AIC 2016 SANTIAGO DE CHILE
COLOR IN URBAN LIFE
Interim Meeting • October 18th - 21st

AIC2016 INTERIM MEETING COLOR IN URBAN LIFE: IMAGES, OBJECTS AND SPACES

SANTIAGO DE CHILE, OCTOBER 18-22, 2016

BOOK OF PROCEEDINGS

(with USB Flash Drive enclosed)

Edited by Ingrid Calvo Ivanovic
Published by Asociación Chilena del Color

Santiago de Chile, October 2016

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This publication includes lectures, papers and posters presented in AIC2016 Interim Meeting, Color in Urban Life: Images, Objects and Spaces, held in Santiago de Chile, 18-22 October, 2016. This meeting is organized by the Chilean Color Association, more info in: www.aic2016.org

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AIC PRESIDENT'S MESSAGE: NICK HARKNESS

It is a true reflection of the global presence of the AIC that an AIC meeting is being held for the first time in Chile in the dynamic city of Santiago de Chile. This is my third visit to Chile and I have wonderful and colourful memories of the natural and rugged landscape of Patagonia and Torres del Paine plus the strident blues of the Grey Glacier and the turquoise of Lake Pehoe. The urban environment is equally colourful with the amazing trompe l'oeil of Punta Arenas and the World Heritage City of Valparaiso.

What better a location than Chile for hosting an AIC Interim Meeting on Colour in the Urban Life.

On behalf of the AIC Executive Committee and AIC family, I would like to thank Co-chairs Ingrid Calvo Ivanovic , Maria Rosa Domper, Paz Cox Irarrázaval, Mariana Kaplun and the team at Asociación Chilena del Color who have put together an outstanding programme in which to absorb ourselves for three colourful days.

Highlighting the global significance of the AIC there are more than 100 oral and poster presentations at AIC 2016 from twenty seven countries from Asia, Europe, North and South America, the Middle East and the Sub-Continent. AIC membership now stands at 26 regular members, 20 individual members and three associate members.

I would like to thank and congratulate Asao Komachiya, Hirohisa Yaguchi and their colleagues from the Color Science Association of Japan for hosting a very successful Mid-Term AIC Meeting 2015 in Tokyo in May last year.

Future AIC meetings are scheduled for Jeju Korea AIC Congress 2017, Portugal AIC 2018 and Argentina AIC 2019. Please check the dates and plan your schedules. There are three candidates to host the AIC 2021 Congress.

The AIC Executive Committee has been working on a number of initiatives this year including the establishment of an AIC Student Award to encourage the next generation of colour researchers.

I should also mention and thank others who actively support the AIC and the Executive Committee:

Berit Bergstrom who in addition to working with Maria João Durão in obtaining UNESCO recognition for the ICD is also responsible for reviewing the AIC logo.

Jose Caivano who does an enormous amount of work behind the scenes keeping the AIC Website up to date; most recently overseeing the transfer of our domain name to a new home together with Frank Rochow and Dimitris Mylonas. Jose Caivano has also worked with Vien Cheung Associate Editor of JAIC to include the JAIC onto the main AIC website. JAIC is now live on www.aic-color.org

Stephen Westland, Vien Cheung and Kevin Laycock do a fantastic job as Editors of JAIC as do the technical review committee in creating a very high quality journal of which the AIC can be proud.

There are four active AIC Colour Study Groups in which you are invite to participate:

Study Group on Colour Education chaired by Robert Hirschler
Study Group on Environmental Colour Design chaired by Verena M Schindler
Study Group on Colour Vision and Psychophysics chaired by Katsunori Okajima
Study Group on The Language of Color chaired by Dimitris Mylonas

I look forward to meeting you in Santiago and wish you all a very successful, enjoyable and creative AIC 2016

NICK HARKNESS
President
International Colour Association

AIC PAST-PRESIDENT'S MESSAGE: JAVIER ROMERO

The International Color Association (AIC) together with the Chilean Color Association (ACC) has developed an ambitious project for 2016: to hold the annual meeting of the AIC in Santiago, capital of Chile. This event –that will be held between the 18 and 22 of October– will gather 26 color associations and individual members from more than 30 countries.

The ACC is a Chilean nonprofit organization associated with the AIC. It was founded in 2008 in order to share, create, promote, coordinate and disseminate initiatives that support topics related to color. These initiatives may be applied –through education, extension and research– in different areas such as sciences, humanities, art and crafts.

The main topic of this event, *Color in Urban Life: Images, Objects, and Spaces* as decided in relation to the characteristics of the hosting city, a big and complex urban place with a population over seven million habitants. Santiago presents the common dynamics of contemporary Latin Americans' megalopolis, and it is marked by a rapid urban growth. It is therefore an excellent scenario to bring together experts from different disciplines and backgrounds, looking to contribute to the Santiago urgent challenges by providing greater physical and emotional well being to its habitants.

The resulting work of this event, based on the lectures of outstanding specialists, technical conferences, and workshops proposed by the Chilean Association of Color and both the University of Chile and Pontifical Catholic University, will be reflected in subsequent publications and transmitted by different broadcast channels.

Being able to receive in Santiago academics, researchers, artists and professionals of different areas, is a big opportunity to share and celebrate; it is a party in the broadest sense of the word, a meeting of chromatic experiences!

JAVIER ROMERO
Past President
International Colour Association

ACC PRESIDENT'S MESSAGE: PAZ COX

This book is the evidence of the great interest produced around the AIC2016 conference main theme, *Color in Urban Life: Images, Objects and Spaces,* within the international community dedicated to the study of color, both academically and professionally. The contributions presented here, cover a wide range of topics related to the conference theme: environmental color, architectural color design, urban color, color perception and vision, color and culture, color in design, color psychology, color science and materials, color health and wellness, color education, aesthetics, among many others. As it can be seen, the list of papers is extensive and each of the topics will provide the reader, through the interesting scientific papers, an idea of the contributions made to the color field around the world.

The conference main theme couldn't have been better chosen, because color impregnates every aspect of our daily lives especially where we live: the city. Color is in the streets, inside buildings, in objects and so on. More than ever, the use of color has to be thoughful and the color itself is critical for object design and connotation. Color gives life to our visual sensations and incites expected and unexpected emotions. Some expected and some not.

Color not only accounts for the present and future of our actions, but also has been part of the previous experiences of humanity, it helped founding what we call culture. Therefore, is important to emphasize that this conference has devoted special attention to color issues related to design, health, culture, and education on the knowledge and use of color, which ensures a scientific and cultural enrichment for generations to come.

Personally, I believe that the organizing and scientific committees of the *AIC2016 Interim Meeting, Color in Urban Life,* have done a remarkable work selecting the papers and editing this book, which will be corroborated by rewarding discussions during the conference. Congratulations to all of them and to the Chilean Association of Color, they have been constantly working through the years promoting and encouraging studies of Color in Chile with great international projection.

PAZ COX
President
Asociación Chilena del Color

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AIC2016 CONFERENCE THEME:
COLOR IN URBAN LIFE: IMAGES, OBJECTS AND SPACES

The aim of AIC2016 Interim Meeting is to share experiences regarding the use of color in images, objects and spaces, from different perspectives and disciplines. All of these to contribute to a better user experience and to improve life quality in our cities.

This meeting will provide an opportunity for the presentation and further discussion of the latest findings in the following topics, from both theoretical and practical points of view:

Color & Environment: environmental color design; landscaping; colorful neighborhoods & cities; color in planning, designing, and realizing the built environment; sustainability, urban agriculture; color as affected by geography, geology, and climate

Architectural Color Design: interior design; architecture; urban planning & design; innovative projects

Color Perception & Vision: color vision, deficiencies, abnormalities, synaesthesia

Color & Culture: color & identity; graffiti; color interventions & installations; cultural heritage; conservation; preservation

Color in Design: branding; color in wayfinding systems & signage; communication design & digital data visualization; color trends; usability; graphic design; typography; marketing, materiality, texture & surface; transparency and translucency; reflection and glossiness; ergonomics; customer behavior; street furniture; product design; packaging

Color Psychology: perception, chromatic harmonies; emotional interactions; perceptual illusions; color combination, palettes & schemes; color & form; phenomenology of color

Color, Health & Wellness: well-being, visual comfort, lifestyle, chromotherapy, biodiversity, waste, pollution; the design of hospitals, assisted living facilities, medical offices, laboratories

Color Education: didactics, methodology & theory; teaching aids; color naming and categorization; static and electronic media applied to color teaching; color order systems

Color, Materials & Science: color constancy, color adaptation, color appearance models, lighting design, LEDs, color rendering indices, metamerism, shadow, night vision, color measurement, photometry, quality control, digital color management, reproduction, image processing, color imaging, computer graphics, virtual reality, color in 3D printing

Color Aesthetics: art; arts & crafts; visual culture & studies; photography; performance; museology; scenography; music & sound; virtual & media projects; fashion; textiles; cosmetics; food

Colour Education: a Basic Methodology and a Framework of Experiments for Colour and Lighting Design Teaching

Maurizio ROSSI
Design Department, Politecnico di Milano

ABSTRACT

In this article, a series of basic experiments on the visual perception of light and colour are presented. They are intended to provide practical verification of, and experimentation on, three fundamental aspects that govern the relationship between light, colour and humans: the light's physical traits, visual-optical aspects and cognitive aspects, which influence our perception of objects and the environment.

1. INTRODUCTION

Since the time of the Bauhaus, experimentation as a way to teach design has been notably important, especially relating to research. In terms of education and training, basic design is a fundamental subject, which creates dialogue between the formal, expressive, technological and scientific aspects that form the foundation of the discipline encompassing the creation and design of products, spaces and communication. From a practical standpoint, this methodology was introduced to the Colour & Lighting Design educational programme at the School of Design at the Politecnico di Milano for the master's degree in Lighting and Colour Design. In fact, a series of experiments carried out with the contributions of those same students is still available at the school's Laboratorio Luce (light laboratory). A few of the experiments may seem commonplace for those who have intimate knowledge of parameters such as illuminance, colour temperatures and colour rendering, yet it is worth noting that these themes are all but intuitive and are highlighted to students during their design coursework. The purpose of these experiments is to join the theoretical and methodological aspects with the practical aspects of design: knowledge and know-how.
Know-how is essential; it helps us to understand why, in teaching design, basic design is treated with a practical-experimental methodology whose purpose is to involve the student in the experimentation to develop an idea. Basic design was fundamental to the didactic methods of the important design schools that arose over the course of the twentieth century: in the vorkurs (foundation courses) of the Bauhaus at first, then in the grundkurs (basic courses) at the Hochschule für Gestaltung later on. At the Bauhaus from 1919 to 1923, Johannes Itten was the instructor for the vorkurs, where students were asked to touch and experiment with, hands-on, simple objects and materials until they had committed their visual, tactile and emotional qualities to memory (Itten 1975). The students were also assigned simple elements such as wire, cardboard, razor blades, newspapers, matchboxes and other discarded materials and given the task of improvising, creating something instinctively, pitting their imagination and creativity against the limits imposed by the material characteristics of the objects available to them. These experiences were also extended at the Bauhaus by the lessons in form and colour theory taught by Paul Klee (Klee 1961, 1973).
Gestalt psychology (the psychology of shape and form), which developed in Germany at the start of the twentieth century, has had a strong influence on basic design (Wertheimer 1938). As Kurt Koffka states, it creates a relationship between perception and phenomenological experience. "In reality experimenting and observing must go hand in hand. A good description of a phenomenon may by itself rule out a number of theories and indicate definite features which a true theory must possess. We call this kind of observation "phenomenology"...For us phenomenology means as naive

and full a description of direct experience as possible" (Koffka 1955).
Gestalt psychology, along with the scientific method and representational-geometric aspects, ensure that basic design includes the foundations for creating the balance and connection between a project's rational aspects and the creative act, whose equilibrium is always at the base of successful designing. In the development of our experiments, we pursued similar aims, adding the theme of control over artificial light, as it is essential to visual perception in modern society.

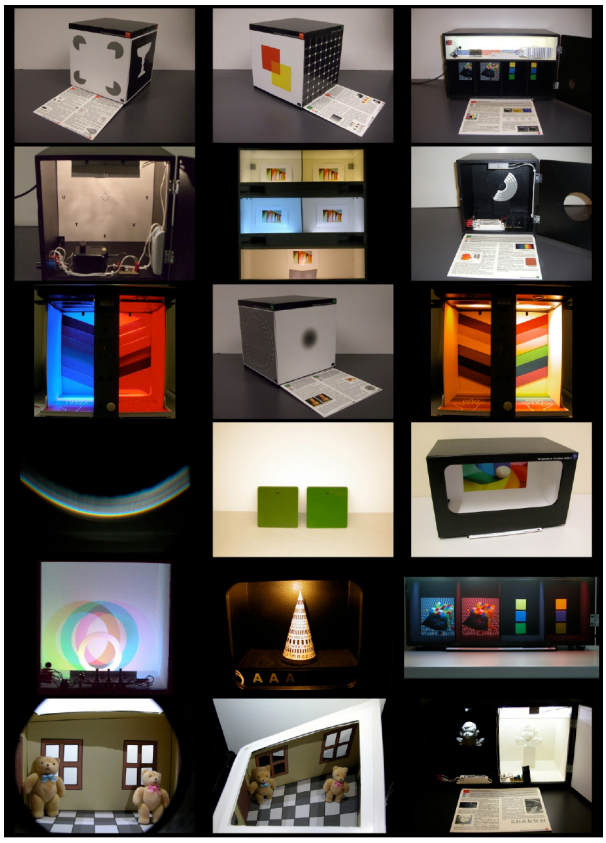

Figure 1. Some of the experiments made by students Barbara Ripamonti and Paolo Pezzotta at Laboratorio Luce.

2. METHOD

Every day, we live, work and study in changing light conditions due to natural or artificial illumination (or both). Changing light may influence the experiments' conditions, so experimental wood and cardboard boxes were built which allowed us to limit and control the quantity of environmental light that otherwise could alter the perception of the resulting effects. One of the walls of the boxes may often act as a screen to present samples or to see the results of lighting effects. Of course, we mustn't forget that light is invisible and that we can only see it when a surface reflects it or otherwise directs it towards our eyes.

2.1 Physical aspects of light and colour

The first group of experiments concerns the physical aspects of light and colour. These aspects are the characteristics that we usually describe when light interacts with matter. Such experiments are the base of understanding the interaction between light and matter, which happens daily with objects and environments, albeit

on various scales. In these interaction phenomena, we can see aspects that are of a geometric and chromatic nature. For the experiments concerning these effects, we used white LED light sources with various correlated colour temperatures as well as coloured light sources. These experiments include the reflection and transmission of light on the material, and the phenomenon arising from the wave behavior of light, such as refraction, diffraction, interference, dispersion and phenomena caused by the polarization of light. Lastly, they include the concept of the correlated colour temperature of the white light and the fundamental theme of the lighting colour rendering.

2.2 Optical and visual phenomenon

A second group of experiments dealt with the theme of vision as it relates to optical and visual phenomenon. These phenomenon mainly regard the behavior of the eye and of the retina in particular, and they are able to explain a few interesting optical effects that we find in our everyday sight. These retinal phenomena are also very important to understanding four fundamental elements of seeing an environment: glare, contrast, visual acuity and a few aspects of colour vision. We know that the retina is made of layers of cells. The innermost layer is composed of photosensitive cells, cones and rods. The top layers contain other nerve cells that process and transfer the signals produced by the photoreceptors to the optic nerve. These nerve cells are layered starting from the photoreceptors in horizontal, bipolar and amacrine cells, ending in the ganglion cells in which axons are connected to form the optic nerve. Each ganglion cell collects information from a number of photoreceptors. The retina contains approximately 7 million cones and more than 100 million rods, while ganglion cells number only 1.2 to 1.5 million. On average, each ganglion cell gathers information from more than 80 photoreceptors, but this relationship is variable. In the central part of the retina, the fovea, there may be only 1-5 photoreceptors for each ganglion cell, while in the peripheral zones there are many more. In addition, the fovea contains many more cones than rods. This is why we are able to see details of objects and colours only if they are in the centre of our field of vision. What's more, the ability to distinguish colours depends mainly on the fact that there are three types of pigment in the retina, which react to different light wavelengths, allowing us to distinguish between hues. The experiments in this group allow us to understand terms such as visual, static and dynamic acuity or foveal and peripheral vision, but also themes such as additive and subtractive colour synthesis, problems related to metamerism and the generation of chromatic signals on the retina. Another fundamental subject that was experimented is that relating to contrast and glare, such as simultaneous contrast, the contrast rendering factor in relation to the lighting, after-images and, lastly, the phenomena of colour and lightness assimilation.

2.3 Cognitive vision

The third group of experiments relates to cognitive vision, which is the question of how the creation of an image's perceptive sensation happens in our cerebral cortex. Of course, this is a complex question and an area of constant research worldwide. In fact, vision of the environment that surrounds us is a mental representation that isn't necessarily correlated to its physical and radiometric nature. This has been shown by numerous laboratory experiments and optical illusions alike. Such experiments highlight the diversity between the physical reality of an object and the subjective perception of it. Light carries the visual information about the environment, such

as geometric shapes and colours, to our brain, but this luminous information may be extremely variable, changing according to the position of the observer, the time, the weather, the season and the physical properties of artificial light, such as its spectrum, direction and intensity. Such a complex set of information must be adapted to our evolutionary needs to see it in a stable manner, where possible, which is exactly what the brain is tasked with doing. In this group of experiments, the themes of perceptual constancy, with reference to the colour and brightness of surfaces, and even the brain's ability to insert imaginary, inexistent parts into reality or to perceive real or represented transparency. All lighting effects that are favorable or unfavorable to perceiving the three dimensionality of objects, spatial perspective and the consistency of shape and size that our brain makes us perceive (even when not correlated by the geometric reality) also comes into play here.

3. RESULTS AND DISCUSSION

Starting from the introductory assumptions, we took into consideration the fundamental elements that come into play in designing lighting and colour: the visual-perceptive aspects and the material-colourimetric aspects of the objects in relation to the physical-phenomenological aspects of the illumination. This arose from the experiential and even scientific observation that one's visual perception does not register the surrounding environment in the same way that a tool for measurement does, but rather interprets it. Josef Albers confirms that "...experience teaches that in visual perception there is a discrepancy between physical fact and psychic effect" (Albers 1975). But it is Edwin Land that supplies the reason behind a few phenomena, including perceptual constancy (Land 1977). According to him, the human visual system evolved to allow us to see the world in stable lighting and colour conditions, compensating for the variations in the colour of illumination within certain limits. Furthermore, he states, humans have the ability to establish a close relationship with the external world that a photographic camera cannot. Thus, our experiments raise the question of the relationship between a light source and visual perception of space and colours as a central point. Such investigative methodology is not simply carried out to produce an inventory of strange phenomenon, but to establish a cause and effect relationship, as upheld by Gaetano Kanizsa, who emphasizes the importance of the method and the aims of the experiment's investigation (Kanizsa 1977). He posits that experimental phenomenology is not limited, as one may tend to believe, to a mere description or inventory of phenomena. Rather, its scope should be more ambitious. It should promote the discovery and analysis of necessary causal connections between visual phenomena, the identification of conditions that determine, favor or hinder their appearance, and the degree of their obviousness.

4. CONCLUSIONS

Approaching the lighting and colour design through education that, at its core, favors this type of experimentation allows us to bolster a more secure methodology and strengthen fundamental skills in the ability to manage multi-disciplinary design, moving between photometry, radiometry, colorimetry, physiology and the physiology and psychology of perception. These individual disciplines may then be further unpacked in the context of a training programme.

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Address: Prof. Maurizio Rossi, Department of Design, School of Design, Politecnico di Milano, Via Giovanni Durando 38/A, 20158 Milano ITALY
E-mail: maurizio.rossi@polimi.it