AIC2013
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AIC Colour 2013

12th Congress of the International Colour Association
8-12 July, 2013
Newcastle upon Tyne, UK

Proceedings

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The Colour Group (Great Britain)

International Colour Association
Internationale Vereinigung für die Farbe
Association Internationale de la Couleur

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Catching the Aesthetic Dimension: On Aesthetic Experience of Colour and Light

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ABSTRACT

This paper springs from a project about concept formation in the field of colour and light. It is based on own reflections and on scientific and scholarly references. It is an attempt to describe a conceptual approach to aesthetic experiences of colour and light relating them to different levels of experience: categorical perception, direct experience and indirect – cultural – experience. Art and design have a special and complex relation to the different levels of experience. Artistic works can serve as "models" or "examples" – indirect experiences – for how we may attend to light and colour in our direct approach to the world. They are also, as appearances, direct experiences. The emotional content we can experience in a piece of art or a designed object is symbolic in a special way; perceptual patterns of colour, light and form, abstracted from their normal context in life, can be used as symbols for felt life in pieces of art and in designed objects. What we are used to calling *formal aesthetics* belongs primarily to the categorical – basic – perception. Adopting a reflective attitude we consciously attend to this perceptual process of understanding and open up for reflection on experiences as such.

1. BACKGROUND

The overall spatial impression of colour and light is an intuitive summary of current perceptions in a context of all experiences we have through living contact with the world. The American philosopher Susanne K Langer calls attention to the fact that the word intuitive is often used in a confused way; intuition is supposed to be "without reasoning" and without "benefit of logic" which ends in "mysticism, mixed with every degree of philosophical irrationalism – and sheer sentimentality and romantic fancies" (Langer 1957: 60). Just the other way round and relating to John Locke she claims that there is "no possible conflict between intuition and discursive reason" (Ibid: 66). Intuition is the fundamental intellectual activity, which produces logical or semantic understanding. It comprises all acts of insight or recognition of formal properties, of relations, of significance, and of abstraction and exemplification. "Intuitions are neither 'true' nor 'false', but simply present" (Ibid).

The basic – categorical – perception of colour and light gives spatial and temporal structure to the surrounding reality. The experience of stability and coherence of the world is fundamental; there is a tight perceptual attunement between human beings and the world around. The experienced world is in ecological balance with the human environment, and the perceptual relation between the outer world and the human inner world is without hindrance (Noë 2004: 156).

By direct experience we gradually learn through living to understand the relations of colour and light to the world around. The direct experience is dynamic and simultaneous; perceptions, feelings and emotions form a coherent whole. Making use of natural perceptual abilities (the categorical perception) and interplaying with the physical world we develop perceptual "skills"; we acquire abilities to catch the spatial significance of colour and light in space.

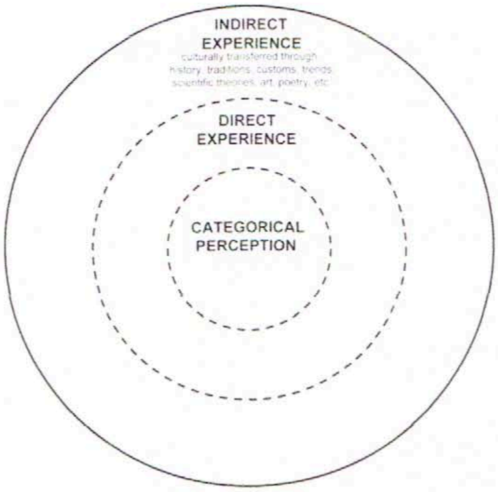

Figure 1: The graphic model shows levels of experience - from experiences based on categorical perception through direct experience of the world around to the indirect experience imbedded in cultural expressions (Klarén 2012).

Experiencing colour and light in a living context always implies an intuitive and emotional understanding: we experience spontaneously spatial relations, the atmosphere of a room or the tone of an object. And our experience of the world around is always influenced by indirect experience – cultural values and knowledge.

The three experience levels (figure 1) – The categorical – basic –perception, the direct experience and the indirect – cultural – experience are interdependent and implicitly present in all perceptions (Klarén 2012). This is how our overall perception normally works.

2. AESTHETIC EXPERIENCE

Art and design have a special and complex relation to direct and indirect experience. On the one hand artistic works can serve as "models" or "examples" for how we may attend to light and colour in our direct approach to the world. On the other hand they are also, as appearances, direct experiences. The aesthetic dimensions in art and design are, depending on aspect, both direct and indirect experiences. Langer says that "in one way, all good art is abstract, and in another way it is concrete" (Langer 1957: 69).

2.1 Aesthetic attention

Maurice Merleau-Ponty (2002: 355) discusses how we approach the surrounding world in different ways depending on situation. He makes a distinction between two modes of attention: *living perception* and *the reflective attitude*. In living perception colour and light are manifested to us in the totality of spatial relations; this is the everyday way of attending to colour and light.

Experience of the world makes it possible to think about it; we would not know what the world is like without experience. In living perception the perceptual qualities are mostly transparent; our attention is on the objects and spaces of the outer world. Adopting an reflective attitude, however, we consciously attend to our spontaneous perceptual process of understanding; attending to aesthetic qualities in art and design – or in the world around – means that we open up for reflection on experiences as such; what we attend to is the perceptual qualities, not the physical thing. We "abstract its appearance from its material existence" (Langer 1953: 47).

2.2 The expressive symbol

Gottlieb Baumgarten, originator of Aesthetics as a specific academic discipline, describes knowledge that implies coherent intuitive understanding and is given directly by sense experiences (Baumgarten 1983, p 80). Aesthetics is not concerned exclusively with art. Aesthetics is an epistemology, and aesthetic experience is an aspect of our natural approach to the world.

Langer's aesthetic philosophy is a part of the epistemological tradition from Baumgarten. Connecting to Wittgenstein she asks, how do we give symbolic form to the tacit dimension of our direct experience? She claims that the emotional content we can experience in a piece of art or a designed object is symbolic in a special way (Langer 1957: 60); perceptual patterns of colour, light and form, abstracted from their normal context in life, can be used as symbols for felt life in pieces of art and in designed objects. Langer calls them logical expressive – or articulated – symbols (Langer 1953: 31).

Wittgenstein says that feelings follow experience of a piece of music, just as they follow courses in life (Wittgenstein 1993: 19); a piece of music consists of a sequence of tones. It has a structural resemblance to courses in life – a rhythm, pauses and breaks, pitches, etc. – and thus they can be used as examples. The auditory structure in music is not a course of life, but felt life abstracted in a logical expressive symbol. The same is true for all sensory experiences.

The direct visual experiences of the surrounding world give emotional content to logical colour and light combinations in the real world. Thus a certain colour combination, a light arrangement or an articulated space can act as a logical expressive symbol. The logical expressive symbols are what we may call the artistic or aesthetic dimension in pictures, in utility goods, in architecture – in the surrounding world (Langer 1953: 31, 51-52).

The logical expressive symbols occur in the borderland between direct and indirect experience. What we are used to calling "expression" in an articulated object or space is perceived as a direct experience, but without being separated from its symbol. Encountering articulated patterns in pictorial art, object design, in interior design or architecture, our perceptual answer is first of all intuitive recognition, not interpretation of meaning.

Expressive symbols are not about abstract signs with associated or conventional meanings. According to Langer they are objectified feelings based on visual experience that can only be communicated by significant patterns of perceived qualities.

2.3 Formal aesthetics

Perceiving colour distinctions and colour similarities are basic to colour perception. If, for example, in a colour combination, the colours have the same whiteness, blackness, chromaticness, hue or lightness, we can sense that these colours have something in common. We are used to saying that colours in such colour combinations fit together or harmonize or that the colours of a painting or a room hold together. This experienced unity of colours, however, has nothing to do with preferences. It follows from the visual system itself: the ability to recognize colour distinctions and colour similarities is part of the categorical perception and is therefore predetermined. It is natural in the same sense as recognition of characteristic colour scales in perceptive colour systems. This hidden perceptual order is implicit in all transformations we experience as we move around the environment. It serves in the business of survival and allows the organism to discover deviations. Used in the context of art and design this is what usually is referred to as *formal aesthetics*.

A conscious or unconscious infraction of given perceptual rules will always be related to them and be regarded as a deviation from normality. Thus it is quite possible to deviate from them, but not to question or avoid them. In artistic tradition there is great consciousness of such perceptual prerequisites.

These basic experiences can, however, never be perceptually isolated. They are always part of the coherent experience of the world and thus always related to the dynamic direct experience and the indirect cultural context.

3. CONCLUSIONS

The aesthetic experiences have their origin in a reflective attitude aroused by recognition of and attention to logical expressive symbols (direct and indirect experience) and basic perceptual order (categorical perception and indirect experience). The qualities and the meanings that make up aesthetic patterns and expressive symbols cannot be examined separately without something essential being lost. The relations of aesthetic experiences to different levels of experience could, however, be described with the aesthetic coherence intact and make possible a communication and an analysis of the aesthetic dimension of colour and light.

REFERENCES

Baumgarten, G., 1983 [1739]. *Texte zur Grundlegung der Ästhetik* edited by H. R. Schweizer. Hamburg: Meiner.

Langer, S.K., 1957. *Problems of Art: ten philosophical lectures.* New York:The Scribner library.

Langer, S.K., 1953. *Feeling and Form.* London: Routledge & Keagan.

Klarén, U., 2012. Natural Experiences and Physical Abstractions – On epistemology of colour and light. In *Colour and Light – Concepts and confusions* edited by H.Arnkil. Helsinki: Aalto University / Konstfack, SYN-TES

Merleau-Ponty, M., 2002 [1962]. *The Phenomenology of Perception.* New York: Routledge.

Noë, A., 2004. *Action in Perception.* Cambridge: The MIT Press.

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Course "Nordic Light and Colours" held at NTNU in April 2012

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ABSTRACT

This paper presents and discusses an intense six day PhD course held in 2012. One of its aims was to contribute to the formation of *colour and light* as a coherent field of knowledge. Both lecturers and participants represented a variety of professional and disciplinary approaches, and to create a common platform for fruitful interchange there was a pre-course reading task and test. The course included lectures, workshops, and an essay task. It gave a broad interdisciplinary understanding of colour and light and their spatial interaction, as well as a network for possible future collaboration.

1. INTRODUCTION

Our visual experience of space is formed in an interaction between light, colour and human perceptual ability. Even in a worldwide perspective there are, however, very few research projects or educational initiatives that investigate this interaction as a coherent field of knowledge (Fridell Anter 2013). In April 2012, a unique PhD course on light and colour was held at Norwegian University of Science and Technology (NTNU) in Trondheim, with funding from NordForsk and participants from four Nordic countries.

The PhD course was initiated from the large Nordic research project *SYN-TES.: Human colour and light synthesis: Towards a coherent field of knowledge* (www.konstfack.se/SYN-TES), which was carried out during 2010-2011 by an interdisciplinary group of researchers and practical light and colour experts from Nordic universities and companies. One of the aims of the project was to enhance collaboration and understanding between different professions and disciplines working with colour and light; education at the PhD-level is a very suitable arena for this.

2. GENERAL PRESENTATION OF THE COURSE

The course in Trondheim had a genuinely interdisciplinary approach, with as much emphasis on light as on colour and involving a diversity of approaches such as physics, architecture, perception psychology, performance art, lighting design and health and care sciences. Not only the lecturers but also the course participants represented a very broad competence. The course was open to PhD candidates at Nordic universities, with the demand that their thesis work should deal with light and/or colour. The seventeen participants were active in Norway, Sweden, Denmark and Finland and belonged to professions and disciplines such as civil engineering, art, architecture, nursing, design, environmental psychology, and architecture. This opened for many possibilities to learn from each other and to develop valuable professional connections for the future.

3. TO CREATE A COMMON PLATFORM

One of the aims of the course was to create the preconditions for interaction between people with different professional and academic perspectives, and the course was open for PhD candidates within any subject, as long as their thesis work dealt with colour and/or light. Thus the field and level of knowledge differed much between the participants. This created an initial challenge to establish a common platform of knowledge, from which lectures, workshops and group discussions could start.

We identified three important aspects of this knowledge platform: Firstly, a theoretical understanding of the fact that colour and light can be approached and studied from many different perspectives, and a recognition of the differences between them. Secondly, an understanding of the Natural Colour System (NCS), which was to be used as the language for descriptions and analyses of colour during the course (Hård et al. 1996). Lastly, an understanding of basic photometric concepts and terminology, which were necessary for understanding lectures and assignments.

To achieve this, all participants were asked to read a number of texts and had to pass a pre-course test before being admitted. The main text dealt with the three knowledge traditions of perception, physics and psychophysics, and the colour and light concepts belonging to these traditions (Fridell Anter 2012). The same words – for example the basic ones of *colour* and *light* – are used within all these traditions, but they do not refer to the same thing. These conceptual ambiguities had to be made clear, in order to make it possible to follow lectures and workshops and to facilitate communication between course participants from different knowledge traditions.

Once the course started, it became clear that the pre-course literature and test had not been enough to convey the basic understanding intended. The photometrical concepts gave the least difficulties, which was obviously due to the fact that practically all participants had already worked with light issues. NCS, on the other hand, was new to several participants and others had only used NCS samples and codes instrumentally without considering the system behind them. During the course it appeared that the introduction of NCS was not enough to give the understanding that would make it useful in workshops and discussions, and some extra time was allotted to explaining it.

We can conclude that to make the course optimally valuable for students with so different backgrounds, more time must be used for creating a common conceptual platform. This could be done before the course or as its first part, possibly with two special sessions: *light for colour people* and *colour for light people.*

4. LECTURES AND WORKSHOPS

The schedule of the six course days was very intense and included all meals, jointly for lecturers and participants. All participants and several of the lecturers stayed in Trondheim during the course. The typical day included two lectures in the morning and two workshops in the afternoon. The lectures covered the following themes:

Perception of light and colour. Prof. Arne Valberg (Biophysics, NTNU) presented what is known and what is still not known about the complex relationship between physical stimuli and visual perception. Assoc. prof. Ulf Klarén (SYN-TES group, Konstfack, Stockholm) demonstrated and discussed different levels of human perception and experience. Their joint conclusion was, that an understanding of human perception cannot be based solely on physical data.

Light and colour in Nordic countries. Prof. Barbara Matusiak (Light & Colour Group, NTNU) presented criteria for daylight evaluation and classification in general, and showed the specific visual character of northern daylight, such as low mean elevation angel of the Sun, low mean colour temperature of sunlight, high occurrence of cloud cover and the impact of snow and ice. Assoc. prof. Karin Fridell Anter (SYN-TES group, Konstfack) presented the typical colour scales of vegetation and ground in mid-Sweden and the exterior colour tradition of Swedish buildings, and discussed this in relationship to other Nordic countries. Prof. Alex Booker (Light & Colour Group, NTNU) showed his art exhibition *Trondheim Derivé* with photos and prints exploring the visual character of Trondheim. All this gave starting points for reflective viewing and consideration of the light and colours that form the outdoor environment that surrounds us and has formed our set of references.

Spatial interaction of light and colour. Prof. Monica Billger (Architecture, Chalmers, Gothenburg) showed, among other things, how colours in a room influence each other through induction and interreflection. PhD Cecilia Häggström (Lighting Design, Jönköping University) demonstrated how our perception of form and space affects and is affected by our perception of colour and light. Assoc. professor Karin *Søndergaard* (Lighting lab, Royal Danish Academy of Fine Arts) showed how light can create spatial zones that relate to our body, feelings and behaviour. All this supported an understanding that the perceptual and experienced aspects of colour and light could not be analysed in a meaningful way without considering the spatial context.

Light, health and well-being. The non-visual aspects of light are essential for our health and diurnal rhythm. In the course program this topic was presented by Assoc. professor Thorbjörn Laike (Environmental psychology, Lund University). Assoc. prof. Helle Wijk (Health and care sciences, Gothenburg University) presented research an applications showing how colour and light can function as a support for visually and/or cognitively impaired persons. This gave a further understanding that light and colour should be seen as fundamental aspects of architecture and interior design.

Daylighting and electric light. Prof. Jan Ejhed (KTH Lighting lab, Stockholm) presented different possibilities to use artificial light and Prof. John Mardaljevic (Building Daylight Modelling, Loughborough University) demonstrated methods for adequate prediction of daylight effects in buildings. This emphasised the importance of adequate technical knowledge in the process of lighting planning, and showed both advantages and limitations inherent in the digital methods aimed to favour this process.

Most of the workshops were based on the themes of the lectures and were held in the two well-equipped laboratories of the NTNU Light & Colour Group. The daylight laboratory is meant for model studies and has an artificial sky that provides diffuse light as from the sky and two artificial suns that provide parallel light radiation and can be set in the accurate angel for any geographical place, date and hour. The room laboratory has large windows in two directions, but can also be made dark. It is equipped with material for easy building of full scale spaces and a large number of different light sources. See www.ntnu.edu/bff/laboratories. Two workshops were held in the historic parts of Trondheim. The nominal and perceived colours of facades were assessed, using the methods of Fridell Anter (2000), and the light situation in the Nidaros cathedral was evaluated, using the PERCIFAL method developed within SYN-TES (Klarén 2013).

5. FINAL ESSAYS

The last part of the course was to write an essay, discussing a topic relevant for the person's own thesis work from the joint perspective of colour and light. These essays came to cover a wide variety of research questions such as a full scale study on the use of virtual environments to study daylight and colour, a survey on how the colour rendering properties of light sources have been presented to customers and an interview investigation on professionals' thoughts about light and colour in nursing home facilities. Some of the essays were published in a peer reviewed publication together with articles by some of the lecturers (Matusiak & Fridell Anter 2013).

6. CONCLUDING REMARKS

One important aim with the course was to contribute to the formation of *Colour and light* as a coherent field of knowledge. We can conclude that the interdisciplinary approach and the diverse backgrounds of participants and lecturers have favoured an interaction between fields of expertise and, more concretely, between people. All participants now have a broader understanding of issues concerning colour and light, and they have also got an interdisciplinary network for future work and collaboration.

When looking at the concrete realization of the course, we can conclude that it included too much of scheduled work and too few opportunities for the participants to share and discuss each other's work. Also, more time should have been allotted to free interaction in workshops, thus making better use of the available laboratories. This will be considered in the planning of the next course, which we hope to give in 2014.

REFERENCES

Fridell Anter, K., 2000. *What colour is the red house? Perceived colour of painted facades.* Stockholm, Architecture, Royal Institute of Technology.

Fridell Anter, K., 2012. Light and Colour: Concepts and their use. In: *Colour and Light - Concepts and Confusions*. H. Arnkil, Ed. Helsinki, Aalto University School of Arts, Architecture and Design.

Fridell Anter, K., 2013. Spatial interaction between light and colour. An overview over current international research. In: *Nordic Light & Colour 2012*. B. Matusiak & K. Fridell Anter, Eds. Trondheim, Faculty of Architecture, NTNU.

Hård, A., L. Sivik and G. Tonnquist, 1996. NCS Natural Color System - from Concepts to Research and Applications. *Color Research and Application* 21: 180-205.

Klarén, U., 2013. *PERCIFAL: Visual analysis of space, light and colour*. Stockholm, SYN-TES report 2E. www.konstfack.se/SYN-TES.

Matusiak, B., and K. Fridell Anter, Eds., 2013. *Nordic Light & Colour 2012*. Trondheim, Faculty of Architecture, NTNU.

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Colour Shift: Perceived and Measured

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ABSTRACT

This paper presents further results from the research project "Translucent facades" that was initially presented at AIC 2012. In the present paper the results of the colorimetric measurements are presented and compared to the results from visual matching carried out by observers. Interestingly, those two methods lead to the same results for all colour samples examined in the project. Both methods, the visual matching and the colorimetric measurements, may be used in the examination of colour appearance, particularly in research projects dealing with glazing solutions.

1. INTRODUCTION

How much do interior colours change their visual appearance due to a given type of glazing and in which direction do they change, e.g. hue and nuance?

The study aiming at answering this question was carried out in the overcast sky simulator in Daylight Laboratory at NTNU and was presented at the AIC 2012 Interim Meeting, Taipei. In this study, 28 NCS colour samples were tested in a scale model, to which different glazing types (or no glass) were fixed. Visual matchings were made between samples seen behind glass (or no glass) and samples behind blinds, both lit by artificial daylight. All glazings were evaluated twice, with the colour samples seen against a white and a black background, respectively. With both backgrounds, the colours shifted towards the same direction, also the shifts were slightly larger when the samples were seen against the black background. As our aim was to detect patterns and tendencies rather than exact measurements of colour shifts, we decided to use only the observations against black background for further analysis, see Figure 1.

The main goal of the present work is to verify:

whether and in that case how the human judgement correlates with the colorimetric measurements.

2. METHOD

In order to answer this question the samples were measured under the same experimental conditions as the observers made the visual matching i.e. the spectral power distribution was measured in the same model in the same illumination (Daylight Laboratory at NTNU) for the same NCS-samples and for the same glazings. The measurements were taken in Feb. 2012 using the Spectro-radiometer CS-1000 from Konica Minolta. The model had two chambers with equal surfaces and geometry, Figure 1A. The reference chamber was equipped with the especially designed, vertical and white blinds-system that enabled precise adjustment of the light flux from the Artificial Sky; different types of glazing could be fixed to the test chamber. To keep equal light level in both chambers the blind-system was used, and the illuminances were measured in both chambers (Hagner EC1 lux meters) before each colorimetric measurement was performed.

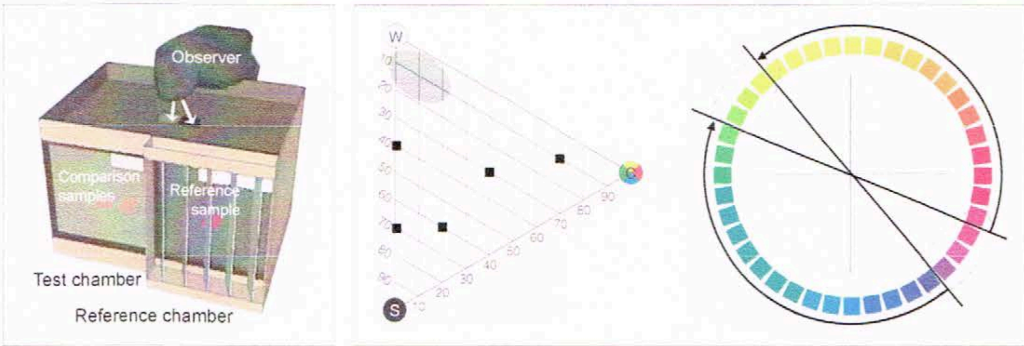

Figure 1: A: Illustration of the model. B: To the left; approximate area where the nuances proved sensitive to hue shifts caused by glazings (shaded area). The points show tested nuances that did not prove sensitive to such shifts. To the right; principle of hue shifts.

3. RESULTS

The results for six NCS-samples and for two situations: no glass and blinds are presented in Figure 2. By comparing the results for each sample, we may find out that blinds reduced the light level to about 43% of the level measured with no glass, without any significant change of spectral power distribution pattern. Due to en almost linear shift, it may be concluded that blinds do not cause any colour change.

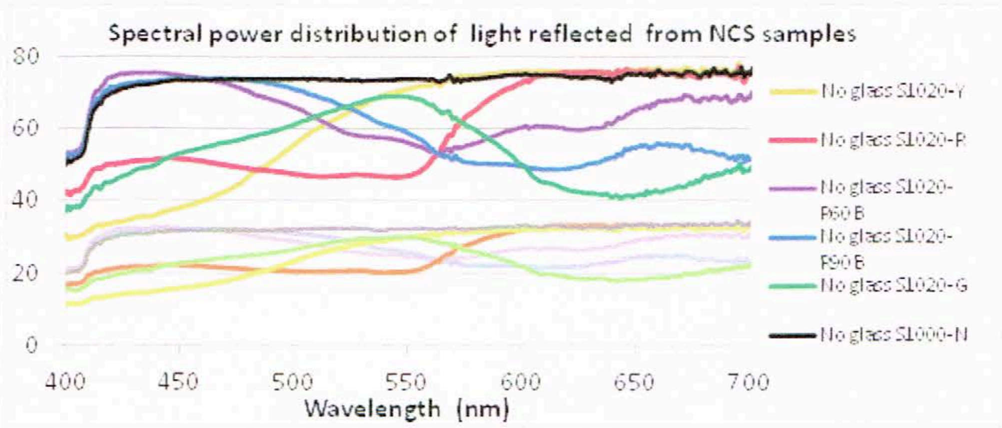

Figure 2: Spectral power distribution of light reflected from the NCS-samples, indicated in percentage of a perfect white sample. No glass versus blinds.

Figure 3 presents the results for the same six NCS-samples in two situations: no glass and 3-layers low-energy glazing. The power of light is strongly reduced by the glazing in the whole spectrum and the reduction varies between different wavelengths. This may be observed by examining the spectral distributions of the grey sample (S1000-N) measured with and without glazing. The reduction in both ends of the spectrum is respectively, down to 35% of "no glass" for blue and to 26% of the "no glass" for red. The reduction in the middle part of the spectrum (yellow-green) is lower, i.e. to 47% of the "no glass" level. Similarly wave-length dependent reductions may be observed for all other colour samples.

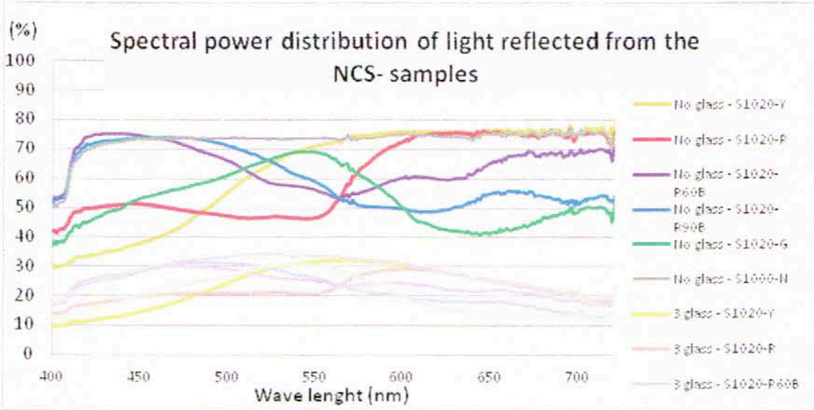

Figure 3: Spectral power distribution of light reflected from the NCS-samples, indicated in percentage of a perfect white sample. No glass versus 3-layers glazing.

Since the illuminance level measured at the sample in both chambers was nearly equal and the samples had very similar reflectances, the luminance level of the samples placed in the chamber with blinds and in the chamber with 3 layer of glass was very similar too. The CIE colour system characterizes colors by a luminance parameter Y and two color coordinates, x and y, which specify the point on the chromaticity diagram. Since the luminances for the respective samples were similar, we may show all the examined colours at the same chromaticity diagram, see Figure 4.

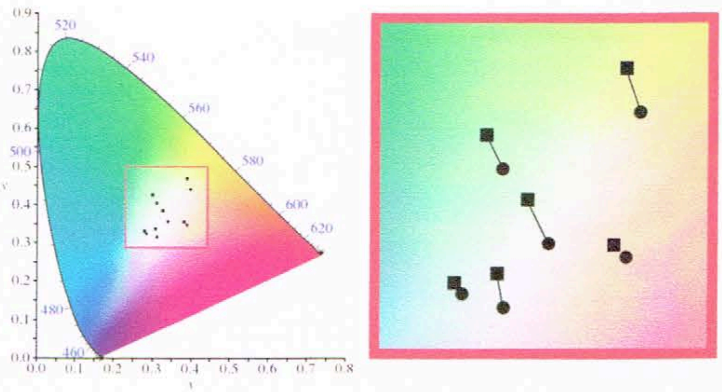

Figure 4: Chromaticity diagram with the results of colorimetric measurements for situations: Blinds and 3-layers glazing for the six NCS-samples. The results for blinds are shown with circles and for 3-layers glazing with squares.

The measured colours of the NCS-samples behind 3-layers glazing (squares) are situated nearer to the green area of the chromaticity diagram than the measured colours of the same NCS-samples without glass (circles). We see the colour shift toward yellowish green as caused by the glazing.

Is it possible to counteract colour shift toward yellowish green? Many different NCS samples were examined, both visually and with the colorimetric measurements, to find out if it is possible to find a sample that placed behind 3-layers glazing has a colour equal to the test sample placed behind blinds; the results for the yellow colour are presented in Table 1. To find out which of the NCS samples placed behind 3-layers glazing is closest to the S1020-Y (Blinds), the distance at the chromaticity diagram was calculated, D(m) in Table 1.

Interestingly, the sample S1015-Y20R (3 glass) which, according to the colorimetric measurements, is the closest one to the S1020-Y (Blinds) was also evaluated as the closest one to the S1020-Y (Blinds) with the visual matching, see the last row in the table! Corresponding observations were done for the other colour samples, i.e.: red: S1020-R, violet: S1020-R60B, blue: S1020-R90B, green: S1020-G and grey S1000-N.

Table 1. Colorimetric measurements for the yellow sample S1020-Y placed behind blinds and a series of NCS-samples placed in the test chamber, behind 3-layers glass.

	Blinds	**3 glass**					
	S1020-Y	**3S1020-Y**	**S1020-Y20R**	**S1010-Y20R**	**S1020-Y10R**	**S1020-G90Y**	**S1015-Y20R**
Y	29,488	30,248	28,229	29,808	29,795	31,109	30,793
x	0,3717	0,364	0,371	0,352	0,367	0,359	0,363
y	0,4124	0,428	0,422	0,405	0,426	0,430	0,415
D(m)	0	0,0181	0,0097	0,0205	0,0148	0,0214	**0,0092**
Vis. match	sample						Best match

4. CONCLUSIONS

The results of this study lead to the following conclusions:

- The visual matching and the colorimetric measurements are both good methods for testing the appearance of colours in rooms.
- The glazing used in the study, 3-layers low emmisivity glass, causes the colour shift of interior colours in the direction to the yellowish green.

REFERENCES

Matusiak, B., K. Fridell Anter and K. Angelo. *Colour shifts behind modern glazing* www.konstfack.se/SYN-TES

Angelo, K., B. Matusiak and K. Fridell Anter, 2012. *Colour Shift Behind Modern Glazing* Proceedings of the AIC 2012 Interim Meeting Taipei.

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