the background color is the $L^*$, $a^*$, and $b^*$ coordinates of 47.24, -0.42, and -0.19 respectively. The arrangements of gray scale pair, texture pair and five gray samples were shown in Figure 2.

The presentation of the synthesized texture samples and the recording of the response were controlled by the computer program developed for this study. All GUI interfaces used in the experiments of gray scale method were developed using the platform of Matlab package. 30 sample pairs were assessed twice by the same panel of ten observers at each of five CIE color centers for lightness, chroma, and hue directions respectively. In total, 9000 visual assessments were made. After the visual experiment, the gray scale values (GS) for each pair was converted to the visual color difference $\Delta V$ scale using Eq. (1):

$$\Delta V = -0.0151GS^3 + 0.1099GS^2 - 1.2331GS + 5.1004 \quad (1)$$

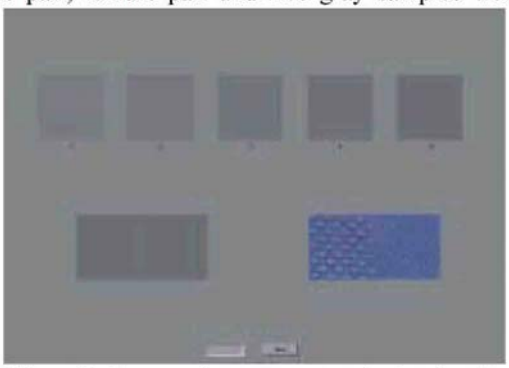


Figure2: the sample arrangement in the visual experiment

**2.3 Definition of Texture Strength Contrast and the Product of Texture Strength**

In this work, a 2-D Gabor Wavelet transform was used to analysis texture images and extract the texture features from the multichannel subimages. Due to the fact that RGB response of a texture image is not colorimetric, all texture images were firstly mapped into CIEXYZ color space using GOG model. Considering the texture or spatial information is mainly contained in the luminance channel, texture features were extracted from the information of the luminance Y for each texture image in this study.

For the texture image $Y(u,v)$ , its Gabor wavelet transform is defined as

$$W_{mn}(u,v) = \iint Y(u_1,v_1) g^*_{mn}(u-u_1, v-v_1)\, du_1 dv_1 \quad (2)$$

where * represents the complex conjugate and m and n indicate the scale and orientation, respectively.

**Histogram Distribution of Magnitude of $W_{mn}(x,y)$**

After applying Gabor filters on the image with different orientation at difference scale, the original texture image $Y(u,v)$ is thus represented by a set of subimages $\{W_{mn}(u,v)\}_{m=1,2,3,4}^{n=0,30,60,90,120,150}$ , which is a multiscale representation of the texture image $Y(u,v)$. In this work, the statistical distribution of magnitude $|W_{mn}(u,v)|$ was used to measure texture strength on the multiresolution decomposition of the original texture image $Y(u,v)$.

**Texture Strength Contrast and Texture Strength Product**

Due to the texture masking effects, visual color difference between two texture colors may depend not only on their corresponding texture strengths, but also on the texture strength contrast exhibited by two texture colors. Hence, a texture strength contrast function $C^{ts}_{mn}$ was also defined in the following. Considering a given level of multiresolution decomposition denoted by $m^{th}$ orientation and $n^{th}$ scale, texture strength contrast function was defined as:

$$C^{ts}_{mn}(\sigma 1_{mn}, \sigma 2_{mn}) = \frac{(\sigma 1_{mn})^2 + (\sigma 2_{mn})^2 + K_1}{2(\sigma 1_{mn})(\sigma 2_{mn}) + K_1} \quad (3)$$

where $\sigma 1_{mn}$ and $\sigma 2_{mn}$ were the standard deviation of $|W_{mn}(u,v)|$ of two texture images, respectively. And the constant K1 was included to avoid instability when $\sigma 1_{mn}$ or $\sigma 2_{mn}$ was very close to zero. In this study, $K_1$ was set to small constant and equal to 0.01.

In the case of the same $C_{mn}^{ts}$ value, two pairs of texture colors may show a different texture strength change. Hence, in order to quantitatively represent the total of texture strengths for each pair of texture colors, the product of texture strength of each pair of texture colors was also given:

$$P_{mn}^{ts}(\sigma 1_{mn}, \sigma 2_{mn}) = \sigma 1_{mn} * \sigma 2_{mn} \tag{4}$$

For each pair of texture colors, twenty-four levels of multiresolution decomposition (six orientations and four scales) were conducted. Therefore, the average texture strength contrast function ($\overline{C^{ts}}$) and texture strength product function ($\overline{P^{ts}}$) covering all levels was given

$$\overline{C^{ts}} = \frac{1}{4*6}\sum_{m=1}^{6}\sum_{n=1}^{4} C_{mn}^{ts}(\sigma 1_{mn}, \sigma 2_{mn}) \;;\quad \overline{P^{ts}} = \frac{1}{4*6}\sum_{m=1}^{6}\sum_{n=1}^{4} P_{mn}^{ts}(\sigma 1_{mn}, \sigma 2_{mn}) \tag{5}$$

**3 Results and Discussions**

The relationships between visual color difference ($\Delta V$) and texture strength contrast, the product of texture strength are shown in Figure 3. It is seen from Figure 3 that the maximum and minimum visual color differences are in the range of 2.30 to 2.92, and 1.31 to 1.42 $\Delta E_{CIELAB}$ units, respectively. Clearly, these scatter points of the maximum and minimum visual color difference are all distributed in the area with the largest texture strength contrast and texture strength product, respectively. Furthermore, it can be seen from Figure 3 (a1), (b1), and (c1) that the visual color differences in each pair of texture colors are steadily increased along with the increase of texture strength contrast. On the contrary, Figure 3 (a2), (b2) and (c2) show that the visual color differences between two texture colors are decreased with the increase of texture strength product.

In order to further quantify the changes of visual color difference with respect to texture strength contrast and texture strength product, the slopes of $\frac{\Delta V}{\Delta C^{ts}}$ and $\frac{\Delta V}{\Delta P^{ts}}$ are defined as:

$$\frac{\Delta V}{\Delta C^{ts}} = \frac{\frac{1}{M}\sum_{i=1}^{M}\Delta V_i\big|_{10^{0.18}<\overline{C^{ts}}<10^{0.2}} - \frac{1}{N}\sum_{i=1}^{N}\Delta V_i\big|_{10^{0.08}<\overline{C^{ts}}<10^{0.1}}}{10^{0.2}-10^{0.1}} \;;\quad \frac{\Delta V}{\Delta P^{ts}} = \frac{\frac{1}{M}\sum_{i=1}^{M}\Delta V_i\big|_{10^{-0.1}<\overline{P^{ts}}<10^{0.1}} - \frac{1}{N}\sum_{i=1}^{N}\Delta V_i\big|_{10^{0.9}<\overline{P^{ts}}<10^{1.1}}}{10^{1}-10^{0}} \tag{6}$$

where M and N represent the total number of scatter points satisfying the conditions of $\overline{C^{ts}}$ listed in the ranges of $[10^{0.18}, 10^{0.2}]$ and $[10^{0.08}, 10^{0.1}]$. The slopes of $\frac{\Delta V}{\Delta C^{ts}}$ for lightness difference and chroma difference phases are quite close. The quantitative analysis found that every increase of 1 units of texture strength contrast $\overline{C^{ts}}$ will cause 1.158, 1.031, and 0.712 $\Delta E_{CIELAB}$ units increase of visual color difference for lightness, chroma and hue difference phases, respectively. However, visual color difference in the color component of lightness, chroma, and hue will be decreased by 0.34, 0.32 and 0.25 $\Delta E_{CIELAB}$ units along with the increase of 10 units of $\overline{P^{ts}}$, respectively. These results demonstrate that $\overline{C^{ts}}$ and $\overline{P^{ts}}$ have a slightly stronger effect on the changes of lightness difference and chroma difference than on hue difference.

**4. Conclusions**

The visual results clearly showed that the visual color difference evaluation is strongly influenced by the texture parametric effects. The quantitative analysis found that the visual color differences are increased in the ranges of 0.712 to 1.158 $\Delta E_{CIELAB}$ units along with the increase of 1 units of texture strength contrast, respectively. However, the increases of 10 units of texture strength product cause the decrease of the visual color difference in the ranges of 0.25 to 0.34 $\Delta E_{CIELAB}$ color difference units.

A new texture color difference model (TCDM) to evaluate the visual color difference of two texture colors with the different texture structures will be developed in the future work.

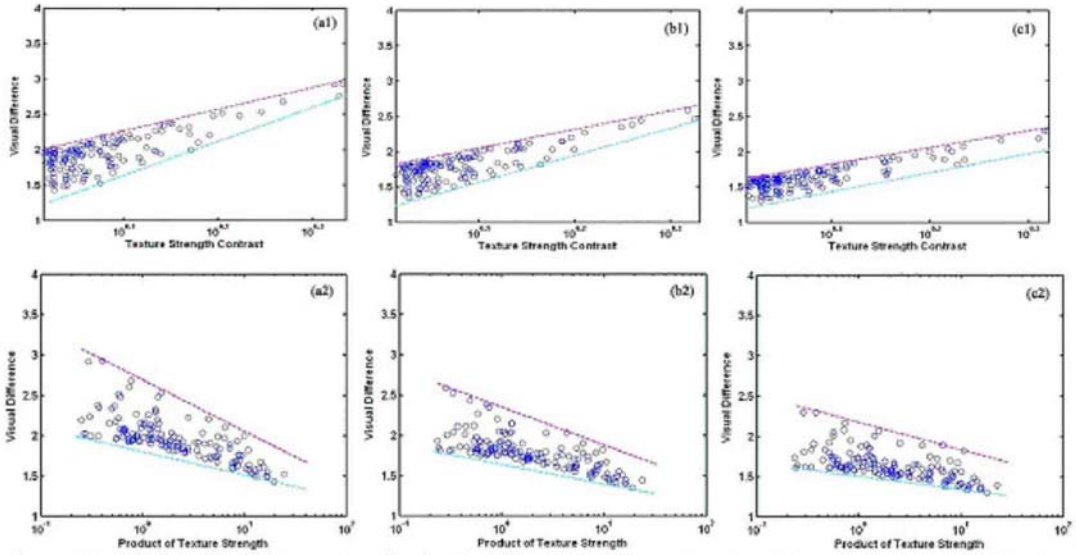



Figure 3: Relationship between small visual difference and texture strength contrast and texture strength product functions: (a1)-(a2) is for the lightness difference dataset; (b1)-(b2) is for the chroma difference dataset; (c1)-(c2) is for the hue difference dataset.

**Acknowledgement**

The authors wish to acknowledge the support of the CERG project (PolyU 5153/01E) from the Research Grant Council of Hong Kong SAR Government and the Hong Kong Polytechnic University.

**References:**

1. M.R. Luo and B. Rigg, "BFD(l:c) colour-difference formula. Part I: Development of the formula," J soc Dyers Colour; 103: 86-94 (1987).
2. F.J.J. Clark, R. McDonald, B. Rigg, "Modification to JPC79 colour difference formula," J Soc Dyers Colour; 100:128-132(1984)
3. CIE Technical report: Industrial colour-difference evaluation, CIE Publ. No.116. Vienna, Central Bureau of the CIE (1995).
4. CIE Technical report: Improvement to industrial colour difference evaluation. CIE Publ. No.142. Vienna, Central Bureau of the CIE(2001).
5. E.D. Montag and R.S. Berns, "Lightness dependencies and the effect of texture on suprathreshold lightness tolerances," Color Res Appl; 25: 241-249(2000).
6. J.H. Xin, H.L. Shen and C.C. Lam, "Investigation of texture effect on visual colour difference evaluation," Color Res Appl; 30:341-347(2005).
7. CIE, Parametric effects in colour-difference evaluation, Vienna, Central Bureau of the CIE (1993).
8. H.L. Shen and J.H. Xin, "Dichromatic based rendering of texture image with high color fidelity," Journal of imaging science and technology, 48:246-250(2004).
9. R.S. Berns, R.J. Motta, and M.E. Gorzynski, "CRT colorimetry. Part I: theory and practice," Color Res Appl, 18:299-314(1993a).
10. J.H. Xin ,C.C. Lam and M. R. Luo, "Investigation of parametric effects using medium colour differences," Color Res Appl 26:376-383(2001).

# A comparison of various methods for establishing the relationship between structure and colour for fibre blends in yarn

G. D. Banyard, T. Cassidy, S. Westland
School of Design, University of Leeds, Leeds, LS2 9JT, UK
S. A. Grishanov
De Montfort University, Leicester, LE1 9BH, UK
Corresponding author: G. D. Banyard (g.d.banyard@leeds.ac.uk)

In this paper we compare the accuracy of existing and novel methods for determining the colorimetric colour of blended yarn based on the percentage of each fibre type used in the blend. We utilise information from 106 yarns comprising blends of up to 3 PAN fibre colours. Neural network, experimental and theoretical models are considered, notably the Kubelka-Munk, Friele and Stearns-Noechel methods. Results indicate that, whilst all methods have a range of accuracy, either an enhanced theoretical approach or a neural network method is best suited to modelling the problem.

## 1. Introduction

The colour of a yarn is determined by two sets of factors – the colour and shape of the constituent fibres and the position and orientation of those fibres within that yarn. These constituent fibres can all be of the same colour, but a single yarn can be composed of different types and colours of fibres. Although these 'melange' or 'blended' yarns may appear mottled, they can be considered to possess a single average colorimetric / spectrophotometric colour value.

Although derived for randomly distributed isotropic media, most theoretical models are based on the Kubelka-Munk equation[1]: a subtractive-mixing model commonly used for predicting the colour of single-colour dyed yarn. The single-constant form of the Kubelka-Munk equation was employed by Davidson[2]. However, both Burlone[3] and Amirshahi[4] used models developed on the two-constant Kubelka-Munk equation [1, 5] with varying degrees of success. The earliest of the theoretical approaches is the Friele model[6, 7], which is based on the Lambert-Beer law, Kubelka-Munk theory[1] and an empirically-derived scattering function proposed by Pineo[8].

Prior to all of these were the purely empirical methods such as the 1944 Stearns-Noechel[9]. More recently Thevenet[10] has applied a neural network approach to the problem of predicting the colour change from un-spun blended roving to yarn. It thus seems logical to extend the neural network method to our problem: Artificial neural networks (ANNs) have proven to be useful in a great number of recent colour problems such as the characterisation of colour cameras[11] and in colour prediction problems[12].

In this paper we compare the accuracy of existing and novel methods for determining the colorimetric colour of melange yarns, using existing data and information from 106 PAN blended yarns. For the various blend percentages of three colours of PAN fibre (red, green and blue) structural and spectrophotometric data are obtained. These results are compared to existing models, notably: the single constant Kubelka-Munk[2, 4]; Friele[6,7]; Stearns-Noechel [9, 13]; and Phillips-Invernizzi's revision of the Stearns-Noechel[13]. These are then compared and contrasted with alternative models, and finally a neural-network model. The strengths of each are compared and contrasted.

## 2. Theory

A melange yarn is created by mixing *n* different fibre colours with proportions $x_i$. Based on this $x_i$ and knowledge regarding certain yarn properties (such as the twist and count) and fibre properties

(such as the fibre diameter and its reflectivity) we wish to obtain the wavelength dependent reflectance factor $R_{blend}(\lambda)$ from which colorimetric values (e.g. CIE XYZ) can be estimated.

### 2.1. The Mixture Function

Most blend-colour models separate the problem of correlating the blend proportions $x_i$ to the reflectance $R(\lambda)$ into two equations: defining a mixture function $f(\lambda, R, \psi)$ and defining a relationship between the mixture function and $x_i$. The mixture function $f(\lambda, R, \psi)$ depends on the wavelength $\lambda$, the reflectance $R$, and $\psi[...]$ which represents any set of variables used to describe the physical and optical properties of the yarn and fibre. $\psi[...]$. For previous research the mixture function relationship has typically been a simple, additive linear relationship [9, 6, 2, 3, 2, 4, 13, 7] between the blend mixture function $f_{blend}$ and the mixture function for all $n$ identically produced single-colour yarns $f_i$:

$$f_{blend}(\lambda, R_{blend}, \psi[...]) = \sum_{i=1}^{n} x_i f_i(\lambda, R_i, \psi[...]) \qquad (1)$$

To predict a blend reflectance we then simply: obtain the constituent $f_i$ mixture functions from measurements of the reflectance for the *n* single colour yarns, calculate the $f_{blend}$ using equation (1) and then rewrite the mixture function to obtain an equation that expresses $R$ in terms of $f_{blend}$.

### 2.2. Single Constant Kubelka-Munk model

For a large scattering coefficient $S(\lambda)$ or a media that is thick enough to become optically opaque, then the basic form of the Kubelka-Munk equation[5] can be employed using equation (1).

$$f_{km1}(\lambda) = \frac{K(\lambda)}{S(\lambda)} = \frac{(1 - R(\lambda))^2}{2R(\lambda)} \qquad (2)$$

### 2.3. Stearns-Noechel model

The Stearns-Noechel model again uses equation (1) but this time with the additive function as,

$$f^{SN}(\lambda) = \frac{1 - R(\lambda)}{b(R(\lambda) - 0.01) + 0.01} \qquad (3)$$

*b* is a dimensionless constant, established for any specific blend via experimental measurement. Phillips-Invernizzi[13] proposed an enhanced version that incorporated a wavelength dependent *b* term,

$$b = \tfrac{1}{1000}(0.12\lambda + 42.75) \qquad (4)$$

### 2.4. Friele model

Whilst equation (1) is still utilised, the additive term is derived from Beer's law, utilising equation (2) in the process. Thus we obtain,

$$f^{FR}(\lambda) = e^{-\sigma(1 - R(\lambda))^2 / (2R(\lambda))} \qquad (5)$$

Where □ is known as the Friele parameter and varies for different fibre types.

### 2.5. Neural Network model

Artificial neural networks crudely mimic the behaviour of neurons in the human brain: a set of neurons can be tailored to receive a set of inputs and deliver a set of outputs, and then by showing it examples of typical input and output information it can be trained to predict outputs based on any desired input set. It has been shown that ANNs can be trained to accurately fit almost any continuous function[14].

A feed-forward backpropagation network can be designed and trained to predict the blend reflectance $R_{blend}$ based on only the blend proportions $x_i$ and the wavelength $\lambda$. Using a 3-layer model (input, output and one hidden layer of neurons) we can create *m* separate networks each with an *n* element input vector (the proportions of all *n* fibre types) predicting a single element output (blend reflectance) for a discrete set of *m* wavelengths. This is in many ways equivalent to a single partially connected ANN. The advantage of this method is two-fold: neural networks respond better when their inputs are of a similar "type", and even with normalisation the functional dependence of the output on the wavelength will be considerably different to the functional dependence on fibre blends proportions; the advantage of traditional methods is their predictive power, and as such the best ANN solution for this problem will be one which can train accurately on very little data.

**3. Method**

For the purpose of this investigation 106 worsted melange yarn samples were produced by ACORDIS. These consist of various proportions of a red (Geranium), a green (Evergreen), and a blue (Cobalt) fibre selected from the Acordis' range of 5dTex Polyacrylic Nylon (PAN) (approx. 25 □m diameter) fibres. The yarns were 55.55 Tex, thoroughly mixed by running 7 or 8 times through a Gill box (6 or 8 draft), and spun into a non-compacted unrelaxed single ply yarn with a single twist of approx. 240 turns per metre in the Z direction.

To obtain colorimetric data the yarn were wound round standard cardboard cones sufficiently so as to behave as optically opaque media and the reflectance spectra measured using a Konica Minolta CM-3600d spectrophotometer with a 10-mm diameter aperture. Reflectance data (with specular component included) were taken at 10-nm intervals between 360 nm and 740 nm (note *m*=39). In order to minimise experimental error, ten different reflectance spectra were taken for each yarn retaining the same angle to the aperture and at the same height from the cone base. The average of the ten measurements was calculated and used to calculate CIELAB coordinates (for the $D_{65}$ illuminant and the 1964 standard observer).

The numerical work was developed in MATLAB, making use of its Neural Network toolbox. A simplex algorithm was used for function fitting, using a mean least squares criterion to the spectral reflectance. The 39 ANNs were feed-forward backpropagation networks employing a Log sigmoid transfer function with a three-element input vector, a single element output vector, and a 5 element hidden layer.

All of the models tested were trained/fitted with various sizes of subset of the reflectance data for the 106 yarn available, ranging from three yarns to all 106 yarn. The quality of the fits achieved were then based on 2 situations 1) the accuracy of the prediction for all 91 major yarn 2) the accuracy of the prediction for the 15 small variation yarns.

**4. Results and Analysis**

Using the mean $|\Delta E|$ of the fit as a measure of how close the colour match is we find that the neural network model is the clear winner out of the 4 models considered as it is the only model that achieves an average $|\Delta E|$ less than 1. However, figure (1) clearly indicates that this can only occur when the training data is in excess of approximately 50 yarns, which may not be feasible in a manufacturing situation. For lower training set sizes the basic and enhanced Stearns Noechel models appear to be the best, even if they still average greater than $|\Delta E|$=1. It is interesting to note that with increasing training set size there is little variation in the predictive power of the theoretical and empirical models, possibly indicating that it is the fine functional dependence that they do not adapt to well.

Figures (2a) and (2b) supports the conjecture that the theoretical and empirical models do not adapt significantly to an increased training set. Only the Neural Network model changes significantly, with a smaller percentage of the colour predictions falling above $|\Delta E|$=1.

As for the 15 fine variation yarns, when trained on the main sets there were significant errors, but when trained specifically to the small detail sets all models behaved with remarkable accuracy. This is however unsurprising as the data over such small ranges is smooth and this was moreover a test of whether the models could fit a smooth curve.

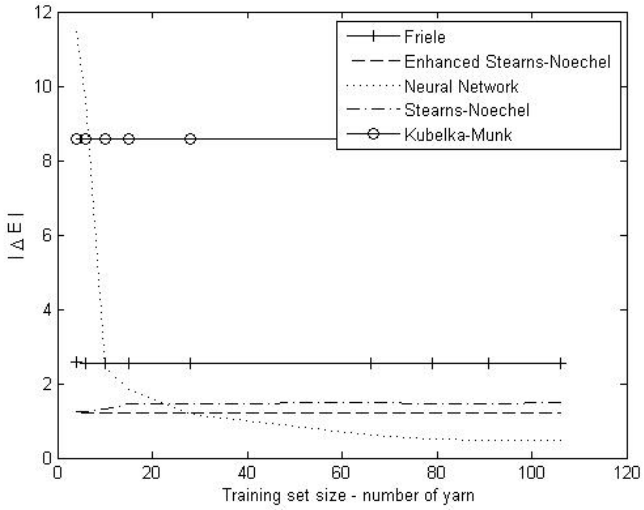
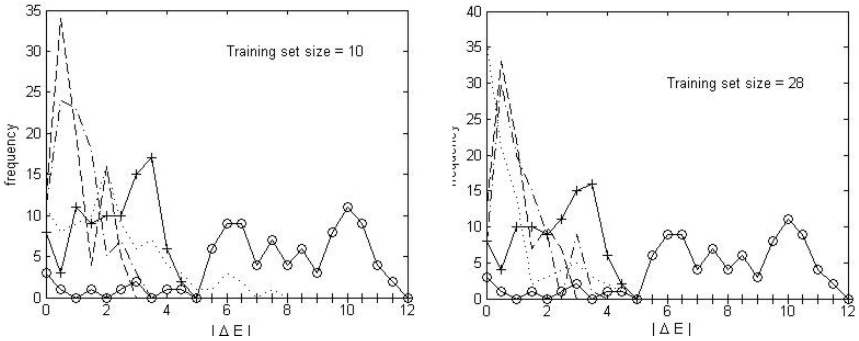



*Figure 1: Changes in mean $|\Delta E|$ of fit with increasing training set size for all models*




*Figures 2a and 2b: Histogram of $|\Delta E|$ for training sets of 10 yarns and 28 yarns*

**5. Conclusion**

Whilst a Neural Network model is the only method to consistently achieve predictions lower than $|\Delta E|$=1, for a small training (20 yarns or less) set it appears that either the basic Stearns-Noechel or the Phillips-Invernizzi enhanced Stearns-Noechel model is the closest predictor. I would like to thank EPSRC for funding this research, Acordis Acrylic Fibres for providing the yarn used, and K. Beverley, V. Cheung and F. Siewe for their assistance in this endeavour.

*1*. P. Kubelka and F. Munk, Zeitschrift fur technische Physik 12 (1931) p593-601
*2*. H.R. Davidson and M. Taylor, J. Opt. Soc. Am., 55, 96 (1965)
*3*. D. A. Burlone, Color Res. Appl., 9, 213 (1984)
*4*. S. H. Amirshahi and M.T. Pailthorpe, Textile Res. J. 64(6) (1994) p357
*5*. J. H. Nobbs, Rev. Prog. Coloration !%, (1985) p66-75
*6*. L. F. C. Friele, J. Text. Inst. 43,(1952) p604-611
*7*. B. Philips-Invernizzi, D. Dupont and C. Cazé, Color Res. Appl. 27(3) (2002) p191
*8*. O. W. Pineo U.S.P.2.218.357 (1940)
*9*. E. I. Stearns and F. Noechel, Am. Dyest. Rep., 33, (1944) p177
*10*. L. Thevenet, D. Dupont and A. M. Jolly-Desodt, Color Res. Appl. 28(1) (2003) p50

*11*. V. Cheung, S. Westland, D. Connah and C. Ripamonti, Coloration Tech., 120 (1), (2004) p19-25
*12*. J.M. Bishop, M.J. and S. Westland, Color Res. Appl., 16 (1), (1991) p3-10.
*13*. B. Philips-Invernizzi, D. Dupont, et al, Color Res. Appl. 27(2) (2002) p100
*14*. K. Funahashi, Neural Networks, 2, (1989) p182-192.

# A Comparative Study on Color Scheme Preferences of Elementary School Children for Their School Environments: Two Private Schools in Ankara

Zeynep Başoğlu
Department of Interior Architecture, Faculty of Engineering and Architecture, Çankaya University
Öğretmenler cad. No: 14 06530 Balgat, Ankara (TURKEY)
Corresponding author: Z.Başoğlu (zbasoglu@cankaya.edu.tr)

## ABSTRACT

The aim is to investigate the color scheme preferences of elementary school children for their school environments regarding the differences in age, gender, and functions of the spaces on these preferences and to realize the effect of the applied color schemes on the preferences for other color schemes. In order to realize the anticipated results a case study has been conducted. The students of two urban private elementary schools with different color scheme applications have been questioned according to the objectives. The results showed a tendency towards certain color schemes and the importance of the color aesthetics in an environment.

## 1. INTRODUCTION

The elementary school environments are important places for children's physical and psychological developments between the ages 6 to 14. They systematize the children's experiences according to an organizational plan. It is indicated that the children's preferences, needs and feelings must be taken into account when designing school buildings as well as the ergonomic requirements.[1] However; it has been observed that the elementary school buildings are generally organized and designed according to traditional administrative lines that meet the needs of the adults rather than the children's. Children who learn in environments that are designed to elicit and reinforce their development will enjoy schooling more than children who learn in an environment designed with other criteria in consideration.[2] The appearance and sense of a school is essential for children and the environment guides them to shape their attitudes and behavior. The schools, therefore, must have positive effects on the children's ability to learn and perform, increase the desire to stay, explore and interact with others.[3]

Application of color in the school environments plays an important role in the achievement of the necessary results. The modern application of color to the elementary school environments improves the scholastic performance along with the psychological development of the students. Regarding these aspects, the use of color in the school environments becomes a sensitive issue. Even though color is such an important element in school environments, it is the one thing that is neglected the most. The functional aspects of color are hardly considered during the design process; leave aside the aesthetical and psychological aspects. This is a major setback in many of the elementary schools. Yet, creating colorful spaces is not a solution since using color for the sake of color would accomplish little that is constructive.[4] It is thought that children's preference for color of their environments should be taken into consideration while choosing the colors to be applied in the school buildings. However, this issue is generally or almost always disregarded. In the general case, the schools are painted with certain colors concerning the maintenance and cost aspects. If they are painted with the mostly preferred colors and color schemes of children, it is believed that they would enjoy their time more, the sense of belonging to the environment would increase and the education process would be more fruitful.

## 2. EMPIRICAL STUDY

### 2.1 Objectives

The objectives of this empirical study are: (1) to realize the color scheme preferences of elementary school children in their school environments; (2) to observe probable differences for color scheme preferences depending on gender, age and the functions of the spaces; (3) the effect of the applied color scheme of the school environment on the preferences for other color schemes.

### 2.2 Characteristics of study sites

For the case study, the students of two urban private elementary schools with different color scheme applications have been tested. The school buildings subject to test were selected according to

their color applications in the interior spaces. One of the subject schools is the Bilkent Elementary school, which was selected due to its carefully planned analogous color scheme application. The other subject school is the Middle East Technical University Trust Elementary school (METU College), which has been selected because it had no specific color scheme application and the spaces were painted with white in general.

**2.3 Subjects**

The subjects were chosen according to their age groups and in total 275 elementary school students were tested. These age groups are the different development stages of children during their elementary school years. The duration of elementary school years in a child's life covers three major development stages: intrinsic vision phase (between ages 5 and 9), concrete functional phase (between ages 9 and 12), and form functional phase (between ages 12 and 18).[5] Accordingly, ages of the subjects selected for this study were the 8 year olds (2nd grade), 10 year olds (4th grade), and 13 year-olds (7th grade). It has been thought that this variable would aid to discuss on the children's preferences for color scheme preferences at different levels of development as their conception and use of space change.

**2.4 Methodology**

For the experimental stage of the study, images in alternative color schemes of the interior spaces have been prepared. These alternative images are the perspective drawings of the classrooms, circulation areas and the cafeterias of the two schools, rendered in six color schemes: the existing color scheme, two similar color schemes (red/orange-warm color scheme, blue/green-cool color scheme), two contrasting color schemes (red/green, blue/orange) and an achromatic color scheme. In order to obtain the alternative images, perspectives of the spaces have been drawn, which were rendered in the specified color schemes. These rendered images were placed on grey cardboards and they were assigned code numbers to be shown to the subjects. The subjects were asked to choose the color scheme they preferred for their classrooms, corridors, and cafeterias from these images provided and to note down its code number on the questionnaire provided. Finally, they were asked whether they liked or disliked the colors applied in their school surroundings. This question was asked to examine how much would the pleasure for the colors in a space affect the preference of children for other color schemes.

## 3. DATA ANALYSIS

For the data analysis, the results have been grouped according to age, gender, and schools and have been calculated using chi-square tests, percentages and correlations. To analyze the results of the color scheme preferences for their classrooms, corridors, and cafeterias the subjects have been grouped according to their ages and gender as well as according to their schools. In addition, the effects of function on the color preferences have been tested. For this analysis, the data has been grouped according to the functions of the spaces and examined accordingly. Finally, the subjects have been grouped according to their schools to be able to compare the differences of preference for the existing color scheme among the students that occupy school environments with different applications of color and to realize the importance the effect of the applied color scheme of the school environment on the preferences for other color schemes.

When the results were statistically analyzed, it was realized that most of the results were not statistically significant for color scheme preferences. However, the percentage rates were significant enough to give an overall impression of the color scheme preferences of elementary school children for their school environments. Since the results were not found to be significant for age and gender, the general results including all the subjects are presented in percentage charts below. As it can be observed from the percentage charts, the blue/ orange complementary color scheme is the most preferred color scheme for the classrooms for all the subjects. For corridors and cafeterias the blue/ orange complementary color scheme and the blue/ green cool analogous color scheme are preferred almost equally the most by all the subjects.

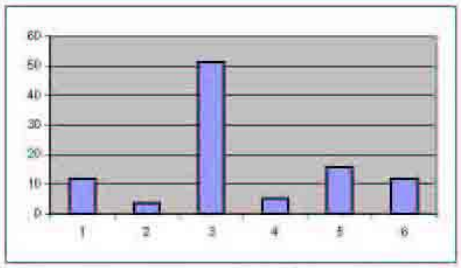



**Figure 1.a.** Classroom color scheme preferences

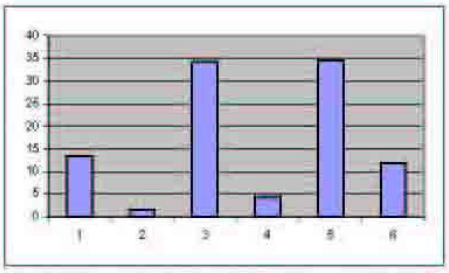



**Figure 1.b.** Corridor color scheme preferences

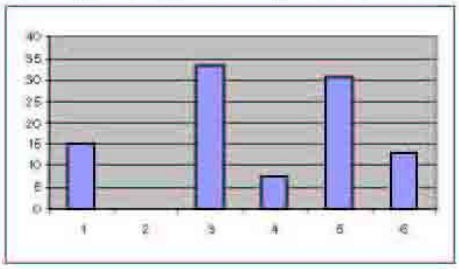



**Figure 1.c.** Cafeteria color scheme preferences (1: existing color scheme, 2: achromatic color scheme, 3: blue/ orange color scheme, 4: red/ green color scheme, 5: blue/ green color scheme, 6: red/ orange color scheme.)

The analysis regarding the differences in color scheme preferences for spaces with different functions did not provide statistically significant results. Since the results were not significant, the results including all the subjects are presented in percentage chart below.

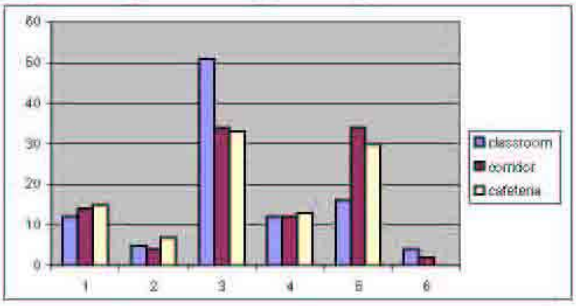



**Figure 2.** Color scheme preferences according to function in percentages (1: existing color scheme, 2: achromatic color scheme 3: blue/ orange color scheme, 4: red/ green color scheme, 5: blue/ green color scheme, 6: red/ orange color scheme)

Regarding these results, it can be said that children prefer different color schemes for spaces with different functions. Even though statistically not supported, the preference for a different scheme for the classrooms is noticeably higher than the corridors and cafeterias. This can be interpreted, as, since children spend most of their time in their classrooms during a school day their sense of belonging towards their classrooms is higher than the other spaces, and this aspect leads them to prefer their classroom environment to be different from the other spaces they occupy for shorter period of times.

The preference for the existing color scheme of the classrooms came out significantly highest among the three spaces examined according to the preference for the existing color schemes in the spaces. (corr: 0.994, sig= 0.006, significant at 0.01 level). This significant result supports the thought that children, who spend most of their time in the classrooms, develop a high sense of belonging towards them and therefore they prefer the existing situation to remain.

The results obtained regarding the effect of the applied color scheme of the school environment on the preferences for other color schemes were also found to be statistically significant. There is significant correlation between architectural color applications in the school environments and like/dislike decisions of the subjects for their own school's color schemes. (corr: 0.965, sig= 0.017,

significant at 0.05 level). There is significant correlation between the applied colors in the school environment and the preference of children for the existing color scheme of the school buildings. (corr: 0.925, sig= 0.009, significant at 0.01 level). These statistically significant results support the importance of color aesthetics within an environment to increase the liking and sense of belonging towards the environment.

When the preference for the existing color scheme results were compared between the Bilkent Elementary school students and METU College students, it has been realized that Bilkent Elementary school students showed higher amount of preference for the existing color scheme of the school environment than the METU College students. Even though not significantly proven, this was an anticipated result and the results were expected to be noticeably different between the two schools with different color scheme applications. This also result supports that carefully planned color scheme within an environment increases the preference for the color scheme of that environment.

## 4. DISCUSSIONS

Even though the results are not significant in most of the situations, they give an idea of what could be done to improve the elementary school environments and make those spaces more preferred environments by children. Since the education is coeducational and since the results regarding the gender aspect for the color preferences showed no significance in this study, the color application in the elementary school environments can be done disregarding the gender. The situation is similar for the age groups. Since the results regarding the age for the color preferences showed no significance in this study, same color schemes and patterns could be used in spaces designed for different age groups.

The children have showed tendency to prefer the blue/ orange complementary color scheme for their classroom environments. This result can be considered as an indication that children prefer balanced color compositions for their classroom with the use of both cool and warm colors, which leads to dynamic but internally balanced environments that would guide the children's behaviors to be more subtle and calm.

The significant results considering the applied colors in an environment and the liking and preference towards them support the importance of the application of preferred colors in the environments. These results, along with the significant results of the preference for the existing color scheme for the classrooms, can be regarded as the first step to a more detailed study regarding the effects of color applications of the environments in the increase of liking, sense of belonging and enjoyment of the classroom environments for elementary school children.

## REFERENCES


**1.** A.R.Binter, H.F.Sherman, The Psychology of the Elementary School Child (Rand McNally and Company, Chicago, 1972).

**2.** L.E.Sturck, The Design of the Learning Environments (UMI Dissertation Services, Michigan, 1992).

**3.** A.Mehrabian, Public Places and Private Spaces (New York: Basic Books Inc., Publishers, New York, 1976).

**4.** F.H.Mahnke, Color, Environment and Human Response (Van Nostrand Reinhold Company Inc., New York, 1996).

**5.** Ş.Ö.Gür, T.Zorlu, Çocuk Mekanları (Yapı Endüstri Merkezi, İstanbul, 2002).

# Color, the Architectural Project and Archetypical Images

Dr João Carlos De Oliveira Cesar
Faculdade De Arquitetura E Urbanismo Da Universidade De São Paulo
Brazil

**Abstract:**

This paper is the result of research being carried out in the Faculty of Architecture and Urbanism of the Universidade de São Paulo, on Color in the Architectural Design, and applied studies in a undergraduate and graduate courses.

In one of the research stages that has the aim of understanding the participation of color in the development of architectural project in its different phases, what was sought was a deeper understanding of the possible color relations use that could be analyzed under the prism of archetypal relations, in accordance with the conceptions of Carl G. Jung.

Jung was not the only one to raise the question of color as an element characteristic of archetypal images, it being possible to find references to that in the writings of Plato, Dionysus Aeropagite, Frank H. Mahnke, Manlio Brusatin, Israel Pedrosa, among others. The question is if these studies can be applied to architecture or not, and in what way.

The paper presents a theoretical approach to the subject, aiming at establishing elements that can serve as tools in the development of the architectural project as to the achievement of its aims, as also in the teaching of architecture.

# Colors of nationality as chromatic intertext

Mabel Amanda López
Secretaría de Investigaciones, Facultad de Arquitectura, Universidad de Buenos Aires
Ciudad Universitaria Pab. 3 piso 4, C1428BFA Buenos Aires (ARGENTINA)
E-mail: ychodos@fadu.uba.ar

**Abstract**: Behind the selection of the national symbols of every country there is a cultural history nurtured of facts, legends and myths that shape the identity. The feeling of belongingness generated by these signs creates an entity that unifies multiplicity and individuality into a supra-subjectivity: the nation. National colors are deeply imprinted in the affective memory of individuals. In the delicate puzzle where every element of the national consciousness is placed, color is a key piece. Color is also one of the elements more easily shifted towards other fields where visual signs are employed: visual arts, film, design, publicity, fashion. This paper will analyze chromatic intertexts in concrete examples, in different genres and contexts of use of national colors.

## 1. The concept of intertextuality in a cultural frame

It seems that there is no "original sin" in the relationships between texts; nobody is the first producer of a text, texts do not arise from nothing. Words, forms and ideas have already been used by others and by ourselves, even when we are not always conscious of that. In a wide sense, Charles Sanders Peirce had noticed the links between signs in the form of *unlimited* or *infinite semiosis*, where a sign gives birth to another in an unlimited recursiveness, only imaginable in thinking.[1] The Argentine theoretician Eliseo Verón makes an application of the peircean concept to the contemporary social functioning. The concept is applied to the analysis of the mass media communication, and gives origin to the notion of *social semiosis*.[2] Texts dialogue among themselves. There are no isolated texts, because their producers and their readers live immerse in a culture, and it is within that culture that the texts acquire a sense and a reason of being. Texts are not absolutely independent from each other, they are inserted in a kind of *web* or fabric. Bakhtin was the first theorist in "proclaiming" the dialogic character of texts: "Every statement is a link in a chain of other statements organized in a very complex way".[3]

This seems to be a premise widely spread in the present culture, which mostly pleases itself in re-elaborating texts and in quoting itself. The incorporation of other voices (in a wide sense) in a text is called *polyphony*. Polyphony comes etymologically from the Greek "poly", many, and "phono", voice, and encompass a more or less explicit and conscious repertoire of resources. Intertextuality, i.e., the relationship of a text with a previous one, is very frequent in visual texts. The study of intertextuality replaced at first the theory of "influences" or "sources" used by the producers of literary and artistic works in general, but in deepening the analysis it was discovered that that was only a small part of a bigger phenomenon. Intertextual relations, in a wide sense, are a big field; remissions and the play of citations only find a limit in the possibility of recognition on the part of the readers or spectators. Intertextuality works as a wink, a gesture of complicity. It is the expectation of interpretation on the part of the utterer towards his model of reader, who (ideally) will be able to recognize the texts to which the author alludes, making use of the intertextual competence.

Intertextuality may clearly address other identifiable text; in other cases, instead, it acquire diffuse limits, when what is "copied" is a feature of a style, whether individual or generic. Another form of intertextuality, almost unnoticed, is the appropriation of styles of epoch that, originated in some discursive field, become dominant features of other styles.

The purpose of using an intertext may be parodic, satiric, ludicrous or serious; whatever it is, always has two directions, it connotes the text and, at the same time, resignifies the original, which never remains intact when entering a new context.

The incorporation of the other text may have different degrees, from copy —plagiarism and falsification are legal figures that work as intertextual limits— to more or less explicit allusion. In art,

copying was always a widely spread practice, a legal exercise made by the own artists as a means of making their work more widely available, and also an illegal practice, by others, with the aim of obtaining some monetary profit. The technical reproducibility —such as pointed out by Benjamin in his classical essay on the subject[4]— allows copying images massively with a great accuracy and at an increasingly lower cost. This fact implies a democratization of the image, which is not confined into controlled and restricted spaces anymore (palace, church, museum). Consequently, images lose the "aura", the authenticity, the originality of being unique and non-repeatable pieces. Technical images lose their relationship with the original, become independent from it. The very concept of originality becomes diluted, because the image imposes its massive presence instead of a non-repeatable presence.

The birth of graphic design as a discipline is not alien to the new conditions of production in the modern world, which among other things facilitated with its technological advances the mechanical copy of images. The pieces of graphic design are intended to be reproduced, including in their very genesis the qualities and specifications to facilitate reproducibility and to lower its costs. They are not thought as a unique work (even when some of them have acquired this status), but as images for massive, and sometimes ephemeral, dissemination. The efforts are directed towards optimizing the multiplication of copies and, consequently, denying the original. In front of this panorama of unrestricted use and dissolution of the image of the author (originality does not depend of the authenticity of the signature that appears on the piece of work), whose maximum expression is the Internet, the copyright regulations imposed for images sometimes provide an insufficient frame to demonstrate plagiarism.

The notion of *hyperimage*[5] was conceived starting from the concept of hypertext, defined by Genette[6] to analyze literary works in the form of parody, imitations and pastiches that had origin in other works. Hypertext (*hyper:* over, above of) is a text that contains another text, because the text being transformed appears "under" it (*hypo:* below). Hyperimages "quote" other images, which constitute a kind of cultural reservoir or "bank of images"; these hypoimages have a rather fixed and standard meaning. Among the most used hypoimages are Leonardo's *Mona Lisa*, as a paradigm of western art, Michelangelo's gesture of the "Creation", Botticelli's *Venus* and *Spring* (youth, beauty), the *madonnas* (maternity), Rodin's *Thinker*, Munch's *Cry*. Hypertextual relationships among images (hyperimages) are frequent in the fine arts. Genette[6] mentions the example of Picasso, who paraphrased classical works in his own "language", one of the best-known examples being the *Meninas* (Figure 1).

*Figure 1: Velázquez's* Meninas *(left), circa 1657, and Picasso's* Meninas *(right), 1957.*

They are not simple parodies or homages, but very complex re-elaborations that produce as a result paradigmatic works in which the artist reflects on art. In this re-reading, the yellow and red of Spanishness replace the realist colors of the scene represented by Velázquez. By means of this substitution, Picasso adds other senses to the original painting.

Mass media reuse these images that have a stable meaning and reproduce at scale one of the general features of the postmodern culture: self-feeding. Images are nurtured of other images in a continuous auto-referentiality, they point to each other in a permanent play, remitting to no reality other than its own representation.

## 2. The national color as chromatic intertext

The use of the national chromatic identity may be explicit. For instance, most of the national airlines are identified with the colors of their countries. One example is *Air France*, whose logo has blue letters with red details on a white background. The meaning of the intertext is clear and univocal for the reader: it is a national airline (Figure 2).

*Figure 2: Logo of* Air France, *a case of chromatic explicit intertextuality.*


In other cases these colors may appear implicitly. Eugène Delacroix applies in a subtle manner the blue-white-red triad to recreate the French flag in his paintings (Figure 3). Here, color is employed in a veiled way, as allusion. In the same way, the cinematographic trilogy *Bleu*, *Blanc* and *Rouge* by Krzysztof Kieslowski, makes reference to the French nationality. The relation needs to be grasped by the spectator and may trigger more than one sense.


*Figure 3: Delacroix (left). Kieslowski (right). Chromatic allusion to the French nationality.*

The concept of *intertextuality* —Bakhtin's *polyphony*[3] or Genette's *hypertextuality*[6]— would encompass these phenomena where the national symbols are explicitly cited (textual reference) or implicitly insinuated (allusion) through the use of color.

The use of the colors of the United States flag is an intertext frequently associated to the exaltation of the national values, where the image of Uncle Sam is a paradigmatic case. On the other hand, the re-elaboration of this text can derive in a satiric hyperimage, where the national values represent negative aspects of the political behavior of that nation (Figure 4).


*Figure 4: Original Uncle Sam (left). Satiric hyperimages quoting the original (center and right).*

The quoted text (nationality) always acquires a new meaning in the context of the quoting text. Both are modified in a textual relationship, which results in the creation of a new text. To quote a nationality may bring positive or negative meanings, according to the representations evoked in the subjects. It may be playful or serious, mean a warranty of confidence or have a satiric, ironic or parodic reading.

**References**

1. Charles Sanders Peirce, *The collected papers of Charles Sanders Peirce*, 8 vols., vols. 1-6, Charles Hartshorne and Paul Weiss, eds. (Harvard University Press, Cambridge, MA, 1931-1935); vols. 7-8, Arthur W Burks, ed. (Harvard University Press, Cambridge, MA, 1958).
2. Eliseo Verón, "El tercer término", in *La semiosis social* (Gedisa, Barcelona, 1993).
3. Mikhail Bakhtin, *Éstetika slovesnogo tvorchestva* (Iskusstvo, Moscow, 1979). Spanish translation, *Estética de la creación verbal* (Siglo XXI, Mexico, 1982).
4. Walter Benjamin, "La obra de arte en la época de la reproductibilidad técnica", in *Discursos interrumpidos* I (Taurus, Buenos Aires, 1989).
5. Jorge Alessandria, *Imagen y metaimagen* (Publicaciones del CBC-UBA, Buenos Aires, 1996).
6. Gérard Genette, *Palimpsestes* (Seuil, Paris, 1982). Spanish translation, *Palimpsestos* (Taurus, Madrid, 1989).

# Author List