

AIC 2004 “Color and Paints”

**Interim Meeting of the
International Color Association
Porto Alegre, Brazil, November 2-5, 2004**



AIC2004
PORTO ALEGRE • BRAZIL

Book of Abstracts

edited by José Luis Caivano - August 2004



AIC 2004 “Color and Paints” is organized by the
 Brazilian Color Association
 (ABCOR, Associação Brasileira da Cor)
 on behalf of the
 International Color Association
 (AIC, Association Internationale de la Couleur)

Program outline (the detailed program will be published later)
 November 2-5, 2004

| TUESDAY, Nov. 2 | | | WEDNESDAY, Nov. 3 | | | THURSDAY, Nov. 4 | | FRIDAY, Nov. 5 | | |
|----------------------|---|--|----------------------|---|------------------------|----------------------|---|----------------|----------------------|---|
| 09:00 to 16:00 | Possible Pre- congress, Seminars and Tutorials (mainly for students) | AIC Executive Committee Meeting | 09:00 to 10:20 | Opening of the scientific sessions and Oral session, up to 3 papers | | 09:00 to 10:20 | Oral session, up to 4 papers | | 09:00 to 10:20 | Oral session, up to 4 papers |
| | | | Break | | | Break | | Break | | |
| | | | 10:40 to 12:00 | Oral session, up to 4 papers | | 10:40 to 12:00 | Oral session, up to 4 papers | | 10:40 to 12:00 | Oral session, up to 4 papers |
| | | | 12:00 to 12:30 | Keynote lecture | | 12:00 to 12:30 | Keynote lecture | | 12:00 to 12:30 | Keynote lecture |
| | | | Lunch | | | Lunch | | Lunch | | |
| | | | 14:20 to 15:40 | Oral session, up to 4 papers | | 14:20 to 15:40 | Oral session, up to 4 papers | | 14:20 to 15:40 | Oral session, up to 4 papers |
| Break | | | Break | | Break | | Break | | | |
| 16:00 to 18:00 | Registration and Posters hanging | | 16:00 to 17:20 | Oral session or Study Group Symposium, up to 4 papers | | 16:00 to 17:20 | Oral session or Study Group Symposium, up to 4 papers | | 16:00 to 17:20 | Oral session or Study Group Symposium, up to 4 papers |
| | | | 17:30 to 18:00 | Keynote lecture | | 17:30 to 18:00 | Keynote lecture | | 17:30 to 18:00 | Posters session and exhibition |
| 18:00 to 21:00 | Reception and Opening ceremony followed by a Concert or some social event | | 18:00 to 19:00 | Posters session and exhibition | Study Group meeting | 18:00 to 22:00 | Sightseeing and Dinner | | 18:40 to 19:10 | Keynote lecture |
| | | | 19:00 to 20:00 | Posters session and exhibition Continued | | | | | 19:20 to 20:00 | Congress closing |

Lectures: 30 minutes. Oral papers: 20 minutes

Posters and commercial exhibition: all three days, November 3-5

AIC 2004 Scientific Committee

Argentina: José Luis Caivano (chair)
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| | | |
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AIC “Color and Paints”, Book of Abstracts

Abstracts include: invited lectures, oral papers, posters.
The type of presentation is indicated in each abstract.

Abstracts are arranged alphabetically by first author last name.
To find a specific author, see the author index, p. 111.
To know the date and hour of a presentation, see the detailed program.

All the abstracts included in this book and presented in the congress have been reviewed by the members of the Scientific Committee.

Languages:

The following languages will be accepted for presentation in the congress (with the specified condition, for oral papers*):

For invited lectures:

English (AIC official language)

For oral papers:

English (AIC official language)

French,* German* (AIC official languages)

Portuguese* (local language)

Spanish,* Swedish* (two additional languages with the higher number of abstracts presented)

* The use of French, German, Portuguese, Spanish, and Swedish will be allowed provided an English translation is projected simultaneously and synchronized with the speech by the authors.

If the presenting author uses English, there is no need of translation to any other language.

For posters:

English, French, German (AIC official languages). However, the use of English is preferred.

Invited lectures:

DA POS, Osvaldo: When do colours become fluorescent?

HIRSCHLER, Robert: Light, colour, paints and pigments - a new concept in teaching colour for designers, architects and artists

LOZANO, Roberto Daniel: Appearance in paints

LUO, Ronnier: Verification of ciede2000 using industrial data (in collab. with C. Minchew, P. Kenyon, and G. Cui)

RODRIGUES, Allan: Color technology and paint

IMAGINATION AND COLOR IN THE CARIOCA SCENE

Poster

Mônica de Queiroz Fernandes ARAÚJO

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This article is a result of the experiences made during the classes of Fundamentals of Colour, which I teach for the Fashion Design Bachelor Degree Course offered by the Faculty SENAI/CETIQT.

We use the imaginative conception, based on Gaston Bachelard's principle of creative imagination for the conception of objects and places, as a methodology for teaching colour to future designers. This didactic choice for the creative imagination was a result of a previous research done with the purpose of revealing the images built in the soul of the self when admiring an object or place.¹ In this way the student self engross and wish to be in a place or to have an object, feeling he as a part of it (as if he has created it).

The project-focused education of the designer, when using his imagination, transforms an intention of a project, since the project comes out as a result of the designer imaginative thinking that leads to the creation of an object already with personality and identity, in which the colour is part of its structure (colour-structure). From this principle we have elaborated an exercise for the creation of the colour palette, taking it from the observation of the urban scene of Rio de Janeiro. The theme emerged in the classroom during a ludic approach for a photographic essay, which could put together different aspects of the carioca way of life: a "Bohemian Rio" that embraces the "Cultural Rio", the "Tourist Rio" that welcomes the "Nature Rio", and the "Historic Rio" present in the day-to-day of the city. The group of students, when separated in sub-groups to choose their own theme, did it with a natural and spontaneous identification that created multiple effects by mixing photography and gouache and by submitting themselves to the psychic action of this walking-urban making.

The well-organised contact with the colours of the city through the methodology of the creative imagination changed the understanding of colour and its application both in the objects and in the environment of each of the students. Colour at the imagination overcomes its psychophysics state and turns to be the structure of the city, as an innovative result to the quality of colour. As a didactic-pedagogic result, the sedimentation of the knowledge acquired throughout the theoretic classes surpassed the simple memorizing of the rules of composition and harmony, turning the colour into a structure of thinking, making it a natural part of the object representation within the project-making process. The project-making process, by being originated from an imaginal germination, liberates the colour application from the critical analysis within its creation source.

¹ Thesis with the title *The hidden dimension of the habitat: A poetic architecture* presented by the author, under the orientation of Dr.Sc. Carlos Murad, for the Architecture Master Degree at PROARQ/UFRJ in February 2003.

COLOUR AND THE DESIGN OF URBAN IMAGE

Poster

María Mercedes ÁVILA,* Marta POLO,† Adriana INCATASCIATO,†
María Inés GIRELLI,† María Marta MARICONDE,† Darío SUÁREZ,†
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Colour is a tool of expression and communication that requires, on the part of designers, an updated knowledge of its scope of action. It is necessary, therefore, to understand the problems involved in the city at the end of the century, which will enable us to fully exploit its communicative and expressive potential.

The research on the action of colour and its use as a tool of design of the urban landscape leads to the fact, today more than ever, that we have to admit that the science of colour is a science of information with a psychological and technical focus which has gained ground and has given back to colour a referential function in the contemporary city.

Taking into account that daylight is the most important element that reveals colour appearance, this communication will emphasize the relationship between the changes of the colour of daylight, the perceived colour of facades and the impact over the used paints. It will develop some provisional conclusions of the last researches of this equipment.

HARMONIC COMPOSITION OF COMPLEMENTARY COLORS ACCORDING TO ITS LIGHTNESS

Oral paper

Nelson BAVARESCO

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After the impact and under influence of Goethe's *Farbenlehre*, published in 1810, some new concept on color perception developed by the young philosopher Arthur Schopenhauer speculated about the role of the retina activity. His essay "Über das Schen und die Farben" (Concerning vision and colors) was published in 1816.

According to Rudolf Arnheim, in *Art and visual perception*, "Schopenhauer [...] pointing to the complementary colors produced by post-images, proposed that pairs of complementary colors happen by means of qualifying bipartition of the retina functions. Thus, red and green being of equal intensity, separated the retina activity into two equal parts [...]. Such a conclusion led to the following scale:

Black, 0 - Violet, 1/4 - Blue, 1/3 - Green, 1/2 - Red, 1/2 - Orange, 2/3 - Yellow, 3/4 - White, 1."

That scale originated a dimensional harmony system for the pairs of complementary colors, by the conversion of Schopenhauer's fractions in modular sections of 12 points for each pair. Harmony is made by the simple invention of those sizes, where a mathematic parameter is used for that kind of bichromatic harmony, applied to countless decorative conditions.

As far as we know, Schopenhauer's scale was never reviewed since its creation in 1816, although scientific conditions are available. But Schopenhauer's values and those of color lightness clearly match.

In spite of what exactly could be primary, secondary or complementary colors at Goethe and Schopenhauer's time, it is clear that the problem is completely solved by now, thanks to a modern color theory. Today we have processes that satisfactorily apply to the colors of television sets, computer monitors, inkjet or laser printers, and any other digital systems. Under certain circumstances those equipment interpret, in black and white, colorful areas of a text or drawing, simultaneously working with the additive and subtractive synthesis.

Consequently, our proposal is to show that Schopenhauer's scale can be updated by a version corresponding to the light absorption and reflection values according to the index adopted in the color management of computer programming language.

According to the study we have developed for Cecor® system, this new scale, enlarged from 3 to 12 pairs of colors including primary, secondary, tertiary, quaternary and correct complementary ones, very interesting results are obtained when converting the index into sizes and its further application to the dimensional harmony system.

Such study shows the methodology of the accomplished researches, also referring to the question of color complementarity, still wrongly presented in many publications.

A DEDICATED COLOR SYSTEM FOR THE COLOR ASPECTS EDUCATION

Poster

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Cecor® Color System (SCC) is characterized for being directed towards education focusing the rather subjective questions regarding color. Inspired by other systems such as Ostwald, Munsell and Gerritsen's, Cecor was entirely computer developed within CMYK standard. Consolidated with its third version, Cecor can be specified in any notation system, for instance RGB, HSB, LAB, etc., when there is the need for standard colors. Cecor's flexibility allows adaptations to new demands as well as the edition of all its material in digital system. One of Cecor's most important aspects is its three integrated modules, as follows:

1) *Regular solid*: as in the system tree, which describes the color characteristics in terms of Hue, Lightness and Saturation (HLS), allowing the digital edition of a multiple purpose color catalog with 2,421 samples. As Cecor is an open system, it can be enlarged to a greater number of colors.

2) *Didactic module*: gives scientific and artistic support to the system, with 20 synthetic charts on theory and psychodynamic interactions in color edited in various kinds of supports and sizes devoted to the study and teaching of the art and science of color.

3) *Harmony chart module*: formed by 22 basic harmonies that create more than 100,000 CMPs (Color Matching Plans). The charts are produced by customer order and work as coordinated color guidelines for any aesthetic or decorative purpose. This module derives from a basic product for the popularization of color culture: the "making harmonies and color mixing" disc that is being sold cheaply at hardware and stationary stores.

In practice, the system's chromatic basis can fully serve countless areas of final products, such as packaging, fabrics, coating and furniture, appliances, machines, vehicles and industrial equipment, paint and decorative accessories, etc. Cecor also includes an application of a refined chromatic methodology analyses for existing situations and prone to color renovation.

The benefits that Cecor is able to provide are also quite comprehensive. From the chromatic planning for auxiliary projects in architecture and decoration directed to work, study or social ambiances to the development of courses, workshops and specific training for professionals, professors and color marketing executives.

CHROMATIC STRATEGIES: DECISIONS AROUND ARTIFICIAL COLORATION OF NATURAL MATERIALS AT PRODUCT'S DESIGN PROCESS

Poster

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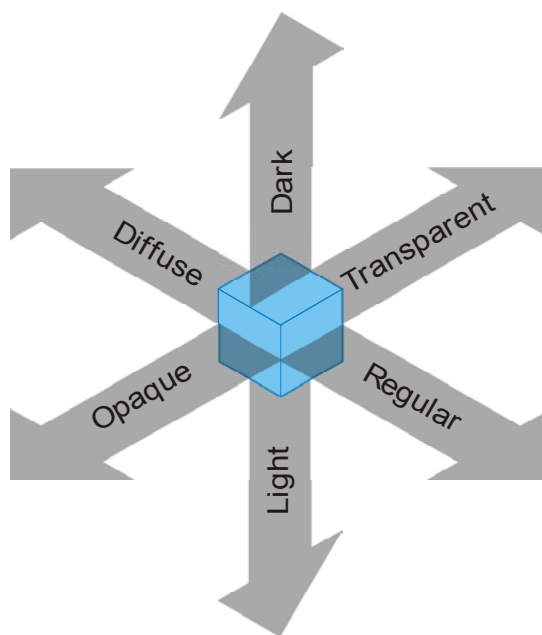
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The design process is based on a central strategy, that leads the professional in all his decisions related to the project's problems, in every aspect: morphology, production, communication, function, etc. This strategy organizes these variables for the product to be the answer of certain aim, fulfilling the user's particular requirements.

When natural materials are chosen to work on, it must be taken under consideration that they have specific physical properties, closely related with the origin and the different transformation processes performed on them, that set all the morphological characteristics: form, texture, color, and cesia. Therefore, when it is necessary to define the chromatic features the dilemma will fluctuate between keeping the natural colors of materials or changing them.

It must be kept in mind that any kind of cover will change, even slightly, the aspect of the material, whether by the way it reflects, transmits or absorbs light, or by the variations that this effect or the pigmentation causes on colors. In any case, these decisions should be taken by following the rules of central strategy, but considering the available coloring possibilities (natural or artificial) from technology, communication and functionality.

This work explores the possible modifications of natural-material's color and cesia through the application of artificial covers, for protective, aesthetical or functional purposes, organizing the variables of both spatial and spectral light distribution, in such a way that function as a reference tool in time for making decisions around color use in the product's design process.



ASPECTS OF COLOUR COMMUNICATION BETWEEN DIFFERENT PAINT MATERIALS

Oral paper

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Different historical findings tell us that man has been aware of and using colour as a visual sensation. Colour as a visual phenomenon has been fascinating people in all times. Colours were probably first used for decorative purposes 150,000 or 200,000 years ago. Paint materials were made of plants and earth resulting in a very limited colour scale. The ability to distinguish different colours was a necessary asset in the fight for survival. Colour helps us to identify different objects, and colour informs us about inedible plants, access to water, distance, whether fruits are ripe or unripe, etc.

In the past it was expensive to paint interiors or dye textiles except in certain natural colours. The objects received their natural colour, which was determined by the available natural pigments. The possibility to influence our surroundings with regard to colour has increased considerably during the last hundred years as a result of the increasing availability of synthetic colouring materials. We now use colour everywhere as an environmental factor similar to shape and pattern. We are no longer confined to nature's limited colour scale. We can choose colours more or less at our own delight.

Because of ever expanding possibilities to control the colour environment, knowledge about colour has become more and more important. The enormous variety of colours can even be a disadvantage and may end in a big chaos of colours. We will have difficulties in orientation and we might feel sick because of over stimulation through colours. Colour planning which is more consciously done is indispensable for a well-oriented society.

The big quantity of colours is setting demands on different needs: colour systems have been developed and are necessary to be able to communicate and produce all this colourfulness. Demands on colour accuracy have increased and today we only accept small colour differences. We are working with different materials like plastic, steel, and textile and we want them to be perceived as "the same colour" even though they are based on different colour materials, such as inks, surface colour, dye and pigments. Nature does not consist of unlimited resources and we have to restrict our use of environmentally harmful pigments and paint materials to protect our world.

The colour has become an even stronger factor than before in different fields like graphic design, corporate identity colours, or marketing, where the colour and paint of a product can be decisive of its fate and success. The colour designer is looking for experience and knowledge from colour research, which can be used in colour design. Colour research in areas like colour and paint, colour combinations, colour preferences, colour emotions, etc. are having a more prominent role and the demands on the practical use of colour research are increasing.

THE EXPERIENCE OF THE PAINTED ROOM: THE SIGNIFICANCE OF LIGHT AND COLOUR COMBINATIONS

Oral paper

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How do various placements of painted areas affect the room? Colour is an important part of the gestalt of a building and influences significantly the atmosphere within the building. This paper presents a study, in which 280 architectural students experimented with colour and light in model rooms. In their laboratory reports they accounted for the ways colour affect each other and how light and colour interact. The students specially studied the perceived colour of light in the room and the colour appearance of each room element, i.e. the walls, floors and ceilings. They also noted how various colour designs affected the impression of depth, width and height.

The students worked in groups of 3-5 participants that had one ground model (50 × 70 cm) and a great selection of uniformly painted room elements in many different hues and a few nuances. They were instructed to start out in a systematic way with a uniformly painted room and vary one surface at the time. Thereafter they combined the room elements freely. Guiding questions for the investigation were:

- How do various placements of painted areas affect the room?
- How do the colours of the floor, walls and ceiling affect the perceived colour of light?
- How can you make a painted area more or less intense?
- Can you change the impression of depth/height/width with different colour designs?

The laboratory reports give significant examples of colour effects in rooms, of shadow colours and how complementary colours affect each other. The students brought up various aspects of the painted room. For example, they discussed different ways of interpreting spatial properties and the difference between experiencing the room from the "outside" and from the "inside". They also tested strategies for how to make rooms with cold and/or dim light character warmer. I will discuss their findings and compare them with earlier studies.

THE PERMANENCE OF CONVENTIONAL AND DIGITAL OFFSET PRINTS

Poster

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The permanence of prints depends on its components and on the influence of the external factors. The deterioration of prints on ageing contributes to the technological conditions of paper manufacture (characteristic of the used raw materials, condition of pulp preparation, method of beating, sizing procedure, type of sizing agent), the techniques of printing and kind of printing inks, effects of lighting, temperature and atmospheric humidity, and the impact of microorganisms and moulds. In prints degradation the following processes are included: oxidative degradation, alkaline hydrolysis, thermolysis, physical-mechanical damage and reactions to mould.

In this work the test form is designed from the standard patterns composed of 210 fields of different combinations of colour value of the subtractive analysis, generated by vector graphics in the steps of 5%. The same printing form was used for printing in the techniques of conventional and digital offset printing. While printing in the conventional offset the model inks with different ratio of renewable raw materials were used. Uncoated paper of 100 g/m² grammage was used in printing. The prints were submitted to natural and accelerated ageing. In the application of ColorOpen the conversion from CIE XYZ into CIE L*a*b* was done in order to present the gamut of prints in the three-dimensional unified colour space.

The differences among particular gamuts of the printed samples in relation to the printing techniques, composition of the conventional offset ink and ElectroInk are presented in the work. The influence of the natural and accelerated ageing of prints on their optical stability is discussed.

The work is in scientific sense the contribution to the explanation primarily of the influence of the printing technique and colour composition on the optical stability of prints.

COLORIMETRIC INVESTIGATIONS AS QUALITY CRITERIA OF THE WORK OF ART REPRODUCTIONS

Poster

Maja BROZOVIC and Nina KNESAUREK

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The quality of the work of arts reproduction has been observed from the point of view of aesthetic and technological criteria. Technological criteria are composed of processes, systems and materials that are used in the reproduction process. Aesthetic criteria include formal and methodological characteristics on which the visually presentable systems are based. The visually presentable systems represent art and technical achievements of the historical periods of the visual arts.

There is the intention in this work to study the reproduction of the works of art of particular visually presentable systems by taking into consideration the aesthetic (arts) and technical (technological) characteristics. The investigations comprise the tonal visually presentable system (Renaissance), the bright-shadow one (Baroque) and the coloristic visually presentable system (Impressionism).

The methods comprise the visual evaluation and instrumental measurements by which subjective and objective evaluation of the reproductions have to be obtained. There is the intention to determine the quality criteria of the reproduction of particular visual image systems by colorimetric investigations of the color characteristics. In the visual evaluation of the observers, persons with defined knowledge and experience in the art practice have been included. By such a choice of the observers it is possible to consider the aesthetic criteria as authentic ones.

The quality criteria of the reproductions for each visually presentable system separately are made by the discussion of the investigation results. By defining the criteria, one wants to contribute to the improvement of the reproduction of the works of art in graphic media. This can lead to better understanding of the achievements of particular periods of visual arts, which represent the basis for the analysis of the visual form on which the graphic design is established.

CESIA AND PAINTS: AN ATLAS OF CESIA WITH PAINTED SAMPLES

Oral paper

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The name "cesia" has been given to the modes of appearance produced by different spatial distributions of light. From the physical point of view, an object may absorb light, and the non-absorbed portion can be either reflected by the material, or transmitted through it. Both reflection and transmission may occur regularly (specularly) or diffusely, and any intermediate combination may also appear. These are the stimuli for the visual sensations of cesia: transparency, translucency, glossy or mirror-like appearance, and matte appearance, with different degrees of lightness, and all the intermediate or combined cases. Every color appears in some of these modes of appearance. Now on, the stimulus for color can be produced by primary sources (objects that emit light) or by secondary sources (objects that reflect or transmit the light coming from another source). Both in a primary or a secondary source we can have a variation of color, but the variations of cesia only occur in secondary sources, that is to say, in objects that produce changes in the spatial distribution of light that they receive. These changes are mainly due to micro-textural variations on the surface or in the volume of the object. If these textural variations are of a rather small size, then the texture itself is not perceived, but the effect produced on light is, and we see cesias.

Paints are one of the most versatile materials to produce these kinds of variations. A paint may cover a surface, working as an opaque coating, and in that case the stimulus for cesia is due to the surface finishing. A rough surface produces a matte effect, while a polished surface produces gloss. But if the paint is more or less transparent, then, in addition to the surface finishing, the internal composition, working in the whole thickness of the layer, is important. In these cases, the stimuli for cesia are of a more complex nature.

An atlas of cesia made with pieces of glass was presented in AIC 1997, Kyoto. The aim of this paper is to present and explain a new atlas of cesia produced with painted samples. The atlas consists of 5 pages with 25 samples each, that is to say, a total of 125 samples. The samples in every page have a different degree of perceived *permeability* to light, from the opaque samples (1st page) to the transparent ones (5th page), passing through samples with different degree of perceived turbidity. Furthermore, in each page, the variation of *lightness* (from very light to very dark) and the variation of *diffusivity* (from matte or translucent to glossy or crystalline) occur. Figure 1 shows a scheme with the development of the first and last pages, and the indication of the three intermediate ones.

| OPAQUE (perm. 0) | matte | half-matte | satın | half-glossy | glossy |
|---------------------|-------|------------|-------|-------------|--------|
| white | 1/1 | 1/.75 | 1/.5 | 1/.25 | 1/0 |
| light gray | .75/1 | | | | .75/0 |
| mid gray | .5/1 | | .5/.5 | | .5/0 |
| dark gray | .25/1 | | | | .25/0 |
| black | 0/1 | 0/.75 | 0/.5 | 0/.25 | 0/0 |

HALF-OPAQUE
 (permeab. 0.25)

 TURBID
 (permeab. 0.50)

 HALF-TRANSPARENT
 (permeab. 0.75)

| TRANS-PARENT (perm. 0) | translucent | half-translucent | intermediate | half-crystalline | crystalline |
|---------------------------|-------------|------------------|--------------|------------------|-------------|
| very clear | 1/1 | 1/.75 | 1/.5 | 1/.25 | 1/0 |
| clear | .75/1 | | | | .75/0 |
| middle | .5/1 | | .5/.5 | | .5/0 |
| dark | .25/1 | | | | .25/0 |
| black | 0/1 | 0/.75 | 0/.5 | 0/.25 | 0/0 |

Figure 1. Scheme of the 1st and 5th pages of the atlas of cesia made with paints. The first page (opaque) has perceived permeability 0, while the last one (transparent) has perceived permeability 1. The numbers inside the tables indicate the perceived degree of lightness (varying in vertical, from 1 to 0) and diffusivity (varying in horizontal from 1 to 0): lightness/diffusivity.

BUILT AND HUMAN ENVIRONMENT: NEW PAINTS?

Poster

Cristina CAMELO GOMES

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Colour influences any life form: reproduction, survival, food, shelter, it all may depend of colour. That makes it a codified symbol in any communication process. Chromatic symbols are, throughout history and nature, an unquestionable way of communication for individual or collective identification.

Architecture, often designated as the royal art, frequently forgets and neglects the power of colour to influence reactions and behaviours; it uses an aesthetical motivated colour code, framed between materials and constructive processes and techniques, where volumes, planes and surfaces are showrooms for a particular artistic movement or fashion of the hour. This influences the built and human environment, by the use of colour as an element of the communicative process illustrating political and social ideologies and realities. Colour is a statement. Radical examples can be found within the modern movement, where the demanded sobriety and the emergence of the social classes' ideology and conscience were coloured with achromatic environments; or in the post-modern movement, where despite the aim of recovering the cultural and historical background of the place towards the recovery of the spirit and identity of the place, colour and ornament are frequently translated elements of the cartoon world to the built environment. This radical attitude illustrated by the imagination of each artist was once again unaware of the place and user's identification and requirements. None of these attitudes has considered the physiological, psychological and cultural impact in human behaviour, and yet some voices arise with a holistic comprehension and background, criticizing very often the clinical or focused analyses and interpretation of the people related with psychological effects.

Marketing and publicity use psychological studies, such as the ones on colour or the Maslow pyramid, taking the maximum profit from this dialectics to achieve their aims and objectives. Built and human environment has its own ephemerally provided by the experiences and the life cycle of each building.

Empirical studies show that colour changes with the location and orientation of the building, is influenced by climatic features of the place, can integrate the building with the surrounding environment, as Frank Lloyd Wright demonstrated, can be the product of the cultural choices of one population or place, can influence the user will of permanence and can create a path way, can influence our perception of time, temperature, affect our way of thinking and determine our reactions. Colour is influenced by light, and the light is a moment of vivacity or seriousness, emerging and hiding areas, objects, creating real or fantastic environments.

The anonymous architecture that is spreading all over the places, neglects the identity of the place and the user. It may be the characterisation of the moment, but the life cycle of the buildings is determined by factors that go beyond its aesthetical integration or physical condition.

The construction industry is one of the most prominent economic sectors of Portuguese economy. Presently, to be an architect is a fashion or a dream that leads hundreds of students to architectural degrees. Colour and light's impact is not subject of

teaching and are hardly researched. Academics pay little attention to it, university curricula neglects them and practitioners do not think about it.

Historical areas within cities deserve some attention from public institutions and academic works, towards the rehabilitation of the spirit and identity of the place. Yet, these questions also apply to peripheral contemporaneous areas, the big majority budget residential areas, where colour seems to serve only the purpose of warning the traveller about the neighbourhood he/she is entering. Beware!!!



REINVENTING INDOOR LAYOUTS: THE CONTRIBUTION OF LIGHT, COLOUR AND TEXTURE TO A STIMULUS AMBIENCE

Poster

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The way the human being inhabits is directly related with its way of survival. The grotto, first form of human shelter, was characterised by the moisture, texture, and light provided by the opening enter and geographical orientation. The rapid permanence of the man within this space was not impeditive to human intervention. An example, Lascaux caves, 17,000 year-old painting on a stone wall, was the primary aesthetical attitude within the human shelter, one of humanity's earliest narrative compositions considered by many experts. The man set out to identify, characterize and enjoy its territory.

The sedentary society, characterised by agriculture, raise a new way of living with a special emphasis on the sedentary way of life and the geographical and physical relation between the place of dwelling and the place of working.

Construction process and materials applied were the ones possible to find within the immediacy. Texture and colour were consequence of materials and mineral pigments available. Light was the result of voids in walls, and geographical and atmospheric conditions were determinants.

The exodus from the country site to the metropolitan areas that characterised the 20th century, raise a new way of living and work. Although the sedentary condition of the individual remains, dwelling stands apart from the working site.

Anthropometrical along with ergonomic features introduce their importance in the relation of human to machine. Psychological and behavioural studies boost their significance; nevertheless, both physiologic and psychological issues were surpassed by the economic pressure, and the stubborn of the ignorance.

In the negative sense of the expression, the building is a machine to live in. Man was never considered as an individual with expectancies or personality. The constructive features of the building can be crucial towards its own security and health, as the description of the finishing can be crucial towards the stimulus behaviour.

At the moment, the individual, specially the European one, is the main purpose of the information society. This peculiar society, where information is the raw material as well as the objective production, aims at the inclusion of every human being towards the equity between individuals and geographical regions. To accomplish these principles, ICT (Information and Communication Technologies) lift up its importance. ICT provide the communication between individuals and between regions, establishing new ways of working and living.

The use and abuse of ICT within our daily activities implies an increase of indoors permanence. ICT can misunderstand the space but mainly the time; biological functions and mood can be altered by the new time schedules provided and this insistent permanence indoor.

This insistent permanence indoor, the anxiety provided by the excess of information to manage, machines to operate with, unrealistic tasks and time tables, hot-desking and

virtual teams, lack of identification between individuals plus individual and place, should be a magnet for the attention of professionals to the importance of the ambience stimulus conception.

Anthropometrics is concerned within every workplace project; ergonomic considerations are present within comfort considerations (illumination, acoustic or temperature forms), therefore, psychological reflections towards the minimization of stress and extreme behaviours must be considered too.

More than ever the layout of every indoor, workplace, dwelling or leisure nature, must consider human requirements regarded to status, privacy, territory and social interaction between individuals, which means to consider light, colour and texture further more than a decoration issue, an aesthetical attitude headed for show of.

Concepts of kinaesthesia, proxemics and psychology must be integrant part of the focused information, accessible and disseminated enough, to conscience every professional to recognize the importance of an informed and wisdom conception of indoor spaces.

COLOR AND CESIA IN THE HISTORY OF STAINED-GLASS WINDOW

Poster

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The word "cesia" has been coined to refer to the visual sensations aroused by different spatial distributions of light: sensations of transparency, translucency, matte opacity, specularity, gloss, darkness, etc. (J. Caivano, Die Farbe 42 (1/3), 1996)

The stained-glass window puts in evidence the very own cesia, the translucent, essential characteristic that bases its essence, highlighting that the function of the colored glasses resides mainly in the possibility of being perceived by the transparency effect that is caused by the intensity of light that passes through it.

This effect can be observed from the interior of an atmosphere, depending on the intensity of the existent external light (for example, the natural light coming from the sun), and it can also be admired from the exterior, with atmospheres illuminated in the interior (with artificial light).

The stained-glass window can only be perceived and admired by the transparency effect, thanks to the light that crosses it. We will be able to look and admire its dynamics and changing appearance, where the beauty of its color will change at each instant depending on the degree of cesia existent in each of the glasses.

The technique of stained-glass window is one more in the excellent and original manifestations of the history of art. The intention in this report is exactly to put in relief the varied meanings attributed to its functional character. This art is analyzed with the purpose of understanding the transformations suffered in color and cesia, in connection with its aesthetic, iconographic and historical value.

The analysis will embrace the appearance and the aesthetics of the stained-glass window, as well as the application of color and cesia, observing the similarities and differences perceived according to the technical limits, needs and specific function. The stained-glass window is manifested in greater or smaller degree, and with different characteristics, according to the times. I will also try to establish an analogy between two periods of the art of stained-glass window in the history of architecture:

- 1) The Gothic windows of the 13th century.
- 2) The stained-glass windows in the modern architecture of the 20th century, according to the optics of Frank Lloyd Wright.

We will go through the Art Nouveau, as a period of intermission, in order to establish the existent synchronism between the times and the pertinent styles.

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COLOUR HARMONY, SUBJECTIVE APPRECIATION OR ORDERED CONSTRUCTION

Poster

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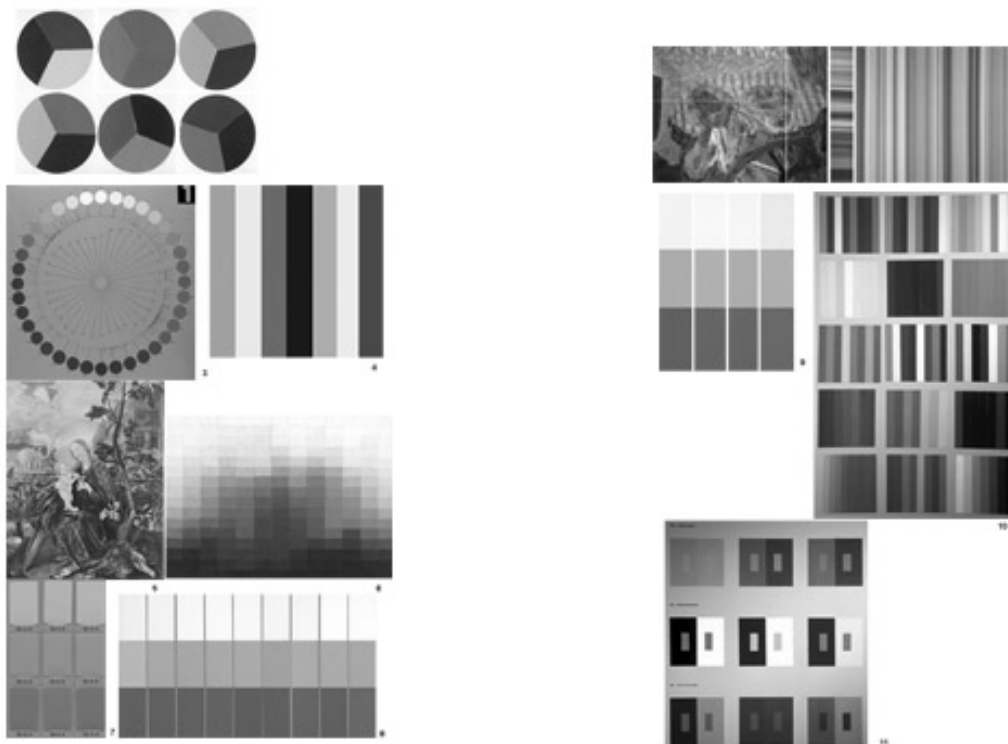
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If it is possible to characterize a colour according to the three measuring parameters, which are hue, saturation and brightness, it is much less obvious to characterize a colour harmony. Still we consider as quantifiable the relation between the colours that form a harmonious whole.

In order to characterize a colour harmony, we will use this clear and concise definition: "*the existing relations between the different parts of a whole thanks to which these very parts work towards the same overall effect*". Desaturation triangles, which are the basis of many colour atlases, correspond to this definition. The space that separates visually each element can be measured and the progressions can be calculated. Therefore the values that define the space between these colour elements can be quantified. Many chromatic constructions, in adequacy with the criteria that define them as harmonious, are quantifiable.



AGAINST COLOUR GLOBALISATION. COLOUR TRENDS AND COLOUR COLLECTIONS: THEIR USE AS A VOCABULARY AND THEIR CULTURAL SIGNIFICATION

Oral paper

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This presentation shows for the first time previously unpublished material on colour trends as indicated by colour collections for industrial building materials. A colour collection is far more than just a simple commercial tool. It acts as a colour vocabulary intended or implying a particular use and also imbued with concrete meaning, associations and evocations. Collectively these influence, control and manipulate the representation of contemporary colour culture. Colour collections are key elements in the process of creating our environmental, urban and habitat space.

In Hong Kong, the West Indies, Mexico, France, Sweden, Moscow... colour is bound up with local cultures that pose dramatic resistance to the sweeping homogenisation of globalisation. Re-defining a colour palette plays therefore a specific role in re-presenting or enhancing the expressive complexity of indigenous colour cultures on a local, regional or national scale. The concept and creation of colour collections are the result of diverse confluences or constraints that are simultaneously and dialectically launched into action: commercial, technical and construction regulations interact with the specific demands of professionals and the general public. Essential elements of a vital colour collection are its legibility and the capacity to inspire the sense and experience of colour.

One project of the Atelier F&M Cler is a series of colour collections or *nuanciers de couleurs*, as they are called in French, which has been conceived for different building material companies. The most important creations were for such diverse companies as Zolpan (2003, paint exterior/interior), Saint Gobain Weber (2002, thick coating), IPA-Weber&Broutin (2001, thick coating), HIRONVILLE Metal Profil Belgium (2000, aluminium cladding), Ferrari Manufacturer of Membranes and Composite Textiles (1998, fabrics), Peintures Gauthier (1988, paint exterior/interior), Griesser (1983, fabrics), and Buchtal (1980, ceramics). Each material has its own qualities and characteristics. Light plays an important part as it serves to reveal the tactile aspects of any surface, texture and colour. As well, shadow must also be considered because the interplay between shadow and light is one of the most powerful determinants of visual effect. Therefore, light is always an important consideration in the creation of a colour collection. That is, while iridescent colours enhance the light and reflective qualities of aluminium, intense colours strengthen the quality of fabrics that filter light and alter shades. Paint, originally an ephemeral material, generally used in religious and festive events, is the best way to evoke a variety of associations, the means used most often individually, culturally and historically to create atmosphere and define space.

As any other special kind of vocabulary belonging to a particular geographical, historical, cultural, economic and social context, colour collections play a dominant part in defining our world. Palettes change. Evolving as new aspects of colour are introduced and others discarded, some colours seem eternal or unchanging, while others seem to be more ephemeral.

COLOUR PROPOSAL FOR TWO EDUCATIONAL BUILDINGS IN VALDIVIA, CHILE

Poster

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The colouring decisions that architects make in their work have different meanings in their origin, depending on their own architectural vision and on the variables of the projects. In this paper I will present two educational buildings, property of the Universidad Austral de Chile, designed by an architecture firm with the advise of a designer and a bioclimatic engineer.

One building is covered with pre-painted panels selected from the Luxalon colour card. The other one, built in fibrocement and concrete, adjust its colouring to a paint manufacturer's colour card. The external surfaces of both buildings work as a bioclimatic element due to their insulation design and to different local colour studies.

These buildings distinguish themselves from the local architecture due to their daring colour design, which is applied also in contemporary architecture.

THE NEW PHYTOMETRIC SYSTEM OF RADIATION UNITS FOR PLANT PRODUCTION

Poster

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The normalized quantum efficiency curve (RQE), published by McCree in 1972, replicated by Inada in 1976 and 1978, and refined by Sager et al. in 1982 and 1988, was adopted here as the basis for developing the phytometric system of radiation units applied to the production of plants. The phytometric system is designed as a method to facilitate the calculations of radiation measurements for plant systems, taking into account the response to photosynthesis.

Based on the multiplication of the RQE curve with the spectral power distribution (SPD) of a given light source, the phytometric measurement would yield units of phytoW-m⁻². The flux radiation unit phytoWatt easily provided conversion factors to the radiation metric, photometric, and photon flux (quantum) systems within the photosynthetically active radiation (PAR) of 400 to 700 nm or within the extended PAR of 300 to 800 nm. The use of the phytometric system was demonstrated by applying it to four types of high-intensity discharge (HID) lamps. Pertinent conversion factors were calculated for each lamp type.

This paper develops a unit of measure for plant lighting, the phytoWatt, which is simpler and more interchangeable than the unit of $\mu\text{mol}\cdot\text{m}^{-2}$, designated for PPF or YPF. The phytoWatt is derived from the radiometric measurement weighted and according to the RQE curve.

WHEN DO COLOURS BECOME FLUORENT?

Invited lecture

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Ralph M. Evans (1949, 1972) was the first to perform a systematic study of fluent colours. He realised that no physical fluorescence but simple luminance relationships between colours are the essential conditions to evoke the correspondent impressions. He called fluorescence this effect to distinguish it from the physical process, and considered it of the greatest importance in developing a new approach to colour theory. Fluorescence would be an intermediate step between surface and luminous colours along a continuum called brilliance. Primarily concerned with the theory, Evans analysed relatively few colours, and until now, except few works (for instance by Gilchrist et al. 1994; Petrov et al. 1998), little research has been carried out in the field. This research presents a systematic study of the luminance threshold separating surface from fluent colours. A rectangular target area (about 2 deg at a viewing distance of 1.5 m) appeared located over either a uniformly white or a coloured Mondrian background (A4) lit at about 175 lux, and its luminance was varied through an independent illumination. The four unique hues, at a very low blackness and at three different chromaticness, were examined in three experiments. In Exp. 1, 12 subjects measured the luminance threshold of the four unique hues, observed over a uniformly white background, by the psychophysical method of limits, and in Exp. 2 other 24 subjects performed the same threshold measurements with the target placed over a coloured Mondrian. Exp. 3 was similar to Exp. 2 with the exception that 22 subjects performed the threshold measurements by a simple staircase procedure. Results show that the fluorescence threshold for the yellow is at about the same luminance of the surface white (sometimes higher), and is significantly higher than the threshold for the green, which is still significantly higher than that of the blue and red; moreover there is a significant inverse correlation between threshold and chromaticness. Fluorescent thresholds with white background are slightly lower than with coloured Mondrians.

A fourth experiment was devised to compare fluent thresholds of some reddish yellow nuances with those of some greenish yellow nuances. The target was observed by 10 subjects both over a white background and a coloured Mondrian. Results show significantly lower thresholds for reddish than for greenish yellow nuances, and for higher than for lower chromaticness. No difference was found between the two kinds of backgrounds. The main results perfectly agree with the data by Evans; moreover fluorescence thresholds seem to follow the natural lightness of the hues, being unexpectedly high for the yellow. This last result is probably related to the stronger white appearance of the bluish white surfaces compared with the yellowish ones of the same luminance. Fluorescence seems to be an overlapping colour category between surface and illumination colours, sharing the reflecting characteristics of the former and the luminous appearance of the last, the hypothesis by Evans that brilliance is a unique dimension to which surface, fluent, and luminous colours belong in sequential order. The decrease of fluorescence thresholds as a function of chromaticness is theoretically relevant in the organisation of colour systems.

COLOUR APPEARANCE OF FRUIT JUICE AFFECTED BY VITAMIN C

Oral paper

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The role of healthy diet is becoming important and is of great interest in the food industry. Consumers tend to choose food products that are rich in nutrition. To meet consumers' needs, many food products have added some minerals/vitamins to improve their nutritional value. In fruit juice, vitamin C is always added. However, the addition of vitamin C may affect the colour of fruit juice and this may lead to unacceptability by consumers, as colour is also one of major parameters influencing the quality of fruit juice. Thus, the purpose of this study was to investigate the effects of vitamin C on colour appearance and colour stability of fruit juice. Mao juice was chosen in this study. Mao (*Antidesma* sp.) is a tropical shrub widely grown in the northeastern part of Thailand. In the juice processing, mao juice was extracted from frozen mao. The juice, pH 3.5 ± 0.1 , contained $17.6 \pm 0.3^\circ$ Brix total soluble solid, 17.62 ± 2.23 mg anthocyanins/100 ml juice, 311 ± 0.36 mg total phenolic compounds/100 ml juice. The study of the effects of vitamin C on the change of 25% mao juice quality was carried out. Vitamin C was added to the juice at various levels to yield 0, 10, 25, 50 and 100% of vitamin C daily intake per bottle after pasteurisation. Juice that had vitamin C added was filled in 190-ml tinted glass bottles with 4.5-ml headspace and stored 24 weeks at 30°C. The result showed that degradation of anthocyanins in each treatment of mao juice was first order at rates of 8.00×10^{-3} , 8.20×10^{-3} , 9.30×10^{-3} , 1.02×10^{-2} and 1.09×10^{-2} / day, respectively. The half-life values of anthocyanins were 88, 84, 74, 68 and 63 days, respectively. The lightness values (L^*) of all treatments tended to increase over the storage period. On the contrary, the a^* values of all treatments decreased over time, indicating the decrease of redness in the juice colour. During storage, microbiological assay (total plate count, yeast and mould) showed negative results. Sensory evaluation for the preference in redness and the overall colour preference of the treatments was also studied. The results showed that the preference in redness and in overall colour ranged from "like slightly" to "like moderately" during the period of storage in every treatment. The change of colour appearance of mao juice due to the addition of vitamin C was negligible.

ROSELLE ANTHOCYANINS AS A NATURAL FOOD COLORANT AND IMPROVEMENT OF ITS COLOUR STABILITY

Poster

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Colour is an important factor influencing consumers' acceptability of food products. This is due to the fact that consumers always associate food colour with other qualities such as freshness, ripeness, and food safety. Thus, many food products have added food colorants to make the products more desirable. At present, the role of anthocyanins as food colorant is becoming increasingly important. Not only do they contribute to the most important attributes of food —both for aesthetic value and for quality judgement— but also they tend to yield potential positive health effects, as they have been observed to possess potent antioxidant properties. Since roselle (*Hibiscus sabdariffa* L.) is widely grown in Thailand and tropical areas, it could be another potential source of anthocyanins as a natural food colorant. However, natural food colorants are not stable in food products. They can be decolourised and degraded during storage. This study aimed to improve colour stability of anthocyanin extracts from roselle by adding either maltodextrin or trehalose as a stabiliser. Colour stability, colour appearance and observers' colour preference of the roselle anthocyanins over a storage period of 12 weeks were quantified and compared to SAN RED RC[®] and synthetic carmoesin, which are commonly used as food colorants in commercial.

In this study, the extract solution of anthocyanins from roselle at a pH of 2.5, 13.5° Brix was subjected to freeze-drying under 0.05 hPa vacuum for 15 hours. After freeze-drying, the dried product was ground into powder. The sample was packed into a sachet made of metalised film. Maltodextrin and trehalose, each at 2 and 3% (w/v), were used as stabilisers in freeze-dried powder. During a 15-week storage period at 30°C, anthocyanin contents, half-life, and colour were evaluated. Addition of maltodextrin and trehalose retarded anthocyanin degradation. Although pigment concentration changed, the change in hue was negligible. The result showed that the extract anthocyanins with 3% (w/v) maltodextrin added provided reasonable colour stability. This extract anthocyanin colour (0.1% w/v) was then used in a model system of drinks to investigate colour stability, colour appearance and preference in comparison with SAN RED RC[®] (0.05% w/v) and synthetic carmoesin colour (0.05% w/v). The extract anthocyanin colour had higher lightness than the other two synthetic colorants but its chroma was much lower. The results indicated that the synthetic colorants were more stable in all colour aspects, i.e. lightness (L^*), chroma (C^*_{ab}) and hue (h_{ab}). In the case of sensory evaluation, it was found that overall preference of a drink with extract anthocyanins added was not acceptable after 8 weeks of storage, while the drinks with added either SAN RED RC[®] or synthetic carmoesin were acceptable through the period of 12-week storage.

COLOR MATCHING FROM MEMORY

Oral paper

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Satisfaction with color and paints in consumer products and in the environment may be related to color sensitivity and ability to remember color. Color memory has been described as successive color matching, a category of matching in which time elapses between presentation of a color stimulus and the attempt to select a matching color. In this research, 40 university students, all having normal color vision and at least average color discrimination ability as determined by the Farnsworth-Munsell 100 Hue test, participated in a color memory experiment. The participants were divided into two groups: 20 with prior color coursework, and 20 with no color-related training. Short-term color memory of the participants was evaluated in four hue categories: yellow, yellow-red, green, and purple.

Munsell dimensions of hue, value, and chroma were used to select the four target colors and nine distractor colors for each of the targets. For each target color, four of the distractor colors differed from the target in hue only, four were of the same hue as the target, but differed in both value and chroma, and one was identical to the target in both hue and value, but differed in chroma.

In each test, the subject was presented the target color chip and asked to look at it in a light booth for 5 seconds, with the intent of remembering it. After removal of the target color, and an additional period of 5 seconds during which the subject focused on a white card, the subject was given a stack of ten randomly arranged color chips, including the target and the nine distractors, and asked to choose the target color. On completion of the four color tests, subjects were asked to explain what cues, if any, they used in recalling the targets.

Of the four target colors, yellow was the most accurately remembered, and green was the least accurately remembered color. Effects of hue, value and chroma differences of the distractors on color selections, differences among the participants with respect to the use of cues, and effects of prior color-related training will be presented.

COLOR AND DESIGN OF PRE-COLUMBIAN CERAMICS TODAY

Poster

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Pre-Columbian designs can be used today in very important collections all over the world. I made a recompilation of signs and symbols used long time ago, that we can use today in interior designs. We can repeat all that symbols, taking care of them, looking for real sources of information. Indians made them with a religious signification, thinking about rain and sun, or to have more animals.

I can show examples of real pre-Columbian designs, made now by ceramics companies; they are not handmade but are similar to handmade examples. They used colors made from new pigments, which gave the appearance of original natural colors and surface textures. Forms and colors can be respected if we know the real sources of information.

THE COLOR OF BRICKS

Oral paper

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In the western world architecture has favored materiality and permanence whereas immaterial and temporary qualities are set aside of the norm. By focusing on color as part of architecture various conflicts can be illustrated, as the relation of materiality and immateriality, and the hierarchical order of the building elements.

The German architect Gottfried Semper's (1803-1879) theories of "dressing" and "material transformation" have been interpreted in many different ways, as his notion of the mask. Semper considered color "the subtlest, most bodiless coating ... the most perfect means to do away with reality, for while it dressed the material it was itself immaterial" (English translation in *Four elements of architecture and other writings*, Cambridge, 1989). He described the enclosure as one of four elements generating architectural form. Woven material, colored carpets, formed the wall, and hanging carpets remained the true walls, when later they were transformed into clay tile, brick, or stone walls. In *Learning from Las Vegas* (1972), the American architects Robert Venturi and Denise Scott Brown argued for architecture as "shelter with symbols on it". The book defines the "decorated shed" where systems of space and structure are directly at the service of program, and ornament is applied independently of them.

The separation of buildings into "structure" and "skin", or "shed" and "decoration", makes it possible to stress on one of them, and to leave one of them outside architecture. "Architecture is colorless", the Italian architect Gio Ponti stated about 1960; "A building made of bricks is a building of bricks, not red architecture ..." In the 1950's and 60's Swedish architecture (projects presented in the architectural press) got rid of all painted surfaces. It started about 1950, when the architect Hans Asplund called Bengt Edman and Lennart Holm "neo-brutalists", provoked by their design for Villa Göth. As to be read in *New Brutalism* by Reyner Banham (1966), the term was dropped into an English context, where brutalism among other things means that the structural materials of the building are exposed, without plaster and paint.

The color of bricks appears from and is subordinated to a manufacturing process. In *Von Material zu Architektur* (1929), László Moholy-Nagy, artist and teacher at Bauhaus, set up a terminology for the different aspects of materials. The term "structure" describes the unalterable manner in which the material is built up. "Surface treatment" means the perceptible result of a working process. By means of the terms structure and surface treatment, it is possible to separate the making process from the later treatment by external force, and to see that bricks, already at the place of production, are buildings in a way that color will never be. Color is almost all surface treatment. Paint is a material, but more than brick it is a product disconnected from a certain place, and the colors of paint both *appear* later, in the perception, after the building is completed, and *disappear*, because it is an impermanent material. The paper examines the color of brick in relation to the color of paint by using the theories of Semper, Moholy-Nagy, Banham, and others, in the analysis of a brick wall from the Swedish brutalism.

THE COLOUR-SYSTEM OF ARCHITECTURAL STRUCTURALISM: THE OFFICE COMPLEX GARNISONEN, STOCKHOLM, SWEDEN

Oral paper

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*A complicated three-dimensional system of communication
runs through the building like water flowing in a tree.*

(The artist Gösta Wallmark commenting the colour-system in Garnisonen)

The Swedish architectural structuralism is closely connected to the golden years of Swedish economy when modular thinking, standardisation and rational prefabrication were prerequisite. The ideological and practical foundation was Anglo-Saxon post-war architectural theory as well as English and Dutch practice (for instance the work by Alison and Peter Smithson and Aldo van Eyck). Distinct Swedish examples are the Huddinge hospital (1967-1972), The Arrhenius laboratory at the University of Stockholm (1971-1973) and Hans Borgström's student housing in Rinkeby in the outskirts of Stockholm (1969). Maybe the most typical example from this period, and the richest from a colour point of view, is the object of this investigation: The giant office complex of Garnisonen on Karlavägen in Stockholm (1969-1972, Tage Herzell, A4/ELLT architects). The building consists of a uniform facade which stretches along the entire block (347 meters) covered in plates of dark aluminium. The pedestrian arcade opens up to a system of inner courtyards of a more intimate scale and character. The interior, as well as windows and doors, were given manifest strong colours according to an organised system. The building was divided into colour-zones of blue, red, yellow and green, combined with unpainted concrete.

Since colour is the main focus of this study, I have chosen to, along-side of other sources, interview the person responsible for the original colouring and art-program of the building: the artist Gösta Wallmark. Which motives and influences can be found in the choices of unpainted concrete and strong, pure colours within the architectural structuralism? The investigation shows that colours are used as a contrast to the super-rational system of modular building, an element of rebellion associated with play (a kind of lego or meccano) as well as the contemporary strife for an informal, relaxed and more democratic working life. The colours are organised in a system which resembles a drawing (a *picture*) of a technical flow-chart —a frozen three-dimensional flow of energy, water and air.

The study is also attempting to discuss the modernistic roots of architectural structuralism through the concept of *addition*. Addition (to add part by part) as a working-method in the creation of architecture was already present in 19th century neo-classicism. The use of the concept returns in 20th century architectural theory, in the description of architectural structuralism as well as in the organisation of the practical work in creating Garnisonen, which consists of standardised and modularised "office-boxes" added piece by piece. Theory and method is one thing however, final results

another. The final result in this case cannot be characterised as a simple addition of parts. Instead the building appears, one could say, as time-less; its architecture has "classical" features such as well-balanced spatial proportions, legibility and other qualities. The colour-system, and the art in general, plays an important role for the entirety in being integrated in the general architectural picture.

COLOR AND PATRIMONY IN LA PLATA CITY, ARGENTINA

Oral paper

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Color in the urban space fulfils an essential function for the identification of place. It reaffirms its significance and it is a referent for the valuation of the urban patrimony. The important role that color plays and the search for a chromatic identity has motivated our map of color for the city of La Plata.

La Plata city was founded in 1882 and designated as the capital city of the province of Buenos Aires, in Argentina, as a result of a political decision. It was especially designed and planned. Its singularity lies in the modern urban model, which combines neoclassic urban art and the new theories of hygiene of that time.

Together with this map of color we present the *first chromatic palette* in harmony with La Plata's environment and identity. This palette takes into consideration environmental, historical and cultural aspects of this particular place and its inhabitants.

These color charts result from a thorough and systematic data collection on the color of the building materials used in the place.

Two systems are applied to the map of color:

- Environmental Identity Range (as a general use referent)
 - Historical Identity Range (to be used in buildings considered of patrimonial interest)
- The historical chromatic documentation helps in recovering and preserving the architectural patrimony of La Plata city.

PAINTED WALLS – FROM PICTURES AND IMITATIONS TO COLOURED SPACE

Oral paper

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Why do people paint their rooms and buildings? Certainly there is a technical aspect, especially for outdoor painting. But, just as certainly, the technical aspect has seldom or never been the primary reason for painting. The effort to paint has risen from an urge to satisfy both human and divine needs, and from a desire to create beauty, status, illusion...

In my presentation I will show and analyse different ways that the material *paint* has been used throughout architectural history, in order to create suitable space for varying human activities. Most of my examples will be taken from Swedish building tradition, but there will also be broader comparisons, including Pompeian frescoes as well as the colourful spatial modelling in the Dessau Bauhaus School.

Painted surfaces have often been used as surrogates for other materials that have been too expensive or simply not available. See, for example, the elaborated imitated marble surfaces in 17th century palaces, and their simpler followers in later workshops and farmhouses. But also the colours themselves have been a symbol of status and wealth. For example, there is a thread of influence from northern gothic red brick churches to the red distemper painted farmhouses still dominating the Swedish countryside.

Much wall painting consists of pictures. Religious motives have been common, not only in churches or temples but also in the homes of those who could afford to paint. Pictures can tell something about the room's functions and activities, or the social status of the owner. They can also convey the illusion of a place somewhere else —such as the garden paintings that turned Pompeian town houses into countryside villas, or the numerous "Italian piazzas" painted on the walls of recent pizza restaurants all over the world.

A third principle for wall painting is to rely on colour in itself to create space and atmosphere. The early modernists juxtaposed evenly coloured surfaces of contrasting colours, and in structuralist architecture colour could be used as a signal, differentiating building parts according to their functional or structural role in the system.

The use of large monochrome surfaces has eventually led to a growing interest in the material aspects of paint itself. Apart from the quality of *colour* a surface has qualities such as gloss, transparency, texture... all of which can be chosen with care, in order to obtain a certain totality. The last few decades have brought a number of new or renewed paint materials and painting techniques, and once more inspiration is gathered from what has been painted throughout history.

LIGHT AS A GENETIC ELEMENT OF THE IMAGE

Poster

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Since a long time, the Research Group HUM-480 "Constitución e Interpretación de la Imagen Artística" has been working in the area of research about the perception of the work of art, paying attention to what is called *genetic elements of the artistic image*: light, matter, space and time, where color is a very important element inside the artistic languages.

At the beginning of March 2004, a theoretical-practical seminar was carried out with the professor of stage design from the National Institute of Art and light-worker in the Colon Theatre of Buenos Aires, Mauricio Rinaldi, who is also a member of the Argentine Color Group. The title of the seminar was "Illumination in Art and Stage Design" ("La Iluminación en el Arte y en la Escenografía"). In this seminar, the light work was treated from the more technical point of view: electric system, power phase and distribution, external-internal knowledge about different spotlights and mixing-light desks, etc. From the point of view of the significance, the focus was not just on how to use the light but also on why to use it. The aesthetics of light and the theory of communication have been analyzed, considering the illumination as a communication element inside the object of art, like stage design or plastic art.

The experience of working with 49 students was very interesting. They made very complex narrative works of art, in which light is an essential part of the communicative exercise. The above-specified members of the research group have developed a communication about this experience. The importance of this research is to integrate the Light and Materials Laboratory¹ into the Faculty of Fine Arts of Granada University teaching practice.

¹ The Light and Materials Laboratory is a creative and technical research project with the purpose of integration in the new syllabus of the Faculty of Fine Arts studies.

INSTRUMENTAL WHITENESS EVALUATION – PRACTICAL RESULTS OF INTER-INSTRUMENT AGREEMENT TESTS

Oral paper

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The instrumental evaluation of white objects treated with fluorescent whitening agents, such as commonly found on substrates like textiles, plastics and paper, is a task not as straightforward as it might seem. One of the main reasons is the fluorescence of the optical brightening agents that is influenced by the amount of UV radiation in relation to the amount of radiation in the visible range of the spectrum. This makes it necessary to perform a UV adjustment on the light source in reflectance spectrophotometers to establish the adequate ratio of UV and visible radiation, as defined by the CIE. There are different ways of doing the calibration and adjustment and there are several standards available for this task.

This paper compares whiteness measurements of textile samples treated with fluorescent whitening agents made on 4 different industrial reflectance spectrophotometers, some using a traditional method of adjusting a filter position for UV control and others performing a numerical and virtual UV control. Comparisons are made between instruments of the same model and of varying models, also using differently sized measurement apertures. Two sets of standards are used for the calibration and the measurement results obtained after the different calibrations are compared.

The same samples were also measured on a bi-spectral spectrophotometer and results are compared to the ones obtained with the industrial instruments that only have a single monochromator. The double monochromator measurements allow the calculation of the spectral radiance factor for a standard D65 spectral power distribution, as defined numerically by CIE, and the subsequent calculation of whiteness values.

THE ROLE OF COLOR IN THE INSTITUTIONAL LANGUAGE

Oral paper

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The city, as a social complex manifestation, answers not only to different cultural aspects, but to political interests and economic projects as well. The official institutional head offices contribute, as a matter of fact, to the consolidation and transmission of a desired scenery and landscape that stand for an explicit city and society project.

Public work is characterized for being the visible expression of the governmental action and has been used as advertising manifest by different political actors.

From the middle of the 19th century, education is present in the city and is one of the typologies —as well as health— more used as a manifest of the governmental action. From this period on many schools have been built in Córdoba city, some of them display the monumental classic architecture, others exhibit the modern movement tendency, and the rest of them reveal the need for massive public education which forces to choose technologies of low rate cost and quick building.

The Faculty of Architecture has evolved through history according to didactic contents and the development of teacher-student relationship in class. Technical advances and cultural currents have impacted in the formulation of classroom design, but the pedagogic innovation has been the actual engine of the deepest transformations in the configuration of school space; between these transformations the study of color and the incorporation of chromatic systems happened to be quite determinative of school places and also influential in human beings' behavior (this according to some psychological currents). Nevertheless, these deep innovations in the use of color with a renovator pedagogical purpose and the use of education as the engine of cultural affirmation and social leveling are absent in public works in Córdoba city; though they incorporate color, were designed more with the intention of leaving the stamp of a governmental action than with the goal to consolidate future generations' identity.

This work proposes to analyze the relationship between color as a typical element of the architectural language and the *communicational purposes* in the official architecture of Córdoba.

It has been taken into consideration as consulting material of study institutional works carried out by the State in different historical periods and under different administrative and political systems in the province of Córdoba, Argentine Republic.

COLOR PRACTICE AND THEORY: A VIRTUAL LEARNING ENVIRONMENT BASED ON THE CHROMATIC PROBLEMS SOLVING FOR THE ARCHITECTURE AND DESIGN FIELDS

Poster

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Virtual learning has been based specially on written language. Fields such as architecture and design, which are based on the development of visual-graphic language, have not yet created models of learning environments adapted to its specific demands. On this way, the VLE-AD project of the Universidade Federal de Santa Catarina presents, as a main issue, a specific structure aiming at the creation of virtual learning environments for architecture and design.

The VLE-AD is based on the tripod of communication and information technology (CIT), problem based learning (PBL) and theoretical contents of color. Collaborative learning depends on the CITs and put in evidence the socio-interacionism character of the learning environment. PBL does not constitute a theory itself, but is an educational approach, based on the presentation of open and suggestive real situations, which demands an active attitude and an effort to find its own answers, its own knowledge.

The collection of contents is structured in a flexible and interactive way and can be accessed according to the learners interests, not depending on time and place. The theoretical base is then grouped in five big axes: concept definition, classification, chromatic models, composition, and color reproduction. In the first axis, *color concept* is defined based on its implications according to physics, physiology of perception and culture. The item *chromatic models* deals with the characteristics and uses of the systems RGB, CMYK, HSB, HSV, CIE-LAB, Munsell, and NCS. In the item *composition*, the principles of chromatic combinations, harmony strategies and contrast are explored. The item *color reproduction* approaches the reproduction systems, its particularities and applications. This item also deals with the apparent modifications that color experiences according to the formal context, environment and illumination. Each item also offers exercises, literature indications, study suggestions and tips that intend to amplify the basic knowledge about the topic. A specific color glossary is available along the whole learning environment. The learners also have access to an image bank, learning material, videos, animations, presentations, gallery of works developed by the groups, allowing the consultation at any time. They also can save their files, notes and projects in specific "places" on the server.

Based on the finalization of the contents implementation, problems and testing of the prototype, it is expected to create parameters for the construction of learning environments focused on knowledge fields based on chromatic language.

COLOUR THEORY IN INFANT EDUCATION. PRACTICAL EXPERIENCE

Poster

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Once upon a time there were three very elegant noblemen. One of them was named the Red Knight. Do you know why? Because he was entirely red! His clothes, his face, his shoes... everything about him was red. He was the most dangerous because he was always very, very excitable. But do you know what else happened to the Red Knight? He fell in love even with the flies that passed him by!

Imagine a class full of children aged 4-5 years old, looking at you expectantly. How can you introduce them to colour theory? How can you put them in touch with the physiological and expressive qualities of colours? How can you make them understand and take these ideas on board, as if they were their own?

We could propose that they "fill in" the spaces in the chromatic circles and learn a list of the physical and expressive qualities that each colour possesses... Do you think that would be useful? Moreover, do you think that these procedures would really do any good for our primary, secondary or higher education students? This activity is not about repeating lists by memory, our objective must be much wider: to achieve that the students "experience" colour and understand it from the significant experience that this has offered them.

The following study shows part of a didactic unit carried out in 2003 with boys and girls of 4-5 years of age from the Alquería School in Granada (Spain), in which, making use of games and designing clothes, the children learnt about colour theory and related it to their surroundings and to their own life.

In the first part of the study we explain the objectives and contents that are proposed for the session entitled "We're Clothes Designers!" in which colour theory is worked on. Immediately afterwards we focus on the activity "The Noblemen's Shirts", a story that is used to aid a first approach to the physiological and expressive qualities of colour. Finally we explain the practical part in which the children have direct contact with colours, mixing paints and printing on the cardboard costumes that they have previously made.

This study vindicates the need to enable children to approach colour analysis from a very young age. Since this contact, as in all early experiences, this approach will shape the rest of their life experiences.

PROJECTION OF GREEN FLUORESCENT LIGHT UPON TULLE AND A FEMALE BODY. PRACTICAL EXPERIENCE

Poster

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The following work shows the results of research carried out in the Faculty of Fine Arts of the University of Granada, Spain, in the year 2000, within the subject of Pictorial Techniques corresponding to the final year of the university degree. The main objective that motivated this study was to empirically and theoretically investigate the idea that it was not only possible to paint "for sight", but it is also possible to paint for "hearing" and for "touch".

This hypothesis, follows on from the conceptual analysis of various pieces by Tadeusz Kantor which were worked on in class by the students —*La Clase Muerta (The Dead Class)* (1975) and *Wielopole* (1980), amongst others—, departing from the solution to the premise that lights, sounds and textures can be mixed by using technical processes similar to those employed in the physical mixing of colours to produce a painting.

The experience that is displayed focused on the analysis of light as a pictorial medium which enhances the tactile appreciation of the created object. The resources used to achieve this experience were a tube of green fluorescent light, tulle material from which a dress was made, some white walls and a female body upon a pedestal, who would put on the dress. Lights, textures, opaque and translucent elements were mixed, just as in a painting, to create an installation in which the visual and sensorial experience enjoyed similar importance.

The first part of this work expounds the theoretical ideas that guided the practical development of this installation. Immediately afterwards, the construction process of the piece is shown. This concludes with an image of the final state of the work, alongside which are exhibited some reflections on the piece, by way of a conclusion about the analysed experience.

THE FLUORESCENCE OF SUNPROTECTED WHITE COTTON FABRICS

Oral paper

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Beside the vital and powerful role of sun in our everyday lives, the overdose of UV radiation on skin can lead to potential skin damage from exposure to the sun's ray. Compare with visible light that interacts with dyes UV radiation interacts with ultraviolet absorbers and fluorescent whitening agents. Middle UV-rays (UV-B region, $\lambda = 280-315$ nm) causes acute and chronic reactions and damages, such as skin reddening or increased risk for other diseases. For such reason it is important to protect the people from the ultraviolet radiation falling on garments and sun-screening textiles such as tents. The level of such protection of fabric depends of a large number of factors as the type of fiber, porosity, density, moisture, color and FWA in the case of white textiles.

In this paper, we report an experiment in which cationized cotton fabric was treated with UV reactive absorber on the base of oxalanilide, Tinofast CEL, to improve the UPF of fabric. Exacust method was applied following peroxide bleaching and optical bleaching procedure. For optical bleaching three stilben derivatives as optical brightness agents were used in wide concentration range. The UV protection factor (UPF) measurements were done using Varian Carry-50 AnAs UV-Vis spectrophotometer, the whiteness degree and yellowness by Datacolor Spectraflash 600 plus-CT and relative intensity of fluorescence by Carl-Zeiss Fluorometer. The aim of the paper was to study the FWA's fluorescence changes of sunprotected white cotton fabric.

COLOR AND PATTERN IN CONTEMPORARY APPLIED ART: TIME AND SPACE ASPECTS

Poster

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This paper presents a research of interactions between the color and the pattern in form construction and composition process in contemporary applied art. Analysis making base is the visual. It separates applied arts works time and space conditions.

The purpose of the research is to build a theoretic formulation about color and pattern nature in contemporary applied art. Color not as technology and material, but as conscious use of artistic possibilities of so-called colors dynamic and static; and the pattern, as considerable motor of image building process and composition unity.

The analysis of different color/pattern combinations from form construction and work's idea realization point of view leads to contemporary creative work peculiarities working out. The light and the space are an important factor in this time process. They define the importance of color and pattern. Thus the research is directed to art psychology axioms and perception mechanisms.

Observations' conclusions are generalized using examples of contemporary Bulgarian applied art. Color/pattern theoretic possibilities in aesthetic effect on individual, society and inhabitable environment are presented practically through architectural space organization.



A MODEL FOR THE APPLICATION AND ANALYSIS OF COLORS IN THE MEDIA

Oral paper

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This article deals with the intentions in the use of colors as information and creates a theoretical instrument to analyze and develop journalistic products that use color images.

Color is definitely one of the most instantaneously received medias in journalistic communication. The expression of colors, as other codes used by the media, is a result of the technological development and the cultural relationships of different periods, different societies, and different ways journalism is seen, produced and perceived.

This article presents and justifies a function to color, focused on the information produced by the journalistic media, the *color-as-information*. In this perspective, a critical and descriptive analysis is made on how the use of the color, instead of contributing to the consuming of media products, has determined adhesions to ideas and goals that are out of the common intentions of the information and the communication, not to speak of some distortions, exaggerations, prejudices and other anomalies in the published news.

Regarding all the problems caused by the interference of reality operated by the visual medias, this research presents color as an element able to go against the reduction of the information to the two-dimension plane.

After analyzing and describing a series of color-as-information positive uses (actions that perform the informative and communicative functions in responsible, ethic and transparent ways) and negative uses (actions that cause miscomprehension or information distortions), this research presents an ontogenic instrumental model of color, with applications both at analysis as well as at production of media texts in which color is an important element of meaning. It is an orientation structure to the comprehension and use of color as information, indicating ways to the wise and responsible use or to the objective analysis of the color-as-information texts.

BACKGROUND: AN ESSENTIAL FACTOR IN COLOUR HARMONY

Oral paper

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Colour harmony is typically assessed using a neutral (e.g. grey) background, but little is known about the effect that background colour has on the perception of saliency and harmony. A series of experiments has been conducted to assess the effects of lightness, hue angle and chroma difference on observer perceptions of saliency and harmony for an array of single and dual foreground colour patches viewed against numerous backgrounds.

Experiments enabled observers to cluster perceptions of saliency and harmony as a function of variable background colour based on a 5 point semantic-differential scale running from a strongly harmonious to strongly disharmonious continuum. Results indicate that each background colour has the potential to create either high or low saliency and harmony ratings depending on the specific foreground colour/s viewed against it. This suggests that background colour is intimately linked with observer perceptions of saliency and harmony and should be seriously considered in future work as a further dimension and determinant of colour harmony.

Results seem to raise questions on already existing "harmonious" colour combinations that have been proposed to date. With a simple change in background colour, the possibility of creating a "disharmonious" from a formerly termed "harmonious" combination seems highly likely. The reverse holds true.

PAINT OR COLOR?

Oral paper

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For a while, environmental designers and colorists were widely complaining of grayness of cities and how people were suffering problems because of the lack of color in townscapes. Modern districts of many cities in Turkey were not exceptions as well. However, nowadays we witness an explosion of polychrome effect, either in new districts or in facade renovations of relatively older ones. While this effect is being observed in many areas, the most widespread ones are seen in housing areas. The chaotic effect of this explosion has brought some reactions like color restrictions in some areas, which is far away from ideal solutions. Meanwhile the reaction is understandable because of the poor visual quality of the polychrome facades. Architects who have had no color education do not welcome them, but at the same time they do not address to colorists or those who have been familiar with color in any kind. In fact, I am not sure if it is possible to call those facades "colorful" or the layers on them "architectural colors". Tons of paints are applied on buildings' exterior surfaces.

This happens while these cities have rich colorful vernacular architectures and tradition of creating colorful products. Being aware of those colorful backgrounds brings the question of how the grandchildren of the ancestors who had so sensitive color applications can come to such an awful point with color. Is this case similar to Slovakian shawl makers that brought Christopher Alexander to talk about "unselfconscious and self-conscious processes of making color decisions"? That the master ancestors with their colorful vernacular products "were not artists but craftspeople able to make well-considered judgments only within the limitations of their craft and its range of available colors. Once they were presented with more complicated choices, their apparent mastery and judgment deserted them"?

Although the range of today's available colors is an important factor, yet I believe that the case is more complicated in architectural facades. Too many things are changed in our times. This paper is going to discuss cultural changes and reflection of those to architectural facade colors in Turkey. How the squatter areas, which in some ways follow the traditional/vernacular architectural rules, are changed to "luxurious" housing areas and the "adventure" of color with such cultural changes.

COLOUR EMOTIONS IN FULL-SCALE ROOMS

Oral paper

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The aim of this investigation is to study colour emotions due to light and colour. As colour appearance differs depending on light conditions, the question is: does colour emotion also change?

An investigation was made where two full-scale rooms in different compass orientations were observed in daylight. The rooms were painted in 12 reddish and greenish hues in two nuances, NCS 1010 and NCS 1030, and observed one by one. One yellow and one blue hue in nuance NCS 1030 were added. Ninety subjects individually evaluated emotions evoked in the two rooms, using semantic scaling. To classify emotions, a method by R. Plutchik was used. This consists of eight terms of emotions classed by Plutchik as primary emotions. The emotions are: expectation, disgust, sadness, fear, surprise, joy, anger and surprise.

The study shows a complex mixture of both "positive" and "negative" emotions. The unitary hues evoked the strongest emotional expressions. Evaluations in rooms in greenish hues showed different emotional expressions to rooms in reddish hues. The latter caused complex emotional expressions with distinct differences between the hues involved. The nuances were described with clear difference from each other, with different emotions and weaker emotional expressions.

**LIGHT, COLOUR, PAINTS AND PIGMENTS – A NEW CONCEPT
IN TEACHING COLOUR FOR DESIGNERS, ARCHITECTS AND
ARTISTS**

Invited lecture

Robert HIRSCHLER

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The SENAI/CETIQT Colour Institute in Rio de Janeiro, Brazil, integrates the colour-related activities of the different departments of the institution, particularly those of the Applied Colorimetry Laboratory, the Design Institute, the Faculty of Industrial Textile Engineering and the Faculty of Fashion Design. Based on fifteen years experience in teaching colour science for engineers and colour fundamentals for designers, an ambitious new course is being now launched, aimed at professionals in every walk of life (designers, architects and artists among many others) working with colour. Making use of the specially constructed classrooms and the vast range of reference works, visual aids and demonstration material available, a team of a chemical engineer, two architects, two designers and two artists is preparing the highly interactive, experiment-based course material for the 480 hours post-graduate course to be offered for the first time in February 2005.

ASSESSING COLOUR DIFFERENCES WITH DIFFERENT MAGNITUDES

Oral paper

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The CIEDE2000 colour difference formula, which was recommended by the CIE in 2000, is mainly used for evaluating small size colour-differences (less than 5 ΔE^*_{ab} units). It is also known that the most widely used colour space, CIELAB, performs well for large colour differences (over 5 ΔE^*_{ab} units). This study is intended to address colour-differences ranging between them, medium sizes.

The grey scale technique was used to assess colour difference of each pair by a panel of 20 observers. Sixty-two pairs of textile samples surrounding 5 colour centres were assessed against a middle-grey background under a D65 simulator. The average ΔE^*_{ab} of these pairs was about 5 units. These samples were then colorimetrically reproduced onto a CRT. These colour differences of CRT stimuli were then enlarged by 150% and 200% respectively. In total, four data sets were accumulated: surface, CRT-small, CRT-medium and CRT-large. The results were used to understand the colour difference size effect and media effect (surface and CRT). Finally, the performances of 4 colour difference formulae (CIELAB, CIE94, CMC and CIEDE2000) were evaluated for colour-differences covering from small to large colour-differences.

WHAT HAS MADE THE USE OF NCS SO WIDESPREAD IN THE AREA OF PAINT?

Oral paper

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NCS-Natural Color System is scientifically based with more than 100 man-years of research behind it. The research was carried out in a very open-minded environment with researchers coming from architecture, physics, psychology, education, and technology, always keeping the focus on the different user groups. The NCS is a neutral—product independent—colour system describing the colours the way we perceive them. This makes the NCS colour system a valuable tool for many different needs. A given colour selection, for example in a geographical region, can be visually defined and analysed (examples from Brazil, India and Portugal) and can become the base for further colour development and colour planning in that area.

Paint as well as any other manufacturer of coloured products need to communicate in a visual way what they can offer to their customers. By use of the NCS colour notation system they have an instrument for visual colour selection that is recognized as independent by the global architect and design community and could be used for any coloured material, not just paint, facilitating the work of their professional customers. The point of sales dealer has a complete system at his hands to help customers locate the colour closest to the desired colour and visually helping them find their way through the colour space.

The manufacturers of paint and other products must be able to trust the quality of the colour samples and this is equally important for the end users. This will save time and money for both groups. Therefore, the authorized NCS colour samples are subject to a very strict and publicly available quality control, i.e., the NCS Quality Management.

During 2004 200 new NCS Standard Colours were released. The colours are located in the, for designers, extremely important area of off-whites. To be able to produce these colours accurately enough to satisfy the professional customers, very high demands are put on colour accuracy in the production. The basis is high quality standards; NCS Calibrated Matching Standards satisfies these high quality needs.

Each year the now 1950 standardized NCS colours are produced. More than 800 hours are invested in this annual quality control project. The colour samples are divided into different quality levels depending on their future use, each quality level with clearly stated quality goals. The results for the different groups are published after each production round and a comparison over the years shows that a consistent and extremely high quality is being maintained for the best of the users.

The NCS Quality Management was created in 1995 together with global paint manufacturers. It secures the accurate colour communication from design to laboratory standards for matching. Calibrated matching standards are manufactured and calibrated and guaranteed a maximum tolerance of ΔE from a primary standard.

INVESTIGATION OF SIMULATED TEXTURE EFFECT ON PERCEIVED COLOR DIFFERENCES

Poster

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Sample surface structure (texture) is an important parametric effect, of high industrial relevance. Currently the International Commission on Illumination (CIE) recommends the study of texture on color-difference evaluation (*Color Res. Appl.* 20, 1995, 399-403). For textile samples the CIE has recommended the use of $K_L = 2$, $K_C = 1$, $K_H = 1$ in most recent color-difference formulas (CIE94 and CIEDE2000). Although this recommendation has been associated to texture, its origin is not well understood and additional research has been claimed.

We have obtained visual data on the effect of simulated textures on suprathreshold tolerances using CRT sample pairs. We have analyzed separately the lightness, chroma and hue tolerances for the 5 CIE centers recommended in 1978, considering both homogeneous and textured samples. Our texture is made up of random distributed dots, with different sizes, percentages of covered surface, and color attributes. These variables have been systematically modified obtaining 33 different textures for each CIE centre. A panel of 5 observers with normal color vision assessed each pair against a fixed achromatic anchor-pair with a color difference of 1.6 CIELAB units. In overall 7,706 suprathreshold visual tolerances have been obtained.

The difference in the size of the dots (1 or 4 pixels), and the difference between homogeneous and 5% percentage of covered surface were not significant in visual color tolerances. In comparison with homogeneous color pairs, the textured ones showed a reduction in lightness tolerances around 50% for the strongest textures (those made up of black dots covering 80% of the surface of the samples). In addition, the influence of these last simulated textures is not negligible on chroma and hue tolerances. In all cases visual tolerances consistently increase with percentages of covered surface of 20%, 50% and 80%. We feel that although the effect of texture on color differences would be very important, it is not possible to provide a simple set of parametric factors for all potential textures available in industrial applications.

ANALYSIS OF COLOUR EFFECT IN JAPAN - SOUTH KOREA WORLD CUP FOOTBALL GAME

Poster

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Various colours are used for sports. The colours have some effects for watchers of the sports. In this study, we tried to analyse the effects of colours used for sports with a viewpoint of a watcher, especially about the effects of uniform colours. We used the game of the FIFA Japan - South Korea World Cup in 2002 as a sample of this study. Impression and visibility of the uniform colours of two teams and their difference on the video images of the World Cup games, twenty-four games held in South Korea, were evaluated by fifty watchers through semantic differential method. With the evaluation results, some of the colour effects in the football game were discussed.

COLOR-EMOTION ASSOCIATIONS: PAST EXPERIENCE AND PERSONAL PREFERENCE

Oral paper

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Some colors are associated with several moods and some moods are associated with more than one color. Despite a rapidly growing literature on the impact of color on our emotions and considerable interest in this research area, many studies have failed to use color stimuli from a standardized system (e.g., Munsell Color System), while others elicited individuals' responses to verbal labels of color instead of using actual color stimuli. The purpose of this study was to examine the color-emotion associations among college students, referencing color stimuli from the standardized Munsell Color System and to investigate the reasons for emotional reactions given to each color. Ninety-eight volunteered students were asked to indicate their emotional responses to five principle hues (i.e., red, yellow, green, blue, purple), five intermediate hues (i.e., yellow-red, green-yellow, blue-green, purple-blue, and red-purple), and three achromatic colors (white, gray, and black) and the reasons for their choices. The color samples were prepared by using Freehand 10.0 software. Each color sample (10 cm × 12 cm) was displayed in the middle of the computer screen one at a time on a neutral gray background, Munsell N/7. Order of presentation of the color samples was randomized across participants. Students were allowed to state only one emotional response for each color.

Based on the results obtained from the student's responses, a total of twenty-two emotions were gathered. Green and blue elicited positive emotional responses, including the feelings of relaxation and happiness, comfort, peace, and hope. Reasons given for positive responses to green showed that green was associated with nature and reminds someone of outdoors and springtime. Blue was associated with the ocean or the sky and thus inducing relaxing and calming effect.

Color symbolism can be apparent in how an individual associates colors with things, objects or physical space. Red-purple, for instance, was associated with the color of red wine, plum, bridesmaid dress, or the color of a bedroom.

A color-related emotion seems to be highly dependent on personal preference and one's past experience with that particular color. Reasons given to each color based on previous knowledge and experience will be discussed and future research areas will be suggested.

LOCAL COLOURING AND REGIONAL IDENTITY. COLOURS ON BUILDINGS EXTERIOR

Oral paper

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What is meant by the term "local colouring", with relation to a buildings exterior and why is it important for a regions identity? Every day, with or without knowledge, we are presented with "local colours". You see them covering facades surrounding town squares or on farm dwellings passed in rural landscapes. Facade details are painted in relation to each part with regional varieties. Colouring has a local order. We all love areas with strong traditional or local characteristics. We visit them during holidays or form deep relations to them in our home districts. Among a range of identifying factors, colours are defining these areas. The local colours and colouring are important pieces in the description of the identity of a region, and part of its tradition and history.

Today it is possible to paint a building exterior in any colour. How does this affect the exterior colours and our identification of a region? In Sweden it is clear that the tradition of using local colours and colouring has become less common. This process is increasing. The systems for local colouring are quickly becoming weaker. With increasing globalisation it may appear important to strengthen the regional characteristics and make the public conscious about their region's identity.

How is it possible to make the public more conscious about there regions? Perhaps it is necessary to focus on the regional characteristics of colouring in further research projects. The research project I am concerned with seeks to describe the local colours in Sweden. The project is delimited to rural dwellings in southern Sweden during the 19th century. It appears that in rural parts of Sweden, different districts in the 19th century started to have local combinations of colours. These colours had a local connection. The research project indicates that local colours are visible on the facades or remains of 19th century's buildings.

The project's main idea is that exterior architectural colours during the 19th century contain local variations and even various locally produced pigments. It is interesting to notice that the only production today of pigment in Sweden is a red oxide pigment. The first step in the research project was making short interviews with building archaeologists to highlight districts in southern Sweden with adequate dwellings from the 19th century. Then interviews were made with the house owners, archive studies were examined and a series of ocular investigations were carried out. Finally, colour sections at the building objects facades were taken.

The results show interesting varieties in the choice of colours that have been forgotten today. They show the complexity of exterior building colouring and a need of further research to understand the local architectural colouring and identity of regions. A strong connection between (for example) local colour and locally produced pigments is difficult to reproduce but the knowledge about it can be enough to strengthen the identity of a region. The project shows many local ways to combine colours and choices of colours that have been forgotten. To apply this knowledge in new project

constructions and building conservation, can make the local differences in architecture more pertinent and obvious. A possibility to sharpen the architectural language at a local level is not only an aim of locally possession but a national and international interest.

It is also desirable to create comprehension of not only the local colours from the 19th century but also to create an understanding of the local colouring and the combinations of colours today. To be conscious about how the colours describe the architectural language. Not to choose the "right" colours but to understand how the colours perform together at the facade. Therefore, the results take focus on the structures of local colours.

The aim is that the results will be applicable in other situations as a model and inspiration to further investigations in other communities, regions and countries. We plan to consolidate this data to understand local colours within a global perspective.

STUDIES ON THE EXTERIOR COLOR OF STORE: EFFECT ON THE MOTIVE OF ENTRANCE TO A CLOTHING STORE

Poster

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The effect of color and its combination on the motive of entrance to a clothing store was investigated by the experiment.

Eight tri-color combinations used for the experiment were chosen from the image scale for color scheme proposed by NCD (Nippon Color Design Lab.). The stimuli used were illustrations of storefront and were colored by the tri-color combinations. A computer system with twin display was used for indication of the two model stimuli chosen randomly from the eight stimuli. The experimental subjects choose one that he wanted to enter more strongly. The motives of entrance to the model stimuli were calculated by the Thurston's method of paired comparison.

It became clear that the motives of entrance correlate with the clear-grayish values proposed by NCD. By multi-dimensional scaling analysis, the effects of the clear-grayish values are indicated as the first-dimensional variable, and the warm-cool values, as the second one.

On the other hand, the motive of entrance to a store is effected by the image of the color combination in order of the image of warm > cool – soft > hard. The result obtained by the experiment, therefore, supports the usefulness of the image scale for the color scheme proposed.

A STUDY ON THE FEASIBILITY OF ESTIMATING SYMPTOM IN TERMS OF FACIAL SKIN COLOUR

Poster

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In the recent decade, the application of colour to medicine held more and more people's attention and curiosity, and that would become an important event in the world. For instance, *Color Medicine: The Secrets of Color / Vibrational Healing* and *Light: Medicine of the Future* have been published by Klotsche and Liberman respectively. Meanwhile, the concept of colour has also been employed on the related description of therapy in the ancient medicine of China, such as five shades (Cyanine, Magenta, Yellow, White and Black), five elements (Wood, Fire, Earth, Gold and Water) and five organs (Liver, Heart, Spleen, Lung and Kidney) paralleled to each other. It is obvious that colour has high relativity to medicine or therapeutical medicine. In addition, nowadays, various high colour techniques have been developed, including colour specification and image processing. Therefore, in this study, the CIE L*a*b* colour specification is firstly used to define the facial skin colours of the people tested, and also further estimate the relativity between facial skin colour and symptom. The results indicate that there exists a significant difference in the lightness of facial skin colour between the normal people and those having a specific symptom (say Icy-hand-foot) tested. And this result also happens to those not directly related symptoms (say Dysmenorrhoea and Bad-appetite). For the latter, there also exists obvious difference in the chroma of facial skin colour. Hence, the CIE L*a*b* colour specification may be usefully applied to estimating the relativity between facial skin colour and symptom.

THE EFFECT OF VARIOUS DEVIATE VISUAL FUNCTIONS WITH 1° ANGULAR SUBTENSE ON THE COLOUR FIDELITY OF DISPLAYS

Poster

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For the technology used on colour management, there has been great achievement since the researches mostly conducted on the development of cross-media colour transformation technique. But, so far, the target of the technique, "What you see is what you get (WYSIWYG)", has not been still completed, i.e. the results of the technique have not reached to what people expected. The suitability of the visual functions used in developing the technique cross-media colour transformation is one of the most important causes resulting in not reaching to the target "WYSIWYG". Showing colour on displays is the first important step of the colour management. Hence, the visual fidelity of the colours shown on displays also becomes more important. Although the CIE 1931 and 1964 colour matching functions have been used in colour specification for decades, many researchers, such as Allen 1970, Nayatani 1983, Ohta 1985, Rich and Jalijali 1995, Kuo and Luo 1996, and so on, have also found that there exists a great visual mismatch on the discrimination of colour difference as in terms of the CIE colour matching functions. And, hence, some significant error would be made on colour specification due to employing the CIE 1931 and 1964 colour matching functions. Therefore, the four deviate visual functions developed by Kuo et al., and the CIE 1931 colour matching functions and the CIE Standard Deviate Observer (CIE SDO) are used in this study to investigate the effect of these visual functions on the visual fidelity of the colours shown on displays. The results indicate that the visual colour fidelity of displays is significantly affected by the deviate visual functions proposed in this article. Also, the deviate visual functions with the best performance in the visual colour fidelity of displays among those tested in this study can be the base of the colour fidelity of the display.

**A BETTER ARTISTIC EXPRESSION OF GOETHE'S LITERARY
WORLD, BASED ON THE CORRECT CHOICE AND
COMBINATION OF PAINTS, COLORS, AND TEXTS**

Oral paper

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The right application of paints and colors on artworks, in the case of literature, can enhance the better understanding of texts and enforce their creativity, while the wrong use of paints can decrease their imagination and lead to misunderstand their concepts. It means that the real artwork consists of a correct combination of paints, colors, and texts, in order to get a maximum result.

My paper seeks to find out the best way to express artworks by using paints. For that aim, I am going to illustrate different experiments of combining paints (oil/ acrylic/ pastel/ watercolor), colors (the prime/ secondary), and literary texts (spring/ summer/ autumn/ winter) of Goethe's *The sorrow of young Werther*, whose book is the most suitable for this presentation.

COLOUR, PAINTING AND COMPUTING

Oral paper

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Discussing the relationship of digital colour to analogue colour, through the physical and perceptual experience of making paintings. In my recent work I am using Chromafile,¹ a software program that 'simulates paint colour mixing on the computer monitor' in the creation of painted, screen printed and digitally printed pictures. Chromafile relates virtual with material by providing a common colour language for the painted and printed images.

Digital printing, a system in its relative infancy and painting with its history and materiality are combined to set new pictorial problems and create a shared pictorial language. There is extensive use and influence of digital media in art, however my project is to create paintings using original and specific research. The technical problems are such that issues of style, identity or artistic precedent are initially, less relevant than the consistent application and observation of the research material.

The practical solutions and experimental data could have broad relevance wherever there is an established or potential use of digital printing, or where varied printed substrates are part of the output.

I will describe the Chromafile Colour System, its use in the development of a computer based colour course, and its role in my own painting.

¹ Co-designed with Dr. Ferdy Carabott, see www.chromafile.com.

THE SYNTHESIS AND DYEABILITY OF CARBOXYLIC ANTHRAQUINONE DYES FOR POLYESTER (PTT)/WOOL BLEND FABRICS

Poster

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Polyester (PTT)/wool blend fabrics have more properties than pure wool fabrics for dressing. Because of the vastly different nature of wool and polyester (PTT), two classes of dyes are employed in a two-bath process or together in a single bath containing some auxiliaries. Time-and-cost-saving is the main advantage of the single bath process for dyeing polyester (PTT)/wool blend fabrics. Two significant disadvantages of this process are the staining of the wool component by disperse dyes and proportions of the two dyes varying by the ratio of the component fibres in the blends. An obvious way to eliminate the above disadvantages is to develop a single dye, which exhibits equal affinity for both fibres of the blend fabrics, and high fastness properties. The present work aims to investigate and develop a series of anthraquinone dyes containing carboxyl group for the polyester (PTT)/wool blend fabrics. These dyes were obtained by the condensation 1,5-Dinitro-4, 8-dihydroxyanthraquinone or 1,8-Dinitro-4, 5-dihydroxyanthraquinone with 2-aminobenzoic acid, 3-aminobenzoic acid and 4-aminobenzoic acid. All dyes were tested on polyester (PTT), and polyester (PTT)/wool blend fabrics at different pH value (pH = 3, 4, 5, 6) and their dyeing and fastness properties evaluated. The fastness properties of all the dyed samples were in accordance with commercial requirements, and one of the carboxylic anthraquinone dyes was used to dye polyester (PTT) and wool fabrics to approximately the same depth.

HOW "TO PAINT" WITH WORDS: TALKING ABOUT COLOR IN LEARNING SITUATIONS IN GRAPHIC DESIGN

Poster

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This analysis is circumscribed to the verbal discourse about color in situations of graphic-language learning. It does not deal with the teaching of color theory in graphic design, however, but with the linguistic descriptions that involve chromatic aspects in pedagogical interactions. Only the verbal interactions resulting from the review of students' works in the stage of evaluation will be considered as the subject matter of this analysis. We start from the hypothesis that verbal language endows the student with an essential tool for the conceptualization of his graphic production.

The corpus of analysis has been collected by recording teacher-student interactions in the review of students' works in the Graphic Design Workshop courses at the Faculty of Architecture, Design and Urbanism of the University of Buenos Aires, in Argentina.

Color, one of the factors that are evaluated in the practice of design, is a topic of discussion and analysis in the verbal utterances about the project. The quasi-pictorial descriptions of the chromatic resources employed emerge recurrently in the dialogues about the students' proposals for graphic projects. Not only they show their work to the teacher, but also that action of exhibition is accompanied with a verbal argumentation about the adopted choices. The verbal description depicts —actually "paints"— with words the piece of design. It does not simply exhibit the design, but makes it explicit. That new "coat of paint" reinterprets the project, assigns values to it. Also, this "coating", or layer, demonstrates in the concrete practice the degree of acquisition of concepts, theories, uses and cultural values assigned to color by the students.

APPEARANCE IN PAINTS

Invited lecture

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Appearance is much more than colour. Implies shape, contrast, light level, adaptation, texture, transmittance, translucency, and reflection, among other factors, which affects the perception of a human being in front of an object. As Bardier¹ mentions in his book, there are many factors that takes part from the vision of an object to the knowledge of what is being seen.

This paper tries only to analyze in a simple way a few of the factors which take part of the whole visual appearance, no directly related to colour, but certainly affecting its perception. They are related to the finishing of the object surfaces, which, particularly in paints, have a great importance because they define the quality of the application, especially in the automobile industry.

For most people involved in quality control, the present approach tries to explain how new techniques are being used measuring details using coherent light analysis which before were measured by integral photometric methods. Understanding the basic theory will drive to better understanding of phenomena and better use of the new instruments developed to measure these characteristics.

¹ Dardo Bardier, *De la visión al conocimiento* (Montevideo, Uruguay: Ed. Privada, 2001).

VERIFICATION OF CIEDE2000 USING INDUSTRIAL DATA

Invited lecture

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CIEDE2000 colour difference formula was recommended by CIE in 2000 for industrial colour-difference assessments. A new set of paint samples were prepared and were assessed by panels of observers from two companies and one university. The results were used to reveal observer accuracy and repeatability, to test different colour difference formulae and to set their colour tolerances.

Two phases of experiments were conducted. Phase 1 was a pilot study carried out at the university. Sixty-eight pairs of samples surrounding a grey colour centre were prepared. Both perceptibility (using a pair comparison method) and acceptability methods were used to scale colour-differences. Phase 2 experiment used 60 pairs of samples surrounding 10 colour centres. These pairs were assessed by a panel of 10 professional assessors against a mid-grey background under a D65 simulator.

The results from Phase 1 were used to compare the differences between the acceptability and perceptibility methods. Both phases of results were used to test the performances of 4 colour difference formulae (CIELAB, CIE94, CMC and CIEDE2000).

The results showed that CIEDE2000 formula outperformed CIELAB, CMC and CIE94, and it is also more accurate than panels of observers.

TEACHING COLOUR PLANS

Oral paper

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"Colour and Paint", the title of this year's AIC meeting, covers a transversal area that embraces philosophy, research and plans. Our contribution to the meeting will be to present the planning, development and results of the first Italian "Fashion Colour Consultant" course which will finish at the end of June 2004. The course, lasting one year with 680 hours of lessons and a 320-hour internship, is made up of short, intensive theme-based didactic modules:

- *Basic chromatology*: Colour, as the first element of the product's identity, and its interaction with the product's covering, material and surface as it is perceived and experienced.
- *History*: Analysis of colour shades and "range qualities" predominant throughout different historical periods.
- *Colour and production*: Colours and painting products —oil, tempera, acrylic, watercolours— from raw material to production. The natural and synthetic colours of vanish and paint for interiors. The natural and synthetic colorants for textile dyeing and printing.
- *People and colours*: The relationship between personal colouring, make-up and clothing.
- *Colour and communication*: Methodology for the analysis of chromatic communication, applied to a product type and a specific medium
- *Colour and fashion*: Research methods, discovery and colour proposals for consumer trends, colour charts and shades.
- *Colour used in exhibits*: Colours used in display: communication, emotion and memorisation.

COLOR SIMULATION METHOD USING IMAGE PROCESSING SOFTWARE

Poster

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The image of interiors, buildings or streetscapes would change when the surface color has changed. Color simulation on personal computer has become a popular method to check these images nowadays. Changing color itself is not difficult if you use image-processing software, such as Adobe Photoshop. However, the color simulation considering lighting condition is not simple. This study focuses on the color simulation method, which trace the color change in a certain lighting condition in the real world.

The base of the method was proposed by Yoshiki Nakamura et al. in 1997: the color should be changed according to the RGB gradation of the color paper in another image at same point of the area whose color would be changed in the same lighting condition.

Two points of view, the technique to reserve texture and to change the shadow part of the same color correctly, were set in this study to apply this method to the typical scenes of color simulation.

For the first point, the technique that changes luminance separately from hue and chroma of the color can maintain the information of the distribution of luminance. The author found that the assignment of the luminance value calculated by the formula $L = 0.3 * R + 0.6 * G + 0.1 * B$ should change color correctly.

For the second point, the color alternation of the bright area according to the method described above could not change the shadow part correctly, so that the measure of the luminance and the gradation of several cubes covered by achromatic colors were conducted to define the relationship between the brightness of the colors and the gradation of them in a certain lighting condition. The modification method of the tone curve dialog in Photoshop is proposed according to the result of the measure. The tone curve should be a straight line, where the gradient varies according to the luminance distribution of the image.

WHEN COLOR ORGANIZES THE ENVIRONMENT

Oral paper

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The first environmental impact that we have when entering into a space is the one produced by the light and color of the surroundings. After a few seconds, the shapes become evident, and we perceive their identities. Meanwhile, the identity of the environmental color does not fade, it continues accompanying the situation.

In previous papers, I have made reference to a possible methodology to apply color in the environment, and to the parameters and technology to be considered (for instance, in Bolcolor 2001, newspaper *El Día* of La Plata, etc.).

In this paper I will face the problem of how color organizes the environment, whether by creating a certain atmosphere, by signaling to different sectors, among other aspects, but particularly in the situation where the presence of an artistic painting accompanies the environment or modifies it with its color. Furthermore, this painting may produce an environmental conflict. Thus, I will show the cases in which the color focalized in a relatively small object in a certain environment, accompanies, contradicts, or imposes a direction into the environmental atmosphere.

COLOUR & LIGHT IN ARCHITECTURE

Oral paper

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By failing to recognise that light and colour in architecture are two different aspects of the same problem, and therefore indivisible, research into the two areas has generally followed different paths. In the field of luminotechnics it has mostly aimed to solve aspects of visibility and comfort, while in the field of colour attempts have been made to solve the needs of design, style and fashion, but have not always been based on verifiable data or criteria. This has led some to believe that "everything is possible", while others take the view that it is a "topic for specialists". However, both views are mistaken. Thanks to the labour of qualified architects and designers, and with the evidence of their work all around us, no doubt remains today as to the importance of their research.

In particular, psychophysical methodology applied to the analysis of individual or multiple variables, has allowed certain criteria to be established and basic aspects to be resolved both in the field of colour and in luminotechnics. Although few persons are interested in colour and light *per se*, the importance of these investigations in solving basic aspects that contribute to human comfort is today widely recognised. Therefore, it appears that these investigations have a prosperous future ahead of them in helping us to understand and improve fundamental aspects of life such as health, the economy, security and even emotion and feeling.

Where does research stand today? How do light and colour behave in each of us? It seems that there are three paths: the visual system, the perceptive system made possible by the cognitive system, and the circadian system. To date we have sufficient knowledge on the visual and cognitive system on which to base valid research in the area. However, until the present day, research in luminotechnics has only been carried out in connection with problems of visual comfort or discomfort, and in the field of colour in aspects that have to do with reproduction, constance, memory, ranges or simply the study of its variables. In both cases, it is still necessary to investigate the general state of the observers in specific situations that may influence good daily performance. For this reason we believe that a holistic vision of the way in which colour and light are applied in design is still some way off. Finally, the circadian system is still the subject of study, despite that fact that it is our body clock. Recent research has shown that in addition to the system of cones and rods there is another photoreceptor system in the eye that relies on a chemical called melanopsin, which operates particularly under bright light conditions by controlling pupil size and visual activity. A better understanding of this melanopsin may lead to a deeper insight into many of man's biological responses to colour and light, and help in the treatment of disabilities like jet lag and SAD.

This paper discusses these areas with the object of opening doors to new questions and research that might develop aspects which together make up the bases of our daily perception of light and colour in architecture.

METAMERISM IN THE VISUAL SYSTEM

Poster

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For the colour industry, metamerism is an unpopular word since it implies different mixes of the colours of the spectrum, which can be seen to be the same only under certain conditions. However, can this assessment be extended to the visual system? Or could metamerism be the system's mechanism to *balance* the stimuli it receives?

Back in 1972, in a study on colour equalisation through the use of a combination of filters while controlling both brightness and colour, Jennifer Birch noticed that "some subjects found it possible to match the test colour with more than one combination, while others could not". "When the individual results are plotted on the CIE diagram two distinct patterns are obtained. Firstly the matches may appear to occur along a line similar to the isochromatic lines described by Pitt (1935), or secondly they may appear to be grouped within a McAdam (1942) ellipse". These two observations, which were substantiated in one of our earlier papers, did not prevent each equalisation being considered correct for the observers who took part in the experiments.

The question that we would specifically like to formulate today is whether the metameric equalisations of dichoptic chromatic mixes are more dependent on brightness than on hue. In other words, which of these two variables is furthest from those inherent in the colour to be equalled. Adding the problem of dichoptic vision the mix of three or four primaries, as proposed by this study, has as its sole objective to place the visual system in different circumstances that might allow an analysis of variability and strategy of balance in greater depth.

Experiments were carried out with a Wright-type visual colorimeter to which a new channel was added in order to reproduce the dichoptic situation. The two sets of primaries chosen were 650, 530, and 460 nm, and 650, 565, 513, and 460 nm. There were nine colours to be reproduced: 650, 600, 570, 550, 530, 520, 515, 500, and 450nm. The retinal illumination was kept constant at an average of 40 trolands. Four observers of normal colour vision aged between 35 and 40 took part in the experiments.

From the results it could be observed that 1) the visual system reveals great stability as to perception of hue, making colour a basic and preattentive sensation; 2) greater plasticity as regards brightness; and 3) the summation of brightness is given by the sum of the luminosity from each eye, affected by convenient functions of weight. By adjusting both variables, the system achieves a state of balance by permitting it to maintain a stable perception of the radiations that reach each eye independently.

NEW MATERIALS FOR CONTEMPORARY ART: EXPERIMENTS WITH HAIR DYES ON SUPPORTS OF DIFFERENT NATURE

Poster

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This paper proposes an experimental pictorial technique that uses hair dyes —instead of the traditional pigments and adhesives— on cellulose, protein and synthetic supports.

The experiment has been done with seven kinds of hair dyes (permanent and non-permanent hair dyes) and a natural dye (as a contrast) on eleven types of supports (cotton, linen, jute / felt, suede, leather, dogs' hair, sheep's wool, human hair / viscose-polyester, fibrin-polyester).

The main aims of the study were, on the one hand, to test the color fading by studying the resistance to humidity and light of the different products used on each support, comparing the results obtained with synthetic hair dyes with the results obtained with a natural dye such as onion dye and, on the other hand, to take into account the expressive possibilities of the techniques and the materials used. This aspect was made real by producing two paintings.

The different experiences were systematized in a catalogue made out of cards of dye where the results obtained with the different hair dyes and supports were registered, following the methodology proposed by Kate Wells (1997) for the classification and preparation of patterns. In the same way, the numerical experimental data was classified in five tables of indexes of estimation according to the standardized methodology of industrial catalogues of stuff dyes samples. These five tables of indexes were: resistance to humidity (1-5), resistance to light (1-8), indexes of satisfaction (referred to the artistic result) (1-5), indexes of difficulty (referred to the rate of difficulty in the capacity of fixing the color to the support) (1-5), indexes of adaptation (quotient between satisfaction and difficulty) (0-5).

The need to adapt the technique to the support made us compare the results obtained on protein material (the ideal for this kind of dye whose natural support is hair) with those obtained after using other types of supports (cellulose supports and synthetic supports in which the degree of color fixing was not so high). However, because of that we obtained a wide variety of tones, which enlarged the expressive richness. The base color of the different support samples contributed to accentuate the shades of the final works and not disturbed the results of the different estimation indexes tables, because it was taken into account before their elaboration. In the same way, the different qualities of the used fibers enhanced the textural richness of the artistic pieces.

BINOCULAR STOCHASTIC MODELS FOR SUPRATHRESHOLD CHROMATIC CHANGES AT ISOLUMINANCE

Poster

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In the present work, we studied the structure of the binocular color mechanisms at equiluminance using stochastic modeling techniques at the temporal processing level. Uniform circular random step-wise pulses were presented on a color monitor at a 2-deg. field size. Their chromaticity were selected according with the Boynton's two-stage color-vision model (*Color Res. Appl.* 11, 1986, 244-252), along a L&M-constant cone axis and a S-constant cone axis to produce red, green, yellow or blue suprathreshold changes (six visual stimuli in each case). The heterochromatic flicker photometry method was used to obtain an equiluminance level of 15 cd/m². Simple visual-reaction times for manual responses were registered on fovea under monocular and binocular observational conditions using the standard procedure (M. J. Nissen & J. Pokorny, *Percept. & Psychophys.* 22, 1977, 457-462). Two human observers with normal color vision took part in the experiment. To examine the rate at which responses were produced at each instant following stimulus presentation (events per millisecond), the hazard functions were calculated from visual-reaction time raw data for each visual stimulus and for each observational condition using the common smoothing procedure (R. D. Luce 1986, Oxford University Press). Comparing both kinds of functions the binocular patterns found revealed that Poisson time-homogeneous (W. Schwarz, *Percept. & Psychophys.* 46, 1989, 498-500), Poisson time-inhomogeneous (P. L. Smith & T. Van Zandt, *Brit. J. Math. Stat. Psy.* 53, 2000, 293-315), stochastic diffusion models (P. L. Smith, *Psychol. Rev.* 102, 1995, 567-593) or the parallel grains model (J. Miller & R. Ulrich, *Cognitive Psychol.* 46, 2003, 101-151) cannot take into account the binocular hazard functions. These results suggest that binocular color vision could be viewed as space distributed in multiple areas more than a point-combination process as previous studies in color vision suggested (Gegenfurtner & Kiper, *Annu. Rev. Neurosci.* 26, 2003, 181-206). Our results also suggest that the dynamics of parvo- and konio-cellular pathways should be incorporated in these models to take into account the binocular hazard functions at isoluminance.

GAMUT CHARACTERISTICS OF CHROMATIC AND IDENTICAL DESATURATED ACHROMATIC REPRODUCTIONS

Poster

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An important number of parameters decide the quality and fidelity of graphic imprints; among them many are gamut related or gamut influenced.

The research conducted in this paper attempts to define influences that different combinations of rendering methods, as a function of transferring and gamut mapping in reproduction process, have with a various starting color spaces of the original used in graphic technology.

Three different subsections of the test form have been created for research purposes; unsaturated achromatic, chromatic and section for instrumental analysis, stored in three various color spaces: RGB, CMYK and CIE L*a*b.

Each of the samples was rendered with perceptual, saturated, relative and absolute colorimetric methods, and then printed on two different types of printing machines (dry and liquid toner principle) on an identical printing surface, in the same environmental conditions.

Based on the information obtained by spectrophotometric measurements conducted on a whole subject for instrumental analysis, for each of the 24 samples, in CIE L*a*b* color space, single and parallel gamut preview have been constructed and their volume calculated.

Three different methods of visual preview evaluation have been examined, separately for chromatic and restructured (desaturated) achromatic, in standard prescribed conditions, using simultaneous binocular method.

Choosing the best sample was the evaluation criteria; firstly between sets of proposed samples of different rendering methods for each color space, secondly between various individual color spaces for each given rendering method, and thirdly between sets of proposed diversely rendered samples for a given color space, on a reference computer screen.

Based on the obtained results, situations have been defined, and it was possible to establish which rendering method, in combination with initial color space for chromatic or desaturated achromatic reproduction, depending on a type of the digital printing machine, gives specific results related to the gamut.

STUDIES ON ULTRAVIOLET RAYS BLOCKING BY DYED FABRICS: COMPARISON BETWEEN DIRECT DYE/CELLULOSE AND DISPERSE DYE/POLYESTER

Poster

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The mechanisms of UV-blocking with dyed fabrics were discussed on the direct dye on the cotton and disperse dye on the polyester. Cellulose film and polyester film were used as model substrates of fabric, avoid of different factors of fabric such as yarn thickness, yarn count, and fabric structure and so on. Two kinds of similar red chromatic color dyes; C.I. Direct Red 23 and C.I. Disperse Red 1 were used. UV-blocking efficiencies of dyes and film substrates were examined on transmittance (%) of UVA-rays and UVB-rays and UPF namely Ultra-rays Protecting Factor of skin. The results were as follows.

- 1) The UV-rays blocking property of non-dyed polyester film is excellent at UV-region, especially at UVB-region.
- 2) The polyester film improved the UV-rays blocking property at UVA region by dyeing.
- 3) The UV-rays blocking property of the cellulose film improved highly at both UVA and UVB region. The UV-rays blocking efficiency of the cellulose film improved at UVB region, so the highly UV-rays blocking property of the cotton fabrics are expect by dyeing.
- 4) As the increase of the piled-up sheets of the films, the increase of UPF was examined bigger than the UV-blocking efficiency.

COLOUR MANAGEMENT IN URBAN SPACES: THE HISTORICAL AREAS

Poster

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When one has to make a chromatic proposal during the rehabilitation process of an historical area, this proposal can be designed having as base different values, guidelines and methodologies.

In general, this proposal reflects the conditional regulations and the current orientations for the interventions in historical centres, inside a more rationalist perspective, privileging the project author's colour, the colour of the specific era, the pre-existences, cultural and symbolic references.

However, the problematic can be addressed from other points of view, having in attention the spaces functional evolution, their reutilization, the established approaching relationships and the possible different lectures, the form-background relationship and the environmental impact, the treatment for the referential elements in the urban tissue (by tuning or opposition), the light (the natural light and its changes during the day, or according with the seasons; the artificial light and the public lightning, the public art, the special characterization politics, among which the one concerning the buildings, or the built ensembles), the materiality of the built and natural objects, the different pigments existent in the area, the textures (the facade textures and the textures of the revetment materials, of the different elements present in the space, which characterize and condition them), the different ways of lecture and of colour perception, etc.

During the project conceptual process, the colour proposal or the chart (or map) of colours can be at the same time scientific, and in accord with the general orientations and the specific regulations, and also based in a different referential, less rationalist or conventional, when intervening in the cities historical areas.

DESIGN OF FULL COLOR LIGHTING USING LED AND JAPANESE PAPER MADE FROM SILK FIBER

Poster

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Since the light using Japanese paper can make soft light, it is often used to direct a calm atmosphere. However, the reflectance of the surface of conventional Japanese paper is low, and it is very difficult to take out a feeling of gloss. On the other hand, the Japanese paper made from the silk fiber has the gloss that is lusterless on the conventional Japanese paper. The purpose of this paper is to design lighting implement using the silk paper and LED (Light Emitting Diode) and to clarify the psychological effects of that. Small LEDs of red, blue, and green colors are used for lighting. Even if it only uses these three LEDs, it is difficult to make full color. We succeeded to produce full color light by putting many LEDs and giving detailed processing to a reflective side of a hemisphere. The huge advantage of the lighting of LED is that it has small power consumption and a life is long. Some kinds of new lighting implements based on new concepts were made using this lighting implement and Japanese silk paper. We realized new design of the full color light, because the light of artificial LED penetrates the glossy silk paper. For instance, a lighting implement made a beautiful gradation of color based on the design concept of color pile. Since this lighting apparatus can direct light with noble and soft, we think that the LED lighting will become important in the future. Subjective evaluation is carried out about the psychological effects of this light.

EMOTION INDUCED FROM COLOUR AND ITS LANGUAGE EXPRESSION

Poster

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Light is reflected from the surface to the eyes. It is transformed to the RGB cone responses. These signals are transmitted to the brain and become colour emotion. The emotion is described by words such as *light* and *warm*. It is very important to know the characteristics of words and languages in which various induced emotions are expressed, because the words are the output of colour cognition in our brain. Emotions induced by a colour can be expressed by various words, and each word is connected with an area of a colour space usually. In general, a word is not corresponding to only a word in a foreign language, but also to a few or several words. Therefore, understanding the colour emotion phenomena and cross-cultural comparison of colour emotion have been the important topics of colour research.

On the other hand, many colour users are seeking some contribution of a colour emotion research to solve their communication problems. Going to "globalisation", it will be more important to know more objectively about the meanings of emotion words and the differences of the meanings between different languages.

In our previous study, we collected many adjective words expressing colour emotion through a dictionary, and we discussed the relationship between the words and the location of the colour in the Munsell colour space. In this study, we asked observers to choose a word corresponding to an emotion induced from a colour. The number of colour samples used in this study is 212, and the observers are 43 Japanese and 30 Thai. With the experimental data, we analysed the relationship between colour and word in both of Japanese and Thai data. Especially, the frequency categorising was conducted to find out the correspondence of a given colour to an emotion expressed as a word. Through the frequency categorising, we found some similarities and discrepancies between Japanese and Thai data.

COLOUR AND EMOTION: AN INTERCULTURAL APPROACH AND FURTHER ASPECTS

Oral paper

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At the AIC-Congress in Bangkok 2003 we focused on emotion and related concepts as well as on some relevant aspects (evolutionary biology, physiology, psychology...) of emotions. Evolutionary biology sees emotions as phylogenetically developed, intraspecifically inherited and universal specific adaptations of the organism to typical recurrent situations. Ekman's "neurocultural" theory of emotion postulates seven basic—i.e. universal (intercultural) in physiological and psychological aspects as well as in mimic expression—emotions (happiness, surprise, anger, fear, disgust, sadness and contempt).

The crucial question for us at present is how far this postulated universality of emotions could be applied to the relationship between emotion and colour.

Our first empirical approach used a variety of methods to test a total of more than 70 Europeans on how they would represent in colour (single colours, colour combinations or free colour designs) these seven basic emotions. The results of these emotion/colour-coding tests showed (also when compared with other studies) a high concurrence. The following trend in colour/emotion coding emerges, and may be taken as applying also in the reverse, emotion/colour-combination coding: black = sadness, yellow = happiness, red = anger, brown = disgust; happiness = yellow/orange, fear = black/red.

Under the universality hypothesis, do these classifications hold good for, say, West Africa? Six of those questioned for last year's study come from West Africa. This group showed a tendency (though of course not yet statistically significant) towards green/blue, rather than yellow, for pleasure—possibly expressing a different valuation of geographically differing available resources such as light/sun or water/vegetation green—and thus an indication of the (colour-psychological) effect of contextual influences. In the meantime, we have collected data from 30 persons from West African countries. The evaluation and analysis of these data should provide further material for examining whether the universality of emotions is also valid for the emotion-colour-relationship.

We expect to learn more from the following areas and methods of investigation:

1) According to the emotional context of the situation represented, does a typical choice of colours appear in the visual arts and disciplines, or even in cartoons (e.g. red faces or shaded outlines for rage)? Further exploration of the link between emotion and colour might profitably be undertaken through intercultural comparison, for instance between Japanese mangas and European or American products.

2) Do patients in psychotherapy characterise emotion—e.g. in their paintings—by the use of colour in a specific way?

3) Do people differentiate in colour when "articulating" their moods or emotional states—by their choice of clothing, jewellery and make-up, for instance, or by the furnishings in their environment?

4) Is our natural language in its various forms of expression (everyday, [mass] media and advertising, literature) suitable for finding a way to articulate in terms of colour and to characterise emotional messages?

COLOR RATINGS FOR SAFETY SIGNS BY YOUNG AND ELDERLY PEOPLE

Oral paper

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Visual perception of colors used for living environments is affected by various factors, of which psychological effects have conventionally been studied. However, it is difficult to predict actual color visions and the psychological and physiological effects of color targets applied to living environments based on the results of past studies.

The author has considered even if there are some results based on the evaluation of colors used for living environment by many subjects, it should be more useful to predict the perception of the same color plannings. Therefore, the author reports experiments on the rating of colors used for the some safety signs.

The author had conducted experiments using subjects on the color perception of chromatic color targets, and had concluded that the concept of the perception of gray scale obtained from previous studies can be partially applied to the evaluation of chromatic colors for living environments.

However, the ratings of hues widely scattered when compared with other attributes, suggested the necessity of more data to conclude the qualitative tendencies. For this reason, the author conducted experiments on the perception of chromatic colors commonly used for safety signs and living environments by a larger number of subjects.

This paper describes the perception of chromatic colors used for safety signs and living environments using samples against an achromatic color background. The subjects consist of 217 university students with an average age of 19.6 and 228 people studying at a college for the elderly with the age ranging between 58 and 80. For the experiments, 50 colors were used with high, medium Munsell chromas, safety colors, and commonly used interior finishes. The subjects were requested to answer the difference between the visual perception of the color targets and reference by numerical values. The surfaces of the test rooms were all in achromatic colors. The light source was fluorescent, and the horizontal illuminance on the experimental table was approximately 500 lx.

The colors with high Munsell chroma were rated highly by both age groups, with the ratings by the young being higher. Some of the safety colors were perceived as not having the intended effect of distinction by both young and elderly people, posing a problem of safety color planning. The colors commonly used for interior finish were approximately similarly rated by both age groups.

PAUL SCHEERBART'S UTOPIA OF COLOURED GLASS

Oral paper

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Points of departure for my presentation of Paul Scheerbart and his architecture of coloured glass are the concepts of *utopia* and *transparency*. In regard of the theme of the meeting, "Color and paints", one might reflect on whether transparency contains either colour or paint, or both of them.

The German poet Paul Scheerbart (1863-1915) was also a visionary architectural writer and inventor engaged in avant-garde circles. For more than twenty years he wrote about his speciality: glass architecture.

His book *Glasarchitektur* was published in Berlin in 1914. The book—a minimalist essay, a utopian text—consists of 111 very short chapters, or rather pieces composed around a single theme, aesthetically elaborated and mirroring Scheerbart's ideological and technical interest in coloured glass. He writes in the first chapter:

We live for the most part within enclosed spaces. These form the environment from which our culture grows. Our culture is in a sense a product of our architecture. If we wish to raise our culture to a higher level, we are forced for better or for worse to transform our architecture. And this will be possible only if we remove the enclosed quality from the spaces within which we live. This can be done only through the introduction of glass architecture that lets the sunlight and the light of the moon and stars into our rooms not merely through a few windows, but simultaneously through the greatest possible number of walls that are made entirely of glass—coloured glass. The new environment that we shall thereby create must bring with it a new culture.

Scheerbart's aim is to make civilization better, to reform mankind in a new-built society. And the newborn, the future coming is an extensive and far-reaching transparency. New construction technology connected with the decade's metaphysical interest and spiritual movements will grow to be the creative forces. This is the utopia of Paul Scheerbart.

In the summer of 1913 the architect Bruno Taut (1880-1938) met Scheerbart in a workshop for glass painting and mosaic. They became soul mates and the next summer they collaborated on the Glass House at the Cologne Werkbund Exhibition. Taut made the design and construction, and the ideas and visions of Scheerbart soared over the building project. The dream became a reality, the Glass House was realized. Scheerbart contributed maxims and verses on glass and colour to be engraved on the facade: "COLOURED GLASS DESTROYS HATE".

The presentation deals with critical as well as positive aspects of Scheerbart's utopia.

COLOUR PERSPECTIVES – ON COLOUR AND PAINT

Poster

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The purpose of my thesis, and of this presentation, is to give an outline of the current research in colour and paint, and also about previous research within the subject of colour in architecture. The survey begins with a historical perspective of the subject, and also draws an outline of the theory and practice of colour and paint as a whole. The intention is to put the Swedish colour research into a larger context, in time as well as in space. The nature of colour embraces several different disciplines: technology, science, humanistic science, arts and philosophy. Colour as a phenomenon has no distinct boundaries. By belonging to different disciplines and by closely bounding on several different areas of research, the subject is endowed with both depth and width.

My principal question is: What do we actually know about colour? This question is followed by: How is the relationship —at different times and in different areas of research— between the *visual perception of colour* and *paint as a material*? Is it at all possible to separate the visual perception of colour and the paint material from one another, without losing any vital aspects in the viewing of colour?

Colour perspectives consists of three different parts. In the first part of the survey the theoretical issues of colour are discussed, from ancient times to the 20th century. The nature of colour as both transitory and permanent has been a point of interest to philosophers throughout the years. The ancient philosophers regarded light as what makes colours visible. During the Renaissance, Alberti and Leonardo studied the relationship between light and colour. Goethe wrote in his book on colour theory that the nature of colour is that of a phenomenon.

Throughout the years, colour has been systemized in colour spaces, colour bodies and colour schemes. The second part of the survey studies how colour has been used in practice, in architecture and in space, during the 19th and 20th centuries. These two centuries are vital for how the outlook on colour has changed and how the research has progressed.

The third part of the survey focuses on today's research on colour and paint in Sweden, shedding light on the research carried through from the 1960's and onwards. The current international research is discussed in a general perspective, while the Swedish research is discussed more thoroughly. Oftentimes, the international research results form the historical platform for the Swedish research. The survey, and this paper, is concluded by a short summary of colour in an architectural perspective.

COLOR IN THE CITY: AN AESTHETIC AND SEMIOTIC STUDY OF "CHINATOWN" IN BUENOS AIRES

Poster

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The aim of this paper¹ is to analyze the use and meanings of color in the "Chinatown" of Buenos Aires. Situated in a small area of Belgrano neighborhood, it presents a characteristic environmental image, product of the traditions of their inhabitants, from Taiwan and continental China. We will present and describe the different color codes that appear in the site. We will examine in a semiotic and aesthetic study different examples of food, shops, advertising, packaging, buildings, dressing, and pieces of visual arts.

¹ Theme of my thesis in course, Master in Aesthetics and Art Theory, Faculty of Fine Arts, National University of La Plata. Director: Dr. Arch. Fernando Aliata (UNLP and Conicet), Codirector: Prof. Arch. José Luis Caivano (UBA and Conicet).

PSYCHOPHYSICAL STUDY OF COLOUR

Poster

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Colour plays an important role in many practical tasks related to choice, identification, and as linguistic elements of the visual communication system. Colour memory is also one of the factors responsible for the phenomenon of colour constancy. Psychophysical methods and procedures are useful in determining threshold, including visual field analysis. A psychophysical experiment was carried out for describing colour appearance under different viewing conditions. Measurement of visual response can be achieved through several methods.

In this paper the method of constant stimuli is applied. Analysis were made on the base of comparisons with visual evaluation as well as instrumental CIE L*a*b* evaluation (L*, C* and H* colour values). Yellow and blue hues were the chosen samples. *Yes* or *No* response presents a stimulus. Correct response can range from 0% to 100% as shown as stimulus intensity vs. percentage seen. The results obtained, presented in a CIE L*a*b* through C*/L* and a*/b*, showed more disagreement of visual evaluation compared with instrumental evaluation in the area of yellow than blue.

INFLUENCE OF CHEMICAL STRUCTURE OF DYES ON DISCOLOURATION EFFECTS

Poster

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From the ecological and physiological point of view the effluents from textile industries are the most serious pollutants. For achieving water of high quality for recycling use the most important thing in discolouration of effluent is the removal of dyes. In practice it was shown that the application of only one method is not sufficient for total discolouration of textile dye effluent. On the basis of the fact that discolouration of textile dye effluent with azo dyes gives the best results, most methods are based on the removal of these dyes.

The aim of this paper is to achieve the total discolouration of different chromogen water systems. For this purpose the effluent with the following two reactive and two acid dyes are chosen: C.I. Acid Blue (azo), C.I. Reactive Blue 19 (antraquinone), C.I. Acid Red 52 (xanthen) and C.I. Reactive Blue 116 (phtalocianine).

The discolouration of dyed water was carried out by the following methods: using Fentons reagent (with and without using ultrasound) and coagulation/flocculation method. The degree of discolouration was determined spectrophotometrically. Additionally, the following ecological parameters of water were determined: chemical oxygen demand (COD), biological oxygen demand (BOD) and total organic carbon (TOC). It was concluded that total water discolouration is achieved only in the case of water coloured with azo dye.

READABILITY OF CHROMATIC DOCUMENTS

Poster

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It is known that the readability of any document principally depends on the contrast that is established between text and background. This is a subject which has been exhaustively studied in the case of achromatic documents, but the overwhelming appearance of web pages in color has brought to the forefront the problem of chromatic contrast, since texts have become much more colorful with the wider use of the personal computer, color displays and color printers. Obviously, it is not possible to estimate the readability of chromatic documents by using only the three visual factors of achromatic documents: letter size and style, contrast, and luminance of adaptation. For example, in the case of documents whose luminance contrast is 0.0, those with no color difference between letters and background cannot be read, but those with enough color contrast difference can be.

This study attempts first of all to establish a reference measure between achromatic and chromatic contrast, defining the equivalent luminance contrast of an achromatic document whose readability is equal to that of the chromatic document, where background luminance and letter size are equal. By using equivalent luminance instead of luminance contrast, it should be possible to substitute the well-known relationship for achromatic documents, namely the combination of visual factors and readability, for the unknown relationship of chromatic documents. The material of experimentation consisted in phrases of one line in length, written in three alphabets of different readability and with letter sizes between 8, and 20 points. The contrast between background and letter size varied between 0.9 and 0.1 and the purity of color between 0.8 and 0.15. The colors and the color difference were measured in the CIELAB color space. Three situations were analyzed: chromatic letters on chromatic background, achromatic letters on chromatic background, chromatic letters on achromatic background. Thirty observers aged between 20 and 24 took part in the experiment. All had 0.9 to 1.0 of visual acuity and normal color vision. They observed the document from a distance of 50 cm. and were asked to respond as to the level of readability using a scale that was composed of six categories: unreadable, barely readable, readable with some stress, readable without stress, easily readable and highly readable.

It was found that the readability of documents having luminance difference is higher than those having chroma difference, even if they have equal color difference in the CIELAB color space; the lightness difference is underestimated more than the chroma difference of the same color difference. Furthermore, the influence on readability of the color varies with hue, even if the chroma and luminance difference are equal and particularly if the color use are opponent.

TWELVE PERIODS OF SEASONAL COLOR TYPOLOGY

Oral paper

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We observed that there are no evident scientific explanations of the widespread four-seasonal methodology of color selections. Therefore, we tried to find some objectives to interpret the starting-point more precisely, in correlation with its natural origin. We completed the general classification of four-seasonal typology by adding intermediate periods. We proposed that each main period has an entering and closing part, regarding the previous or following period. Therefore, besides four main seasons, eight intermediate periods were added and finally twelve different periods of seasonal typology were classified. Such stratification is also in accordance with our meteorological calendar but not exactly with each month's diversity.

Our twelve-period seasonal typology is based upon astronomical and geometrical correlations between the position of the Earth in relation to the Sun, where the Sun is the main source of the light. For this purpose we developed a special time-cycling system in which daily and yearly color-cycles are included. This system gives us an opportunity to observe the variety of correlations between antagonistic color-characteristics as well as other aspects and relationships between colors and time-cycles. The system represents a more objective basis for analysis, estimations and evaluations of trends in color counseling.

VERBAL AND CHROMATIC SEMIOSIS IN VISUAL IDENTITY

Oral paper

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A primordial question is whether the immediate meaning of the graphic sign (plastic sign) and, particularly, of a color is able to directly substitute the symbolized reality, or the learning of a higher degree of conventionality is needed. That is to say, is the graphic sign similar to a linguistic sign of the symbolized reality?

If this theory is applied to color, is it possible to assimilate color to a linguistic sign? Would color have the semantic potential as to identify groups, individuals or things? If the principle for visual identification is the *difference*, the *distinction*, then, color semantics work as an identifier element in those relationships.

In the case of the distinctive shapes, on the contrary, we could say, for instance, that the entities associated to health (belonging to the same group) have attributes of their own and do not have relationships of semantic attributes with other groups or items, such as gastronomy, or some professional field. Therefore, the plastic representations of these groups should be different and signify in a different way, and also color, as an attribute of appearance, should have the same effect.

This is valid if we consider entities of the same species, but in the chain of identification it happens that "this entity" is distinguished from "another entity", and this is the reason why the problem of visual identification leaves the field of collective and typo-logical entities to become individual and mono-logical.

The paper exposes a sensitive experience and a systematic approach to chromatic designations on the letter (the character) and the word as a principle in the design process, showing a diagram for the semiotic construction of shape and color, as a methodological proposal based on the configuration of the "semiotype" —a modality to access the forms of visual identification.

EFFECT OF LUMINANCE ON COLOR DISCRIMINATION ELLIPSES: ANALYSIS AND PREDICTION OF DATA

Poster

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The International Commission on Illumination and other researchers have called for rigorous studies of the effects of luminance on chromaticity discrimination (CIE Publication N° 101, 1993). Four experimental data sets (W. J. R. Brown, *J. Opt. Soc. Am.* 41, 1951, 684-688; M. Melgosa et al., *Color Res. Appl.* 24, 1999, 38-44; R. S. Berns et al., *Color Res. Appl.* 16, 1991, 297-316; and A. Yebra et al., *Color Res. Appl.* 26, 2001, 123-131) have been analyzed here in order to quantify three effects of luminance on chromaticity discrimination: on axis dimensions (a and b), a/b ratios, and ellipses areas.

Ellipses for aperture, surface, and simulated surface colors in CIE 1931 and 1964 x , y , Y color spaces are shown to reduce axis dimensions with higher luminance by different functions for the major and minor axes. Reduction is greater for major than minor axes, thus improving ellipse circularity with higher luminance. The functions plot straight lines in log-log scale as power law equations, except luminances below 3 cd/m². We give formulae for each of the four data sets mentioned above, and average equations to predict a and b axes, a/b ratio, and ellipse area for almost any luminance in x , y , Y spaces. Our equations represent a first approach to formulating these three effects of luminance, and may need adjustment to accommodate subsequent data or analyses. In any case, the relative error in predicting actual data with our formulae is similar to inter-observer variability.

Effect of luminance is remarkable on ellipse area, which on average halves with every 5 times higher luminance. RIT-DuPont ellipses (M. Melgosa et al., *Color Res. Appl.* 22, 1997, 148-155) are predicted for three levels of equal luminance at 40, 200, and 2000 cd/m². In the latter, ellipses are much smaller and are nearer circular than in the former. It is clear that the relative size and shape of x , y ellipses cannot be judged unless at some level of equal luminance.

Higher luminance is known to improve color discrimination, so reduced ellipse area is to be expected but does not occur in CIELAB and DIN99 spaces due to lack of luminance-level dependency. We discuss our results' implications on uniform color spaces, and the desirability that in future they be luminance-dependent so as to reflect the several and substantial effects of luminance.

PERFORMANCE ANALYSIS OF DIFFERENT OPTOELECTRONIC IMAGING SENSORS FOR APPLICATIONS IN COLOR MEASUREMENTS

Poster

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The standard configuration of a digital image capture device consists of an optoelectronic imaging sensor (CCD, CMOS etc.), the associated electronics, an objective lens and a frame-grabber. These devices cannot be used directly as instruments for color measurements. The chromatic information provided by means of the gray level associated to each channel RGB, should be transformed in order to obtain colorimetric values. The main stages to characterize a digital image capture device as an instrument for color measurements are the spectral and spatial characterization and the color transformation between the RGB device dependent space and a device independent space as CIE-XYZ.

In this work we analyze the performance of different optoelectronic imaging sensors in order to transform image capture devices into instruments for color measurements. We have compared CCD cameras with different level of digitalization (8, 10 and 12 bits), different configurations (3 sensors and 1 sensor), CMOS cameras and a digital photographic camera.

Spectral characterization was obtained experimentally measuring the optoelectronic conversion spectral functions, that is, the digital response versus spectral exposure curves. From these curves it is possible to obtain the spectral sensitivities and the color-matching functions. Spatial characterization was obtained experimentally correcting the response of each pixel in order to obtain an equal response when a uniform field of light was captured. Finally, a transformation between the color-matching functions of the image capture device and the color matching functions of the CIE-XYZ color space was applied.

The obtained results show the influence of the different factors studied in the color measurements obtained using optoelectronic imaging sensors. CCD cameras with a high level of digitalization and 3 sensor configurations show the best performance.

COLOR AS A KEY FACTOR IN THE CULTURAL INHERITANCE OF LA BOCA DISTRICT, BUENOS AIRES

Oral paper

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The following presentation will show how the palette of the famous painter Benito Quinquela Martín (1890-1976) gave identity to a whole district many years ago, and how that identity was successfully rescued by carrying out strategic interventions in two of the most representative spots in the area.

That neighborhood, *La Boca*, was the first port for the city, because it was the only place in all Buenos Aires connected to the river. For this reason, for over a hundred years the color of the urban environment has been characterized by the use of the paint left over after painting boats and ships. Half a century ago, Quinquela Martín started a series of urban interventions in order to give La Boca a new identity, painting key spots in the neighborhood with the same colors he used in his paintings. As a result, the whole district acquired a stunning new aspect, which made La Boca famous worldwide. Finally, after years of decline and poor restorations, La Boca was sadly transformed into a display of brilliant, flashy colors with poor aesthetic value and no historical connection.

My first goal was to recover the palette of Quinquela to two emblematic areas of La Boca: the Museum of Fine Arts and Caminito, a world-famous short street where many open-air exhibitions take place. They were both originally painted by Quinquela. After his death they became severely damaged, due to years of partial and non-professional work that tried to restore the original colors used by Quinquela, although without technical support, which led to poor results.

After restoring the original Quinquela palette to those places, my second goal is to use that palette to strengthen the identity of some important urban icons of La Boca, such as Quinquela Martín square, and the sand storage silos of a traditional barging firm. I look forward to these emblematic and initial works as the first part of a master plan, aiming to revamp the urban landscape and highlight some picturesque corners of La Boca.

In order to make this possible, the palette was included in the future law to be passed by the Urban Planning Department of the Buenos Aires Government, to protect historically relevant districts. Once the law is passed, it will be possible to show people the possibilities of using color to enhance the identity, value and beauty of our city, such as the many successful interventions that have been carried out in European cities during the past twenty years.

EMOTION WITH A FOCUS ON THE MACROELEMENT COLOR DURING THE PROCESS OF CONCEPTION OF NEW PRODUCTS IN DESIGN

Poster

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The color, thought respected and seriously studied at the rigors of science, as an aesthetic visual element in the development of new products might help the designer to emphasize the qualities of the product, present a good design, even if seeming technically equivalent to the competitors.

It can also demonstrate how a company treats quality, organization and credibility with professionalism and, further with the soul of a pianist, to satisfy both the human needs and desires. For color can lead the consumer to fall in love.

However, designers must learn how to look at and hear the colors better, feeling the shapes, tasting the sounds, awaken to the creation of his own solutions to problems. Understanding all the ways of life and self-expression, be them literary, verbal, poetic, sonorous, musical or chromatic, must be holistic and unique, eclectic and only.

The designer must also experience his own search, in a conscious and directed act, trying to organize the shapes, lines, sounds, movements, materials, colors and flavors, to transmit ideas, feelings, human desires, and more than that, try to help others to solve problems that come from human diversity.

Besides that, being a designer is a privilege way to articulate the intelligence, conduct the thoughts, guide the cultural formation of men, the real, the sensitive and inimaginary, leading thoughts which are divergent and convergent, logical and structured, mobilizing and moving new structures in search of the new for the construction of a more hostable place and worthy to the human kind.

MAKING COLOR: PICTORIAL ART TRAINING FOR ENVIRONMENTAL COLOR DESIGN

Poster

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I gained experience in pictorial art training during a workshop I held at the university, where, for the first time, the Design Laboratory of the Degree Course in Industrial Design of the School of Architecture of Genoa University organized a workshop on color.

The study of artistic and pictorial expression may provide an important contribution also in design projects, because it helps increase the designer's formal and aesthetic awareness, even when designing material objects or products made for everyday use or in projects related to the environment. Indeed the aim of the course was to work on colors in the environment: the students had to gather chromatic information about the urban space, proving to be able to see and identify colors linked both to nature or landscapes and to street furniture in public urban areas.

In order to achieve this result, an initial exercise that I have invented, called "Let's invent colors", was very important. Each student created his own palette not according Itten's system of "subjective colors", but with the creative attitude of a painter or even the almost scientific attitude of a researcher who needs to go back to the chromatic formulation after making "his own" color.

Other subjects covered during the course were: color space dimension, transparency, synesthesia (color and touch).

This course was attended by, at least, 70 students with great enthusiasm. The result of this course about color will be shown in March 2004 during a meaningful exhibition "Experience in color, between expression and design" promoted by Assessorato alla Qualità Urbana del Comune di Genova and by the University within the cultural activities for Genoa, European Capital of Culture.

COLOR TECHNOLOGY AND PAINT

Invited lecture

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This paper will summarize current trends and research in instrumental color styling, color matching and production shading of paint and factors essential to success, with particular emphasis on automotive finishes.

Traditional color styling is expensive. Several companies now offer video systems to view color measured off a color sample, visualizing the object to be painted. E.g., a car can be visualized in its environment, determining combined effectiveness of color and body styling, without the expense of painting the car and shipping it for field viewing in a variety of environments.

Computer color matching programs for laboratory use have evolved, addressing the needs of opaque, translucent or gonioapparent paints. Point of sale color matching started with consumer paints but is now common also in automotive refinish.

Shading algorithms for production control are standard on commercial software packages. The holy grail has long been automatic paint making with ingredient dispensing, mixing, and color measurement all under computer control. However, tests before paint shipment require checking of not only color but also appearance and a prediction of end-use performance. In automotive OEM, testing must ensure acceptable color, appearance and film properties at the extremes of assembly line application and environmental conditions.

Three factors are required to be successful with instrumental color:

1) The right measurement geometry for the specific paint: Integrating sphere and 45/0 geometry have been used traditionally and are appropriate for most paints. The integrating sphere is preferable when texture must be ignored. However, for two paints of identical composition applied to yield different surface textures, 45/0 will agree better with visual assessments. ASTM E-12.12 standardized on 15/45/110 for measurement of metallic colors. Research continues on interference-flake colors, which may require more elaborate geometries, depending on test purpose. Color difference equations adapted to multi-angle measurement are only just emerging.

2) Appearance matching: Commonly including factors such as gloss, DOI, haze, etc., gonioapparent colors must also match in apparent texture and sparkle. Appearance mismatch could result in colors measuring within tolerance but visually unacceptable.

3) A reproducible application procedure, representative of the end-use: In consumer paints wire-wound rod drawdowns are commonly used over black-and-white charts to check hiding. Color may not be the same as from brushing or roller-coating, but color match is not very critical. In automotive OEM, robotic spray in a controlled environment, representative of assembly line conditions is necessary.

Research continues to improve instrumentation for color management and control of paints. As we believe we near perfection, there is always a new pigment, paint, or process to challenge us and ensure our continued employment!

THE TEACHING OF COLOUR IN THE MASSIVE UNIVERSITY

Poster

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The experience that we conducted in the public university has special characteristics due to the amount of students that are currently attending our workshops. This peculiarity gives rise to the need of finding methods of teaching which should guarantee those students equal access to knowledge without losing academic excellence.

The chairs themselves, which also include a great number of teachers, have the responsibility of forming these teachers, precisely to meet these objectives. The teaching of colour has in itself the complex aim both to provide the necessary theoretical knowledge and, at the same time to educate students' perception, which is an aspect of great relevance in the courses of design. The experimental method, almost a laboratory method, which is very useful for inferring results in a research process and is generally implemented when teaching at a lower scale in an almost craft like fashion, cannot be controlled according to the quality of its results and requires looking for solutions which, without limiting creativity, should enable us to carry out a systematic process. We conducted the experience in the following subjects: Morphology, which is part of the curriculum of the course of Graphic Design; Expressive Means, which is part of the curriculum of the course of Textile and Clothing Design, and in the first course at the university (Ciclo Básico Común). The first two had an average of 250 students attending the subject and the third, about twice as many. The economic crisis the country is undergoing has also taken its toll. We have had to cut down on the materials we demanded from the students in order not to prevent their access to knowledge, and have also often had to adapt our teaching to the lack of space, the scarcity of institutional equipment and the lack of updating of the same, a fact which has compelled us to increase our didactic resources, mostly when we find ourselves in the need of incorporating new contents, as is the case of the teaching of digital technology. The methods used are diverse and involve different aspects. The theoretical aspect is imparted by means of a lecture, which offers a first step of conceptual unity to teachers and students by making use of theoretical models, ample exemplification, bibliographic material and handouts prepared by the chair. The practical aspect is dealt with through very rigorous programming and very detailed guide of practical work prepared ad-hoc in which contents, materials, objectives and other relevant points are described. All this material is discussed and exemplified in teachers' meetings in order to unify criteria as regards the method of teaching and evaluation of the subject. The work produced by the students is exposed at the beginning and end of each class, discussed and commented upon by the team of teachers with a similar objective, in order to guarantee that all of them get similar enriched information that has been previously agreed upon by all the teachers who make up the team. Evaluation criteria, which are derived from the fulfilment of the objectives and also marking criteria, in order to level the marks of the different groups, are established with equal rigour. However, this demanding method of work leads to the production of a great variety of highly creative alternatives, shown in the results obtained.

LOOKING FOR AN INVARIANT UNDER DAYLIGHT CHANGES WITH L, M, S-TYPE SENSORS

Poster

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Several authors have analyzed the mathematical transformations that relate L-, M-, S-cone signals obtained for objects illuminated under different phases of daylight (Q. Zaidi, *J. Opt. Soc. Am. A* 15, 1998, 1767; S. M. C. Nascimento et al., *J. Opt. Soc. Am. A* 19, 2002, 1484). Also affine transformations are found when second-site mechanisms are considered. Based on these considerations, we have tried to find a definition of an invariant parameter for these color-vision mechanisms which allow us to transform a color image, taken in L-, M-, S-cone signals, into a gray-scale image which does not change when the illuminant does. In this way we will help object-recognition tasks and color constancy models. First we have tested the possibilities to define an invariant at a pixel used in previous results in this field with other sensors (G. D. Finlayson and S. D. Hordley, *J. Opt. Soc. Am. A* 18, 2001, 253). In spite of a good correlation between cone-signals for different daylight illuminants, the definition of the invariant cannot be applied for a variety of objects. In fact, when we transform a color image into a gray-scale image for different phases of daylight, the image histograms do not superpose and then object recognition is impossible. Second, we have tried to improve the invariant in two ways. Due to the fact that the invariant works better for monochromatic sensors, we have employed spectral-sharpening techniques (G. D. Finlayson et al., *J. Opt. Soc. Am. A* 5, 1994, 1553) to linearly transform the spectral sensitivities of L, M and S into narrower ones. Also, we have tried to define the invariant based on second-site color signals instead of receptor signals. With these two strategies we obtained better results than with previous, allowing object recognition and obtaining a high degree of color constancy. In addition to these findings, we have studied the linear transformations that relate L, M and S for different illuminants and the dependence with color temperature of the coefficients of the affine transformation that relates second-site mechanisms.

LINKING PAINTING TO VISUAL SCIENCE: CREATIVITY VERSUS QUANTIFICATION IN THE LAB

Poster

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The study of the visual process started by quantifying the responses to very simple test objects, then it evolved by considering increasingly complex images, culminating even with the natural scenes. For decades the visual system has been regarded mainly as a zero instrument, and the response categories allowed in the psychophysical experiments were three: Yes, no, doubtful. Subsequently, the suprathreshold responsivity was expressed in terms of visual scaling, and color categorization. However, when attacking the multidimensional world of emotional and aesthetical evaluations, a difficulty arose: a gap had to be filled-on because of the lack of a linking model.

Now, the painters, in addition to being privileged by creativity, are visual scientists, however, their starting point and permanent involvement have been and are emotion and aesthetics. They display more or less complex images and sceneries, their obvious tools being any aspect of visual functionality. In other words, the artists since ever dominate the areas that are yet partially unexplored and only tentatively attacked by visual science.

At the start of the 3rd millennium times seem to be ripe to produce in a sort of atlas, a documentation, logically ordered, of the examples where visual science and painting share common views and images. We wonder whether their paths are running parallel or when and how they will meet.

In the present poster, some results of our personal research are displayed, concerning:

- The degree of visual balance, in terms of inverse Munsell's value-chroma-area relation, through the spatial analysis of the intra-frame distribution of colored areas.
- The sensation of full immersion produced by large size frescoes, as well as the assessment of their global lightness, according to Ikeda's RVSI model, by including the apparent sensation of three-dimensionality and of color constancy (discounting the illuminant).
- Moreover, we will display some of the numerous effects which, although elaborated by the painters in their studios, as fruit of their personal "life and style experience", might be regarded as illustrations of educational flavor in any textbook of visual science: for instance, Purkinje effect and Helmholtz-Kohlrausch effect (when painting with light, on stain glasses), the optical illusions and color symbolism (when painting on ceramic), and, on canvas, representing light (hence, pop-out), the spatial integration through divisionism, the color dependence of adapting luminance, the color constancy, the op-art, the simulation of rural landscapes, and so on.

CULTURAL AND SCIENTIFIC ASSOCIATION OF COLOUR

Poster

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From the beginning of the year 2004, Istituto del Colore, operating in Milan since 1998, will convert from a private entity to a non-profit association.

It is a centre of reference, renowned for its activities of research, studies and diffusion of knowledge on colour. The association collaborates with the Laboratorio Colore e Luce of the Faculty of Design situated in the Polytechnic of Milan. It is based on a scientific committee, composed of Italian and foreign researchers, university professors and recognised experts and technicians.

Its main objectives are the following: supporting and promoting actions of research, popularisation and information regarding the scientific activity of the study of colour, promoting training of all levels of operators in the field, favouring the exchange of information and collaboration with other similar organisms, public and private, organizing courses, conventions and seminars of studies, and developing the relation between those entities.

Istituto del Colore follows the stages of progress for the research of application of colour and proposes strategies of innovative and operational development. For such results it disposes of a centre of documentation, where it is possible to consult up to date material, integrated with volumes in the theme of colour, specialized magazines and several periodicals published by industries of the field.

Its privileged partners are professionals, researchers and businessmen who use colour as an element of primary importance in their production, entities and institutions responsible in the programming of the territory, and protection of environmental and urban resource.

The activities of Istituto del Colore are completed with its own editorial activity, by means of publications of books in the theme of colour and of the following periodicals, directed by Arch. Rita Rao:

- *Colore* (quarterly magazine specialized on the theme of colour)
- *G&D Grafica e Disegno* (quarterly magazine specialized on graphic art and printing)
- *Piùsport* (quarterly magazine specialized on the theme of architecture and design for sports and leisure)

FOUR SOIL COLOR CHARTS COMPARED IN CIELAB COLOR SPACE

Poster

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Soil colors are visually assessed by comparing a soil sample (wet, moist or dry) with a standard set of color chips. Currently, there are two main sets of color chips manufactured by the Munsell Color Company (USA) and Fujihara Industry Company (Japan), respectively. Several editions of these charts have been published and are indistinctly used by soil scientists in both field and laboratory. The chips in so-called Soil Color Charts are designated by Munsell notation, trying to be systematically arranged in visual steps of equal size.

Two editions (new and used) of the Munsell Soil Color Charts (USA) and two editions (new and used) of the Revised Standard Soil Color Charts (Japan) have been analyzed. Using CIELAB color space, we are interested in evaluating the regularity of the chips from these four soil color charts from different manufacturers and distinct use degree. Color measurements of all chips were performed using a Minolta CM-2600d spectrophotometer, operating with specular component excluded, and a bandwidth of 10 nm. Nine measurements (3 zones \times 3 replications) were performed for each one of the color chips, and the average result was adopted for further computations.

The lines of constant Munsell hue and chroma were plotted on the a^*b^* diagram. These lines were more evenly spaced in the new editions than in the used ones. CIELAB hue-, chroma-, and lightness-differences between neighboring chips were very similar in American and Japanese new editions. However in the used charts a greater irregularity in the measured values of ΔH^* , ΔC^* , ΔL^* was found. Considering average values of all individual chips, it was found that in the new editions, there were some chromatic discrepancies between American and Japanese charts. In the new American edition, the color coordinates of the chips were closer (lower CIELAB color difference) to tabulated reference data than in the new Japanese edition.

We believe that the original quality of printing, as well as the color fading consequence of field use, lead to relevant color changes in standard soil color charts.

LE CORBUSIER'S COLOUR KEYBOARDS AND THEIR REVERBERATIONS IN COMPARISON WITH LUIS BARRAGAN'S COLOUR COMBINATIONS

Oral paper

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This presentation aims to analyse the "colour keyboards" of the 1931 and 1959 colour collections for the wallpaper industry Salubra SA, in Basel, in which the Swiss-born architect, painter and theorist Le Corbusier (1887-1965) combined colours so that each "colour keyboard" represented a colour mood. More specifically, we inquire into the form and structure of a specific number of colour samples that were presented by Le Corbusier.

These two colour collections will be used as points of departure to inquire into Le Corbusier's approach to developing colour juxtapositions and colour combinations. One of the most important and continuous stimuli for Le Corbusier in his development was nature. The influence of nature is evident in his early art education in La Chaux-de-Fonds, his engagement as a co-founder of the Parisian art movement "Purism", and also in his language of colour naming. As well, Le Corbusier was greatly inspired by the notion of a correlation between structural ordering principles in Nature and those in Art. In his second colour collection dramatic changes occurred. These can be best understood when viewed in the context of the colour collection's creation. By 1959, Luis Barragan, who had been profoundly influenced by Le Corbusier's "white" architecture in the 1930s, was aiming to develop an indigenous and authentic modern architecture in Mexico in keeping with his own cultural roots there. As Le Corbusier, Barragan was searching for very specific colours to apply in his architecture. Barragan's buildings became icons of twentieth century architecture because of colour combinations he applied through simple geometric volumes.

More generally, my presentation will address the following issues:

- How do Le Corbusier's and Barragan's theoretical inquiries into colour combination relate to the practical application of colour combinations in interior design?
- How did Le Corbusier and Barragan integrate colour into processes of realising architectural and urban design projects?
- Are the colour ranges of the wallpaper industry Salubra SA keyboards a kind of theoretical colour leitmotiv of Le Corbusier?
- Arising in the context of Mexican culture at the beginning of the twentieth century, how did Barragan's colour palette differ from those of the European Le Corbusier who was working during a similar time period?

The historical inquiry above will be considered as a bridge between past, present, and future developments in a larger reflection addressing these questions:

- Why would an enterprise's goal today be to reproduce and sell the well-defined colour ranges of Le Corbusier?
- Why wouldn't the colours of Barragan be reproduced as well?

In comparing the colour approaches of two significant twentieth-century architects, the presentation aims to reflect on the general cultural significance, expression and effects of colour in architecture.

ONTOLOGY OF COLOR

Poster

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The goal of this report is to compare color concepts of different investigators. A mirror changes the left direction into the right one, and vice versa. So, for example, the sign of the cross for catholic in the mirror reflection corresponds to the one for orthodox Christians.

Similarly; one can imagine the reflection of colors in the color circle, as far as I know, Newton, Lambert, Young, Helmholtz, Maxwell, Munsell, Judd and Wyszecki arranged clockwise the transition from red through green to blue. As a rule, these colors were stimulus ones.

As for Runge, Goethe, Schopenhauer, Hering, Kandinsky, Steiner, Ostwald, Itten and Wittgenstein, all of them gave the same disposition of colors but in the opposite direction. They have dealt with perceptive colors.

Achromatic colors kept their place in volumetric (three-dimensional) representation. It is explained by the fact that almost all investigators disposed achromatic axis in the color solid passing vertically.

Thus, data obtained by physicists and physiologists turned to be mirror reflections of the ones obtained by psychologists and artists. From here we suppose that there is some intercomplementarity between these data.

On the basis of function lateralization (*Beauty and the brain*, Basel: Birkhäuser Verlag, 1988), left and right color directions in the color circle are explained by priority location of stimulus colors and color-designations in the left part of the brain, while perceptive colors are located in the right hemisphere. In chromatism, lateralization is related with certain similarity of functions in the left hemisphere and functional individualization of the right one. These confirm our assumption.

On the other hand, in his theory Newton considered purple as a color formed by red and blue rays of the spectrum, while green is a primary color. In Goethe's theory purple is a primary color, while green is a blend of yellow and blue.

The given suppositions in chromatism permitted to obtain an adequate concept for the outer (according to Newton) and inner (according to Goethe) color space. In common with color archetypes (Serov, "Semantics of color", *Proc. SPIE* vol. 4421, 2002, p. 48, 430), this space results in obtaining the "atomic" (archetypical) model of a personality.

In conclusion, I might say that as far as the left hemisphere is related with general concepts, known from the past, and the right hemisphere is related with percepts and images, that will be materialized in future, no doubt the art of colors is expected to be developed in future also.

TARGET-POSITION DEPENDENCE OF THE EFFECT OF THE PROPORTIONAL: CONCENTRATION ERRORS FOR DYEING POLYACRYLIC WITH BASIC DYES

Poster

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In this research the effect of the proportional concentration errors will be examined with numerical experiments using optical data of basic dyes applied on polyacrylic. A larger set of target colours regularly spaced throughout the colour space will be chosen. For each target colour several different recipes will be treated and their sensitivities to the proportional concentration errors will be predicted in the following way. Dye concentrations in each particular recipe will be perturbed according to a chosen scheme for one and two standard strength errors and then the predicted mean square colour change (expressed in the CMC (2:1) units) will be used as a measure for recipe sensitivity to proportional errors. The influence of target-position on the predicted sensitivity (of the recipe colour) to the proportional concentration errors will be examined. Then this established target-position dependence of the recipe sensitivity to the proportional errors will be compared to the target-position dependence of the recipe sensitivity to random concentration errors, which was determined in a previous research.

COLOUR EMOTIONS IN LARGER AND SMALLER SCALE

Oral paper

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How does the context affect our associations towards colours? It is well known that colour appearance can differ between a small colour chip and the same colour applied to a real room. The impression of the colour changes between these circumstances; e.g. on the chip it can be subdued, while it is perceived as striking in the room. In this paper, we compare the results of a colour chip study, Colour Emotion,¹ to Hårleman's a full-scale room study. We will discuss the significance of scale, method and expectations.

In the first study, 114 chips were viewed against a grey background in a viewing cabinet. In the other study, two rooms were painted in 12 hues in two different nuances: NCS 1010 and NCS 1030. They correspond well to the hue areas and to two of the nuance categories used in the chip study. Semantic scaling was used in both studies.

The two studies show a distinct difference between words associated to colours of the same nuance and colour category. A clear pattern could be seen. In the room, the colours were perceived as more distinct, stronger and they arouse much stronger emotions. Generally, a colour chip had to be much more colourful to give comparable associations. Moreover, when seen on a chip, none of the colours in these two nuance areas were assessed as "heavy", which they were in the room. "Heavy" and "light" were associated to hue in the room study; in the colour chip study it was associated to blackness.

¹ We here refer to the Swedish part of the international project Colour Emotion, which was carried out at Chalmers. The international project leader is Dr. Tetsuya Sato, KIT, Japan.

FOOD FOR THOUGHT: THE USE OF COLOR IN SCULPTURE

Oral paper

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Claudia Stern, Brazilian sculptor, approaches the use of color in her work as an artist. Being responsible for the execution of 36 public works in many different countries, Claudia's artistic experience exemplifies the power of art in the process of transculturation—to transmit, to exchange values between different cultures.

When examining the artist's path through some of her public works, we see that there are changes in course: *color* in the representative form; *color* in an implicit, abstract way; *color* as result. Claudia poses comprehensive questions as *food for thought*:

- No longer one works with speeches but with flashes and images.
- The process of direct interaction creates, like this, a new relationship type with the space and the social time.
- Art, as a tool, affects the emotion and helps in the translation of ethic- and citizenship-related values.

Presentation proposal: The presentation of *Food for thought*, concerning what should be regarded as a real progress, includes examples of experiences in different communities, not only in the process of building the public work but also in the experience along with the Fellows III Leadership International Developing Program, Kellogg's Foundation. During the talk, slides, a video, or CD of the public works will be used to illustrate the topics.

COLOR IN ARCHITECTURE AND ITS RELATION TO MANKIND

Oral paper

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Like constructions in Greece, Italian-Etruscan temples with their tules and mosaics were colorful and attractive to the eye, as is the case today in India and Thailand.

One could discuss that through some ancient cultural periods, the attractiveness of color was muffled. Unquestionably the Gothic style also used little coloring in its interiors, but it knew how to take advantage, as in no other architectural period, of the effects of colored light itself on the surroundings. In the present day, however, we often see buildings with free-acting color effects which, however, have nothing to do with the building itself. Certainly we exclude certain individuals as Frank Lloyd Wright, Walter Gropius and Oscar Niemeyer.

Whoever deals with color in architecture and has the misfortune to deal with overlaid color without sufficient knowledge about color and its meaning and action, should at least seek the help of color specialists.

Starting from knowledge of the essence of color and its influence on human life, not by the intuition inspired in the religiousness of bygone centuries, but by conscious responsibility of self-criticism, the use of color is justified. This naturally also means considering the psychological effect of color in the discussion of its application. If we work with color it is obvious that aesthetics have to be considered also.

But along with these aspects other problems and factors arose: color became "applied, overlaid", and had nothing to do with the work itself, and paint left natural pigments behind and began to be extracted from coal and its by-products. A discussion arose regarding the matter of how construction should be considered, and two main lines of opinion developed: formalism and functionalism. The problem involves various alternatives. Is the form a visible expression of the function? And where is man with his soul (only with his function)?

Neither formalism or functionalism, nor psychologism —the mission that architectural work requires of the color adviser is far easier to circumscribe. "To relate color in its influence on thought, feeling and wanting, to the environment, and in this manner cause it to help, provide and correct emotional and organic aspects by its psychoaesthetic effects on the human organism."

THE MATERIALITY OF IDEAS

Poster

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The article presents a teaching methodological experience in graduation, which uses color as a fundamental element for the creative development of the students in the Design course, since it helps improving some of the necessary aspects for the graduation of the intended professional, emphasizing the *humanistic* aspects in the professional relationship and, above all, in the use of color applied to the object —be it two-, three- or poly-dimensional.

This element of communication comes from the positive results obtained in the classroom, where we approach the object of study "color" under several fields of knowledge: we adopt philosophy as a starting point —the color doctrine by Goethe, with its poetry, in contrast with Newtonian physics and its rationalist experiments—, to get to the study of human perception and to the formulation of the concept of "creative imagination" proposed by Bachelard, observing through history how a chromatic phenomenon happened in the most important schools of art and thinking, leading to the decomposition of color in its main elements —hue, value and saturation—, fundamental step to the elaboration of the main systems for chromatic ordering developed until current days and its professional use —Munsell, Otswald, NCS, Pantone, etc.

Thus, starting from the conceptualization of color as an "action" and "passion" of the light (Goethe), we developed focused interventions, group activities and professional experience simulations, which go from imaginative conceptualization of projects, the transposition of concepts in colors and shapes, elaboration of briefings and its further materiality, in order to provide the student with needed theoretical and operational tools to use color as a fundamental element in the constitution of shape and its meaning, above all on the aspects observed by visual communication, to the development of several products which, most of all merits, express how the subjectivity of a group of students —designers to be— interpret and solve in a creative way, having color as a supporting element, a suggested imaginary concept, i.e., make passion into action.

QUANTITATIVE ANALYSIS OF THAI SENSATION ON COLOUR COMBINATION

Oral paper

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Colour is a phenomenon of sensation, involving three basic components: light sources, stimuli and human eyes. The eye records information without understanding, unless the brain interprets it based on previous experience such as culture, knowledge, personal preference and so on. The sensation induced by a single colour is generally different from that by a combination of colours. In everyday life, we often see various colours appearing together, rather than single colours. The use of colour combination is thus important in product design, as colour is one of the critical factors influencing customers' satisfactory. This study aimed to investigate the sensation of two colour combinations and quantitatively define colour sensation of Thai observers using equations derived based on experimental results. The colour sensation of Thai observers was examined for 253 colour pairs generated from a set of 23 single colours selected from PCCS colour samples. Each patch had a size of 3" × 3". The colour samples included five colour hues (red, yellow, green, blue and purple) varied in four different tones (vivid, dull, light and dark) and three achromatic samples (white, medium grey and black). Colorimetric values of the colour samples were measured in terms of lightness (L^*), chroma (C^*_{ab}) and hue (h_{ab}). Colour difference (ΔE^*_{ab}), lightness difference (ΔL^*), chroma difference (ΔC^*_{ab}) and hue difference (ΔH^*_{ab}) were calculated for each colour pair. The colour pairs were assessed in a standard light cabinet under D65 light sources. Observers identified colour sensation induced by each colour pair using fourteen opponent word pairs (e.g. Dark-Light, Dislike-Like, and Cool-Warm), whereby the magnitude of each sensation scale was divided into 7 categories. Thirty-four observers ranging in the age from 20-27 took part in the experiment. The experimental raw data were analysed statistically to obtain the visual score for all of fourteen sensation scales. These sensation scales were then divided into three groups with respect to chroma, lightness and hue. A three dimensional colour sensation space could therefore be constructed. The relationship of the colour sensation between colour pairs and single colours was established to derive twelve colour-combination equations. The correlation coefficient values were in the range of 0.74 to 0.86 when the visual scores from observers were compared with those values predicted from the equations. In addition, it was found that "Disharmony-Harmony" correlated with "Dislike-Like" colour sensation through the model based on the hue difference and the chroma difference.

EVALUATION OF THE COLOR IMPRESSION OF COLORED TEXTURE PATTERNS BY A COLOR NAMING METHOD

Oral paper

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Colored texture patterns consisting of multiple colors often give a single color impression of the whole pattern. We have shown so far that for two-color texture patterns made of an identical hue with different saturation, the apparent hue of the color impression was maintained. We have also discussed that the color appearance of the texture's elements became important information in the determination of the whole color impression. In this study, we examined the color impression of colored dot textures consisting of two colors that have the same Munsell value and chroma, except for hue, by a color naming method.

We used random-dot texture patterns occupied by points of two colors with different Munsell hue and equal Munsell value ($V = 5/$) and chroma ($C = /6$). One of the two colors was chosen from 10 colors of the major hues: 5R, 5YR, 5Y, 6GY, 5G, 5BG, 5B, 5PB, 5P, 5RP. The other color was chosen from 20 hues of every 5-hue radii. The size of the textured stimuli was 4.0×4.0 degrees square, and that of the element dot was 4.0 minutes, which was sufficient size in order to be resolved. The stimuli were presented for 1.0 second duration on a CRT display controlled by a personal computer. The observers reported whether a single color impression was perceived as a whole in or not. Then, if a single color impression was perceived, they gave the name of the impressed color by a color naming method.

The results show that the single color impression could be perceived for the color combinations with the difference in the hue angle from about -90 to $+90$ degrees, and the impressed color shifted according to the hues combined with the major hue. In addition, in the case of the combination of 5GY and 5P, a single color impression of gray was obtained, even though those were complementary to each other, which suggests that the visual resolution may affect the determination of the single color impression, because 5GY and 5P of value $5/$ and chroma $/6$ are located on an identical tritanopic confusion line.

INNOVATIVE TOOL FOR COLOURIMETRIC DATA PREDICTION OF ORGANIC PIGMENTS

Oral paper

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Recent developments in colour science and technology provided suitable means to derive information about tone, depth, saturation, etc. of the colorants in various media. In the current study, an attempt is made to predict the colourimetric data of organic pigments in various media for different applications like ink, paint, plastic and textile with the aid of reflectance data of Muller draw down in the visible region (400 nm - 700 nm). Correction factors are applied depending upon the test procedures employed. Using various substrates like paper, polyamide film and polyethylene terephthalate film for making draw downs, an empirical relationship is established between the reflectance data of Muller drawdown and ink application. With the aid of such relationship, the user can get an idea of the colourimetric behaviour of organic pigments for a given application directly from the Muller drawdown.

COLOUR IN TEXTILE DESIGN: IMPORTANCE AND INTERVENTION IN THE HABITAT AND THE INHABITING

Poster

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In view of the extent of the topic we are focusing on and the multiplicity of approaches that can be adopted to deal with it, we consider it convenient to delimit the subject by classifying taxonomically the textile design in order to focus our area of research in a new thematic direction.

Afterwards we will concentrate on the group that best responds to the research we are carrying on. We will explain those concepts based on the formulation and participation of the textile element in shaping our habitat and our ways of inhabit in it.

In order to organize our analysis, we will establish *constructive typologies*, conditioned by their manufacturing techniques, and *post-productive typologies*, conditioned according to their purpose. We have then two main areas of study. On the one hand, the *structural stage*, whose raw material is thread and whose resultant is the manufacture of woven. This division generates two categories of designs: *constructive* and *extra constructive*. Due to this difference, each one of these areas takes its own criteria and intrinsic structures, helping to determine—in this occasion—an aesthetic analysis with the accent on the chromatic aspect.

The second aspect pays attention to the post-production stage, i.e. its use or purpose. In this stage the fabrication of the weft, as a structure, is fundamental. Thus two different types of spatiality are defined: *clothing* and *habitat*. These two typologies are not only the most important ones for our research, but also have a strong kinship which can be analysed formally and chromatically allowing us to see the definition of architecture from a different point of view.

Now we have introduced the macro taxonomies, it is our intention to elaborate on them further emphasizing the importance and the leading role of colour in *clothing* and *habitat*.

Each of these stages, on seeing the spaces from a textile point of view, generates the idea of corporal refuges, which become habitable and protected of our closeness. In short, making our habitat essential for our life.

INDUSTRIAL COLOUR DIFFERENCE EVALUATION - LCAM TEXTILE DATA

Oral paper

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This paper aims to give a brief review of problems occurring in the development of colour-difference formulae. Most of the problems mentioned are well known, but are often forgotten. Numerous studies on colour-difference evaluation have been performed and colour-difference formulae are being modified again and again towards practical applications. The basic issue is how to make the colorimetric magnitude represent the visual one. One of the most important aspects is the relationship between measured colour differences and perceived scales, which is usually assumed to be linear for practical use in industry.

The work in the area colour differences has concentrated on collecting reliable data and developing equations that describe the perceived colour-difference results. Newer equations have been developed based on the CIELAB (CIELCH) colour space with application of weights to difference components such as DL^* , DC^* and DH^* . Weighting functions SL , SC , SH are computed from regression analysis using linear (CIE1994) or hyperbolic models (CMC(l:c)).

In this paper, based on the psychophysical method of paired comparison, an experiment for testing the visual colour difference in relation to colorimetric scales is presented to analyse the relationship between colour discrimination threshold and supra-threshold colour-difference perception and its use in industry. Primarily, actual colour-difference formulae CMC(l:c), DCI1995, DIN99, CIE2000 and MV-1 are discussed.

VISUAL ASSESSMENT OF UV RADIATION BY COLOUR CHANGEABLE TEXTILE SENSORS

Oral paper

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Sunburn, skin cancer, premature aging, and suppression of the immune system are some of the harmful effects of acute and cumulative exposure to ultraviolet radiation (UVR). A decrease of 1% in ozone would lead to increases in solar UVR at the earth's surface and may eventually lead to a 2.3% increase in skin cancer. Wearing clothing, hats, and other protective apparel during sun exposure may reduce risks associated with overexposure. However, fabrics used in summer time apparel often provide poor protection against solar UVR, because they are usually made from light to medium weight fabrics.

Our contribution is not to develop new UV protective materials, but refer to the advantages of using well-known photochromic dyes or pigments for the construction of new textile-based sensors as integrated parts of summer clothes. In our study we wanted to detect not only UV radiation with sensors as indicators, but also the quantity of the UV radiation dose. We have prepared for this study a concentration scale of different UV absorbers and different photochromic dyes. We will show the comparison of sensitivity modulation of our UV textile-based sensors with measuring units (spectroradiometers) and reproducibility.

COLOR VISUALIZATION SYSTEM FOR THE DISCRIMINATION OF INDISTINGUISHABLE SAMPLES IN THE VISIBLE SPECTRUM

Poster

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Samples with the same color or appearance in the visible range, and therefore indistinguishable by the human eye, can have different properties in other parts of the electromagnetic spectrum. Basically, the reflectance or transmittance spectra of these samples are expected to be similar in the visible range but can differ in other regions. In this work we present a system that uses the information included in different spectral bands of the near-infrared region of the spectrum (800 to 1000 nm) in order to discriminate samples with the same appearance in the visible range. This spectral range can contain information related to the chemical properties of the object being analyzed and therefore it can be useful to achieve a separation between samples with similar color but different composition. These properties can be of application in several areas such as paints, textile industry and chemical industry.

The experimental set-up used consists of a monochrome CCD camera (Hamamatsu C7500-51) connected to a frame grabber (Matrox IP8), a halogen lamp (Philips 15V 150W) used to light the samples and filters that define the different spectral bands in the near-infrared region. The proposed system is a color visualization system that permits to obtain false colored images of the samples using a color space representation, which associates the camera responses of each spectral band of the near-infrared range to a color channel of a CRT monitor. The used color space representation is based on a principal component analysis (PCA) decorrelation method that facilitates the colorimetric discrimination between objects and removes the present correlation of the different bands. We have tested different pseudocoloring methods and PCA provides the best results in terms of visual discrimination and contrast levels. With this method, and considering a set of 25 samples, we obtain CIELAB color differences similar to 60 units (mean CIELAB color difference between the set of samples).

EFFECTS OF S-CONE EXCITATION ON COLOR DISCRIMINATION THRESHOLD

Poster

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It is well known that the short-wavelength sensitive cones (S-cones) contribute to human color vision in a different manner from those of the middle-wavelength cones (M-cones) and the long-wavelength cones (L-cones). We are interested in the contribution of S-cones to color discrimination threshold. We measured color discrimination thresholds in several adaptation conditions with different excitation of the S-cone. In the experiment, the observer saw a brief test stimulus with a color slightly different from a background color for adaptation. The background color was presented in a square field whose size was 6 degrees by 6 degrees. We examined several background colors with different S-cone stimulus values but having the same luminance. The test stimulus was presented in any one of four panes, each of them 1 degree by 1 degree, aligned as a 2 by 2 matrix with a fixation point in its center. The observer's task was to report which of the four panes contained the test stimulus. Increment or decrement thresholds were determined along the directions of $\pm\Delta S$, $\pm\Delta(L+M)$, $\pm\Delta(S-(L+M))$, and $\pm\Delta(L+M+S)$ in the $(S, L+M)$ plane of cone excitation space. The staircase method was used to obtain thresholds. From the present experiments, we obtained the following three major results. Firstly, discrimination thresholds along the S-cone change of $\pm\Delta S$ were elevated with increasing S-cone stimulus values of the background color, but thresholds along the luminance direction that is $\pm\Delta(L+M)$ were independent of the S-cone component of background color. Secondly, the thresholds along the yellow-blue opponent color direction of $\pm\Delta(S-(L+M))$ did not decrease down to the minimum at an equal energy white background, but decreased with the S-cone component of background color. This result is different from the previous result of the experiment where the minimum threshold along the red-green opponent color direction of $\pm\Delta(L-M)$ was obtained at the equal energy white background. Thirdly, the increment threshold of S-cone direction $+\Delta S$ was smaller than the decrement threshold $-\Delta S$. The third result suggests that the nonlinearity of S-cone contribution to color discrimination should not be small.

A THEORY ON COLOR PERCEPTION

Oral paper

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In this contribution a theoretical model interpretation of the color perception process is proposed. This interpretation is based in a general theory of the measurement process. It is assumed that any spectral power distribution, $n(\lambda)$, belongs to the Hilbert space of continuous functions over the visible spectrum, L^c . This space is endowed with the natural inner product in order to introduce a topology that allows us to generalize all the concepts of the Euclidean geometry. The concept of orthogonality plays a major role in the proposed model. The subspace $D_3 \subset L^c$ spanned by the color matching functions will be called *detection space*. The subset $R \subset \mathfrak{R}^3$ containing all the possible tristimulus values is the *representation system*. The color perception process can be mathematically described by the *detection application* $D: L^c \rightarrow R$. From this, the concept of metamerism can be interpreted as an equivalence relation associated with this application. By using the previous mathematical tools the action of the detection application can be decomposed in two steps: discrimination and processing. The first of them is described by the *discrimination operator* $P_r: L^c \rightarrow D_3$. The processing step is described by the *processing application* $P: D_3 \rightarrow R$. Thus, the detection application can be rewritten as the composition $D = P \circ P_r$.

A matrix, T , characterizing the colorimetric behavior of a given observer (characteristic matrix) is defined. The property of invariance associated with the inverse matrix, T^{-1} , suggests us that the trichromatic equation should be expressed in the detection space, instead to do it, as usual, in the representation system. Matrix T^{-1} provides a change of basis that allows us to introduce a generalization of the trichromatic equation. The results obtained suggest a possible relation between the concept of angle between spectral distributions and the color-difference thresholds. This relation is analyzed.

The previous definition of the inner product will allow us to propose a re-definition of the concepts of radiant flux and luminous efficiency. From these definitions, we derive a clear physical interpretation of the proposed formalism. This interpretation points out how the visual system only processes in the last instance the *more efficient* spectral distributions. These distributions are those minimizing the entropy and, in the context of the information theory, they are associated with a minimal loss of information. It is shown how the behavior of the visual system is that of a dissipative physical system: from an irreversible dissipation of energy, the system tends to minimize the entropy of the spectral distribution that is processed.

WAVELENGTH DISCRIMINATION THRESHOLDS AND PSYCHOPHYSICAL MONOCHROMATICITY. DEFINITION OF THE MONOCHROMATICITY DEGREE

Poster

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As it is well known, from a physical point of view, it does not exist in nature a truly monochromatic spectral distribution of radiant flux. However, when the psychophysical aspect in the perception of a color stimulus is considered, the experimental curves of wavelength discrimination thresholds point out how each wavelength has associated a spectral threshold (undistinguishable region). Thus the spectral distributions associated with monochromatic stimuli have a certain spectral width. For a given observer, a monochromatic stimulus is characterized by its corresponding associated wavelength and spectral width. In this contribution we propose a systematic method to be used in order to quantitatively evaluate the psychophysical monochromaticity of an arbitrary color stimulus.

For each given spectral distribution of radiant flux it is possible to associate a probability density function (PDF). This function allows us to define the average wavelength of the corresponding color stimulus (expected value of λ) and its spectral width (proportional to the variance). On the other hand, this formal treatment opens the possibility to establish an algebra in order to describe all the spectral distributions of radiant flux.

From the width of two nearby distributions, a physical criterion of spectral undistinguishability is obtained. By considering this criterion and the experimental curves of wavelength discrimination, the set of all the monochromatic stimuli for the visual system is obtained (monochromatic basis). The number of elements of this basis provides the dimension associated with the space spanned by all the possible monochromatic primary stimuli (primary set of wavelengths). Any color stimulus can be expressed as a pseudo-linear combination of the elements belonging to the monochromatic basis obtained from the experimental curves of wavelength discrimination. The number of elements necessary in order to reproduce a given color stimulus, and its corresponding weights, allow us to define a quantitative measure of the psychophysical monochromaticity: the monochromaticity degree. With this definition, the stimuli that belong to the monochromatic basis have associated the unity as monochromaticity degree.

The results obtained suggest us that in color matching experiments primary stimuli belonging to the monochromatic basis should be used.

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