NCS TEACHER'S GUIDE

This NCS Teacher's Guide is a thorough revision and renewal of the earlier booklets NCS Teacher's Manual (1992) and NCS Study Guide (1990) and was carried out by NCS Colour AB together with Grete Smedal, interior architect MNIL, Professor in Colour Design at the Academy of Fine Arts in Bergen.

This revision has been carried out by Berit Bergström, NCS Colour AB under the supervision of Grete Smedal.

The techniques for teaching the NCS system have been developed by researchers in numerous meetings with users. The development started during the annual summer workshop, where teachers and colour professionals meet for an intensive week filled with experiences and experiments on colour and perception. Some of these experiments where carried further and turned into the NCS Educational Material.

For information about the complete selection of NCS study material (exercise material, demonstration material, specialist literature, colour sample collections etc), see our homepage: www.ncscolour.com, contact the NCS Colour AB.

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1. TO THE TEACHER

EDUCATION - FOR WHOM?

An important question for the person who is to pass on knowledge about colour is: what is important for my students? Different target groups, according to age, previous knowledge and fields of interest, will give different answers to this question.

There is a great difference between an easy handling of colours as important elements in everyday life and working with colours in a professional context. This must, of course, be taken into consideration when choosing the angle of approach. Each person must find their own method in teaching about colour, which depends on their own field of expertise, and also on their relation to the group which is participating in a class, a course or in a workshop.

This guide is directed to you, to help you arrange training for your exact target group. Your own involvement and experience are, of course, decisive for how the subject will be introduced, which exercises will be used and what may be relevant. There is no pattern for this, but a great number of publications can give advice, hints and useful ideas for teachers, and this is one of them.

Basic colour education is only a question of relating to colour as a visual phenomenon – to something which we see.

Those who still find it necessary to produce their own colours with the help of pigments, colour tubes or computers may do so, but they have to plan their own education in this respect. The goal of our use of colour is the visual perception, and it is therefore important that the acquisition of knowledge focuses on what we do and what we see.

THE NEED FOR A LANGUAGE

Clarified concepts and a basic terminology for the subject to be taught are fundamental for all education. This applies particularly to colour.

Different concepts for the same phenomenon can easily create confusion and a lack of clarity. What do we mean with our words and how can we describe visual impressions? Whatever the level of our experience, it is important to relate words to what we see.

The study material which provides the basis for this guide is designed to acquaint the student with colour and the different concepts which describe the actual visual perception. The study material creates an easily understood structure embracing the different properties of colour. Against this background,

clearly defined words and concepts are developed, which can be illustrated in different graphical models.
The NCS system is thus described in perfect agreement with its basic perceptual idea, a visual approach, where colours are grouped and sorted entirely according to what they look like.

Based on this knowledge, different skills can be developed. Knowledge derived from previous theories and different practical experiences can be translated to the system's graphical models. Together with new experience and new knowledge, they can be described in a language.

The study material is intended for use in different groups. Parts or the whole of the material can be used in different ways, leading from simple discoveries to a deepened understanding, to fit the teacher's own way of dealing with the topic.

This basic colour theory includes no attempt whatsoever to impart aesthetic values relating to the merits of different colour combinations or rules for beautiful colouring. On the other hand, it can provide a basis so that we can analyse our observations more easily and be able to describe and substantiate our colour compositions.

It is our hope that you, as a teacher, will find support in the instructions which are given together with the study material, that you will find ideas, and be inspired to use all its different possibilities. A deeper understanding of the NCS and a basic understanding of the study material provides confidence in the teaching situation in which the study material is to be used. This manual offers an opportunity for self-studies so that you can begin to feel comfortable with it. We wish you good luck in composing the colour education for your own specific target group and based on your own experience, an education which will give your students a basic understanding of colour that will last a lifetime.

Stockholm, June 2016

NCS Colour Academy/NCS Colour AB

2. SUMMARY

Section 3:
BACKGROUND KNOWLEDGE

- the role of colour perception
- the origin of colours
- different modes of colour appearance
- the need for a colour system

Even though colour is what you see and thus is a psychological phenomenon, it has a physical/physiological connection, which, however, is not always simple and easy to understand. When we speak about colour, it is important to clarify what exactly we are talking about in order to avoid misunderstandings and misconceptions.

We exemplify the importance of colour for our perception of the environment and for our ability to orientate ourselves in our surroundings.

The conscious handling of colour can relate to aesthetic, emotional or functional questions. An arrangement and a joint language about colour (= *colour names*) and a colour notation system (= *colour measures*) are necessary prerequisists for the ability to work consciously and systematically with colour and colour communication.

Section 4:
SOME PROPOSALS FOR INTRODUCTORY TEACHER ACTIVITIES

- using pictures
- collage tasks

It is the target groups' preliminary level of knowledge that must determine how an education is presented. We offer a few proposals and different angles to show how the course might be planned.

Section 5:
NCS EDUCATIONAL MATERIAL

- what does the material consist of?
- how does the material work?

The NCS Colour Academy's systematized study material is used as excercises. NCS educational material gives a unique opportunity to work with colours just the way they look like. Exciting processes train the eye to see similarities and differences among colours. This is an invaluable skill and enables the student to systematically arrange, describe and communicate the properties of any colour with words and graphic symbols where the eye becomes the "sorting machine".

Section 6:

TRANSLATION KEY - EXERCISES

This section shows a translation key between new exercise names, descriptions and structure compared to previous exercises.

Section 7:

COLOUR THEORY

- elementary colours and elementary attributes
- colour resemblances

This section deals with three different exercises which lead to an understanding of a colour's elementary properties and the difference between hue and nuance. These three exercises are fundamental for all the other exercises and they should come first since they describe our colour perception.

Section 8:

HOW NCS WORKS, STEP 1

- NCS symbols

Exercises which train the ability to judge the hue and nuance of a colour and to arrange the colours in a colour triangle and a colour circle.

- colour assessment

An exercise in NCS colour notations and in which way the language works, including how to describe colour with the help of the colour triangle and colour circle.

Section 9:

HOW NCS WORKS, STEP 2

- colour areas & categories

This exercise combines hue and nuance and shows how these attributes can be used to describe colours in a simple and clear way.

Section 10:
COLOUR SIMILARITIES

- visual similarities among colours
- describing similarities with symbols

These exercises train the ability to recognise and analyse similarities and differences among certain colours, and to understand and be able to record how the symbols show these similarities.

Section 11:
COLOUR CONTRASTS

- difference between whiteness and lightness
- lightness assessment

How light or dark a colour is, can be important for how clearly it will be seen against other colours. Lightness is not an elementary property. It is instead defined in relation to the grey scale.

- colour phenomena
- simultaneous contrast

These exercises train the ability to register and explain a few colour phenomena, and how colours are influenced by each other when they are seen at the same time.

Section 12:
ADVANCED COLOUR SIMILARITIES

- advanced exercises for a deeper understanding

These exercises deepen the understanding for similarities of degree and correlation and for the systematic arrangement of colours. The degree of difficulty increases considerably in these exercises, which is why they are to be recommended as group excercises or for students with high ability to distinguish between colours.

- final colour circle test

This exercise is an advanced task in analysing and grouping the colours according to hue and nuance, which usually provides great satisfaction.

Section 13:

REPETITION & NCS NAVIGATOR

- some good advice

At the end of the course, a review and revision may be worthwhile. Here, proposals are offered as to what can and should be repeated. The NCS Navigator is also a way of practice the knowledge of the NCS sytem.

Section 14:

THE DEVELOPMENT OF NCS

A brief historical retrospect covering the development of the NCS system, containing a few examples of how it is used today.

Section 15:

COLOUR GLOSSARY

The manual includes a colour glossary which contains some of the most common colour terms together with a description of how they are used. It is intended as an aid for the teacher when such questions arise.

Section 16:

EDUCATIONAL MATERIAL AND LITERATURE LIST

The literature list includes the course material referred to in the manual and examples of valuable literature for the person who wishes to penetrate the subject.

3. BACKGROUND KNOWLEDGE

THE TASK OF COLOUR PERCEPTION

A human being's ability to see colours is an essential condition for our ability to orientate ourselves and to function in the surrounding world. It is therefore important that colours exist and are used correctly in the environment. In addition, colours have symbolic and aesthetic values.

Colours, in their basic nature, are visual phenomena – sensations – and that includes black, white and grey. Thanks to the ability to see different colours, we can distinguish objects from each other and from their surroundings (*colour contrast*). The colours we recognise in objects make it possible to draw conclusions about their quality – whether the fruit is ripe, whether the meat is well hung, whether a child has a sore throat (*colour characteristics*).

A HUMAN BEING USES COLOUR

A human being can use colour consciously and intuitively:

- for aesthetic purposes (to please, to irritate, to make happy or to sadden)
- to design his/her own environment (formation)
- to create different kinds of cultural and religious symbolism
- to provide information of various kinds (traffic signals, warning marks, camouflage etc)

The potential to influence our surroundings with colour has increased considerably during the last hundred years thanks to the availability of colorants. In former times, it was expensive to paint or colour materials in anything other than certain "natural colours". Consequently, objects often had to keep their inherent colour.

Modern industrialism and a well-developed technology have made it possible, indeed even necessary, to colour our surroundings. Today, we use colour everywhere as an environmental factor just as important as shape, pattern and structure. Colour has become decisive for the success or failure of a product.

Consequently, some kind of system for the colours we want to use became necessary. Under favourable conditions the number of colours – or colour observations – a human being can distinguish, amount to 10 million. But let us assume, for practical purposes, that our colour world offers only about 100 000 colours. Even then it is evident that a simple way to survey these is vital if we are to be able to rapidly find a certain colour, to describe it, and to communicate it.

In all work involving colour, whether it is in interior architecture or decoration, the colouring of houses or products, fashion, art or other fields, there is often a large and varied range to choose from and it is necessary to be able to survey the material – there is an evident need to be able to sort and systematize the colours in some way.

THE ORIGIN OF COLOUR IMPRESSIONS

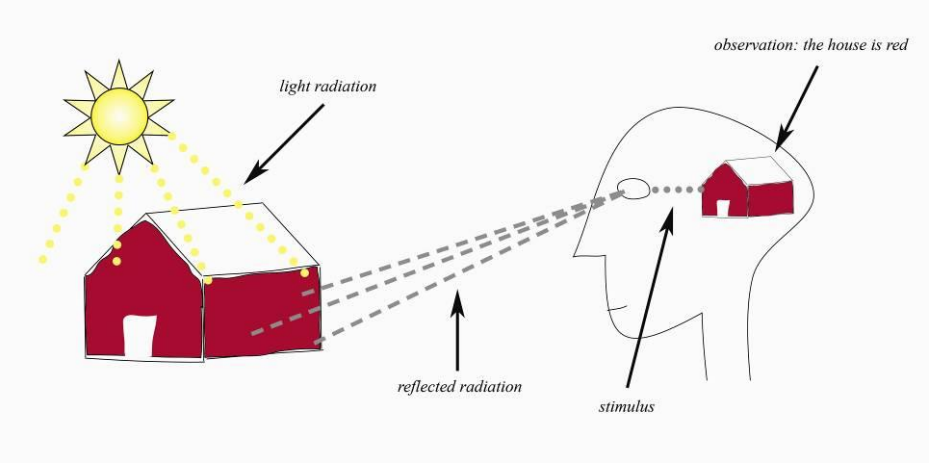
Before we can start to systematize our colour impressions, we must very briefly describe how these impressions are generated.

The first condition for a colour to be perceived in the usual sense is light (although we can also perceive colour from pressure against the eye or a blow on the head). The light source from which the light comes can vary. It may be the sun, a light bulb, a candle, a fluorescent lamp etc.

What we call light is a small part of the electromagnetic energy spectrum, where we have X-rays and ultraviolet radiation at one end and infrared radiation and radio frequency radiation at the other end.

The perception of colour is dependent on the amount and composition of the radiation. The human eye is very sensitive to variations in the radiation within the visible part of the spectrum, and it can distinguish between different stimuli (radiation) with great accuracy.

If we imagine a light source which sends out light radiation of all wavelengths, e.g. the sun, and let this light strike an object, the following happens in the surface layer of the object.



1) Part of the light radiation, i.e. certain wavelengths, is absorbed (retained).

2) Part of the radiation is transmitted (allowed to pass through).

3) Part of the radiation is reflected (thrown back).

The most important thing that has happened is that the reflected radiation no longer has the same wavelength composition as the incident light from the light source (here the sun). The reflected radiation is intercepted by the eye and strikes the retina. Here, the wavelength of the light is "read" and a message is sent via the optic nerve to the visual centre in the brain. Only then does the observation take place (we perceive) that the object which is illuminated has a colour (e.g. red). The colour perceived is dependent on the composition of the radiation when it enters the eye. Light of a different composition would give rise to the perception of a different colour.

DIFFERENT MODES OF APPEARANCE

A colour may be perceived not only as belonging to the surface of the object. Colours may appear in many other modes.

The colour may seem to belong to the material, in the way that we see e.g. wood, stone, metal, flowers and leaves. It may also be associated with a volume, as inside a coloured glass. It may also appear as a detached field, as a shadow, reflecting light or the sky. On a monitor, the colours arise as light radiation and the colours are perceived to be luminous.

The terminology in this guide can be used to describe the appearance of the colours verbally. But it is important to point out that when we speak of NCS®© -Natural Colour System - we are concerned only with colours as colour percepts, and the notations presented in section 8 refer to surface colours.

THE NEED FOR A COLOUR SYSTEM

Why do we need a colour system?

Colour is an important part of architecture and design. Colour informs and stimulates us, it defines where we shall walk or sit, and it allows us to show our feelings and our individuality, it provides cultural as well as practical and commercial frameworks. Modern society makes great demands on more knowledge and on better ways of describing colour exactly.

There are several different ways of systematizing and describing colours. To mention a few:

Colour mixing:

- CMYK which is used to mix coloured inks for printing.
- RGB which is used to mix luminous colours, e.g. on our monitor or our TV.
- Other descriptions of pigment mixtures, e.g. Itten's colour theory, Delacroix.

Colour charts, e.g.:

- RAL, a German colour collection from the 1930s particularly for industrial purposes.
- PANTONE, a printing ink chart with recipes for the printing of colours.

Physics and colour measurement:

- CIELAB, physical measurement values which are used to describe colour differences.

Colour appearance:

- Munsell, an American colour system based on the arrangement of colours according to hue, chroma and value (lightness).
- NCS - Natural Colour System®© which describes the colours in terms of their resemblance to the six elementary colours: Yellow (Y), Red (R), Blue (B), Green (G), White (W) and Black (S).

PRIMARY COLOURS AND ELEMENTARY COLOURS

In connection with these concepts, it is advisable to clarify the differences between words which are generally used about each other; otherwise there may be considerable confusion among the students.

Basic colours or primary colours
The primary colours are the basic colours - usually three - which are necessary to mix other colours within the colour range that blending the basic colours makes possible.

Colour mixtures
For pigment mixtures, it is usually said that "red, blue and yellow" are the three primary colours and from these, the secondary colours orange, lilac and green are mixed. In this context, green is a mixed colour, not a primary colour. This usually provides the basis for different theories about colour harmony.

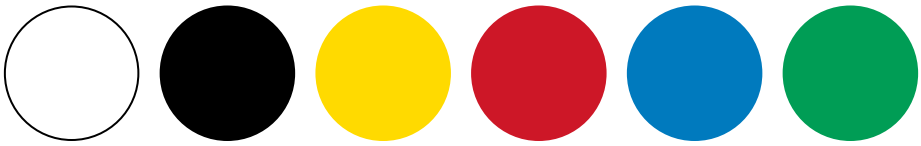
The fact that the three colours are not unambiguously defined may create a problem. If we do not start mixing with the correct three, it may be difficult to produce strongly chromatic colours of all variants.

Printing colours
In the CMYK system, the primary colours are defined as Magenta (a bluish red), Cyan (a greenish blue), Yellow (an almost pure yellow) and Black (K).

Colour on screen
For mixtures of luminous lights (display screens) there are three other primary colours. RGB indicates a red which is slightly yellowish, a reddish blue and a yellowish green, i.e. a variant of red, blue and green. This time, green is the primary colour and yellow is a secondary colour (achieved by mixing red and green light).

These are all examples of colour mixing systems, e.g. how colours can be blended in different ways.

The NCS – Natural Colour System
When, in connection with NCS, the concept of elementary colours was introduced, it was done to emphasize that this system is based on what we see (perceptually) and that it is not a mixture-based system. The six elementary colours in NCS represent the unique colour percepts yellow, red, blue, green, black and white where each colour has no visual resemblance to the other five. The elementary attributes indicate a greater or lesser visual resemblance to one, two or more of these six colours (see further section 7 *Colour Theory*).



4. SOME PROPOSALS FOR INTRODUCTORY TEACHER ACTIVITIES

Different approaches may be adopted as an introduction to the subject. Simple tasks which lead to student activity and which start conversations and discussions, may provide a good beginning to further learning.

Picture shows can have a good effect, particularly if the pictures are chosen and arranged in a way so that they follow the progress of the course and thus elucidate the different fields and phenomena which are dealt with.

A few proposals for simple themes follow here, but of course there is ample scope for using one's own experience.

COLOUR CONTRASTS

- How objects and living beings appear clearly or unclearly against the surroundings.
- The way overall patterns appear because of different clarity in the border between different surface colours.
- Signal and camouflage effects.

COLOUR CHARACTERISTICS

- How objects are recognised through their different colours (identification).
- Fruit and vegetables in different stages of ripeness. Football teams and flags in black/white and in colour, where the coloured picture gives further information about the teams and the flags.

COLOUR CREATION

- How man has used colour from time immemorial. Give a historical perspective by showing pictures of mural paintings from Pompeii, rock-paintings, masks etc. Different symbolic uses of colour from early cultures to modern liturgical and political life.
- Painted sculptures and articles for daily use.
- You can also give examples of exteriors and interiors of buildings, and different decorative and artistic uses of colour.

COLLAGE TASKS

Different coloured materials can be used in the initial work with colour grouping. It may be a simple coloured paper, scraps from newspapers or magazines.

In this stage, it is important that the students do not mix their own colours, but that they work with finished colours instead and according to what they look like. The advantage of doing this is described in the introduction to Josef Albers' book on colour science, where he writes that:

"Coloured paper prevents an unnecessary mixing of colours, something which is often time-consuming and tiring".

This does not mean that colour-mixing with different pigments is unimportant and cannot be a part of the knowledge development. But, in this basic approach, the emphasis is placed on what we see, and on arranging and describing colours according to their visual properties. This is why ready-made colours (colour samples) are so good in this context.

One task may be, for example, to find similarities between colours which cause them to be perceived as if they belong to a related group, a colour family. The students can decide themselves what criteria apply and what is important for these similarities, and arrange the colours in a collage as an illustration of the different groups.

For a more structured approach, the teacher can formulate the task in a manner similar to that used for the different exercises in the NCS study material.

The colour groups can for example be arranged according to their main attribute, more blackish than the others, more reddish etc. Or those which show a resemblance to yellow and red, to blue and red, to blue and green and so on. Groupings such as "achromatic colours" "strongly chromatic colours", "clear colours" or "deep colours" can also be used.

The collage technique is good as it lends flexibility. By adding and subtracting the groups gradually take shape. This usually results in many fine discoveries, and in a material which, later on, can provide the basis for conversations and discussions about the words and concepts which we use to describe what we see. It also provides a good background for continued work with the study material where new discoveries can be traced back to the initial collages.

5. NCS EDUCATIONAL MATERIAL

NCS educational material provides a unique possibility to work and experiment with colours based on their visual properties. The excercises have been developed during many years of experience and on the basis of scholarly research on the characteristics of colours and their visual impact.

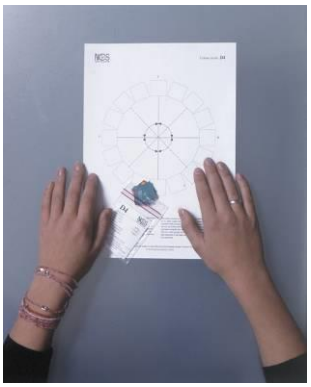
THIS IS HOW THE STUDY MATERIAL WORKS

Each exercise consists of a bag with colour samples and an exercise sheet in A4-format on which to fit the colour samples. Each exercise has its given place in the development of understanding and comprehension. The exercises progress from being easy to being more difficult and more demanding. They are most suitable for individual work, but can also be used in small groups.

Each Colour Exercise Generates Curiosity and the Desire to Discover

As soon as the colour samples in the bag are spread out, curiosity immediately arises and the student feels an urge to create order out of the chaos. Thereafter, it becomes important to put the colours "into their proper places". It is good advice to wait with the excercise sheet, so that fitting does not become the actual goal in itself. Sorting the colour samples without the pattern provided by the sheet, the student will be likely to reach greater concentration and will also experience a desire to discover. It is not until the student has a clear idea of what he or she is looking for, that it becomes meaningful to put the samples in

their places on the sheet. The actual fitting is done with the help of brief instructions on the sheet itself.



Each exercise does have a correct solution, but, in many of the exercises, the colour sample selection is such that it is easy to find alternative ways to arrange the colours. These alternatives are not, of course, completely in accordance with the "answer", but to use the exercises with a creative approach may be an exciting way to arrive at new experiences. The aim is not ”to get it right” but to train perception and the ability to see and analyse similarities and differences among the colours.

Several of the exercises are also available in different colour combinations so that the same exercise can be varied.

In the following sections, you will find concrete examples of how the exercises can be used and how the training can be organised.

Section 1 Colour Theory shows how these exercises can be used in basic colour education to learn about and train our colour perception. These exercises are a foundation for all the other exercises.

Recommendation

We recommend that the NCS Atlas is used in parallel in tuition as a supplementary demonstration material for the teacher.

Recommended Educational Packages

1 Colour Theory: 1.1, 1.2 & 1.3
2 How NCS works, Step 1: 2.1, 2.2 & 2.3
3 How NCS works, Step 2: 3.1
4 Colour Similarities: 4.1 (Hue & Nuance) & 4.2 (Blackness, Chromaticness & Whiteness)
5 Colour Contrasts: 5.1, 5.2 & 5.3
6 Advanced Colour Similarities: 6.1 (Hue & Nuance) & 6 .2 (Blackness, Chromaticness & Whiteness) & 6.3 (Final Colour Circle Test)

6. TRANSLATION KEY - EXERCISES

New & Previous exercise names

Present name	Present code	Previous code
1. Colour Theory:		
Hue Differences	1.1	D7
Nuance Differences	1.2	D8
Colour Resemblances	1.3	E1
2. How NCS works, Step 1:		
Colour Circle	2.1	D4
Colour Triangles: Red, Green, Blue, Yellow	2.2	E2
Colour Analysis	2.3: 1-4	NCS 1-4
3. How NCS works, Step 2:		
Colour Areas	3.1	E3
4. Colour Similarities:		
Colour Similarities: Hue & Nuance	4.1	
Hue Similarity		K3Φ
Nuance Similarity		K5
Colour Similarities: s, c & w	4.2	
Blackness (s) Similarity		K3s
Chromaticness (c) Similarity		K3c
Whiteness (w) Similarity		K3w
5. Colour Contrasts:		
Lightness Similarity	5.1	K1
Simultaneous Contrast: Lightness	5.2	K2
Simultaneous Contrast: Hue, Nuance	5.3	K4
6. Advanced Colour Similarities:		
Colour Similarities: Hue & Nuance	6.1	
Hue Similarity		K6Φ
Nuance Similarity		K7
Colour Similarities: s, c & w	6.2	
Blackness (s) Similarity		K6s
Chromaticness (c) Similarity		K6c
Whiteness (w) Similarity		K6w
Final Colour Circle Test	6.3	D5

7. COLOUR THEORY

Training in our basic colour perception & basic colour knowledge

Exercise material in this section:
Hue Differences (1.1), Nuance Differences (1.2), Colour Resemblance (1.3)

ELEMENTARY ATTRIBUTES

Three basic exercises which describe our colour perception should come first.

HUE DIFFERENCES (1.1)

This exercise trains the ability to see and analyse small differences in colour and leads to the four chromatic elementary properties: yellowness, redness, blueness and greenness. The exercise includes 20 colour samples.

Spread the colour samples randomly on the table, but wait with the exercise sheet.

Are these colours just any colours or are they related? What is their common feature? What distinguishes them from each other?

The student then chooses a colour which can be described according to its resemblance to red, blue, yellow or green and then we look for the colour which most strongly resembles this colour. Step by step, the colours are sorted, finding the smallest difference from the previous one.

What distinguishes the colours from each other is their relationship with two of the chromatic attributes which have been the basis of our sorting procedure, what we call the hue of the colour. What makes them similar to each other is determined by other properties, namely whiteness, blackness, and chromaticness.

In this series of ordered colour samples, several interesting – seemingly self-evident – observations can be made. The series changes character in four places, which we describe as mainly yellow, red, blue or green. From such a point of change, e.g. red, we see that redness decreases at the same time as yellowness increases in one direction and blueness in the other direction. Corresponding observations are possible around blue, green and yellow.

Thus we have found the four attributes yellowness, redness, blueness and greenness. They are called the chromatic elementary attributes of the colours and the relationship between them helps us to describe the hue of any colour.

NUANCE DIFFERENCES (1.2)

This exercise trains the ability to see and analyse small differences in nuance. It also leads to the discovery of the different elementary attributes of whiteness and blackness and the attribute of chromaticness. The latter indicates how strongly or weakly the chromatic elementary attributes appear to be present. The exercise includes 17 different colour samples.

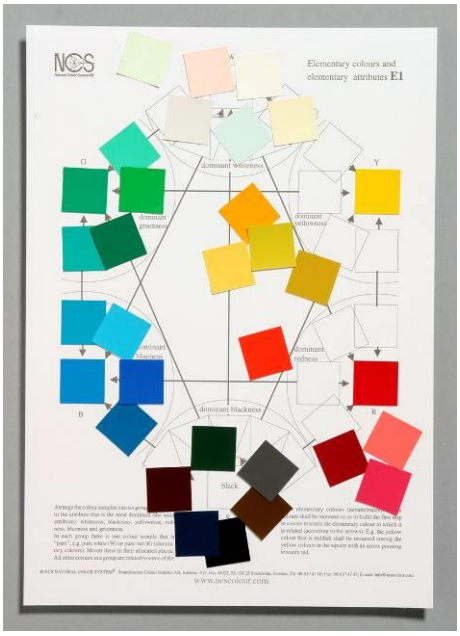
In exercise "Hue Differences", we started the process of evaluating the colours and placing them in groups according to their similarities. We can also use this method to sort the colours in this exercise "Nuance Differences" into different groups, e.g. one group of chromatic colours, and another group of non-chromatic colours, and to discover what the aspect of similarity is within each group.

Thereafter, we spread the samples again and we arrange them in a line with the smallest possible visible difference between each sample. We find the most chromatic, the most whitish and the most blackish colour, and observe that the colours vary in their degree of resemblance to these three.

In this series, we find that the character shifts in three places. From these points of change, e.g. the strongest chromatic colour, chromaticness decreases at the same time as blackness and whiteness increase in each direction.

The two non-chromatic elementary attributes, blackness and whiteness, and the property of the colour of being more or less chromatic, indicate the nuance of the colour.

COLOUR RESEMBLANCES (1.3)



This exercise trains the ability to judge the primary and secondary properties of colours and includes 32 different colour samples.

The two previous exercises demonstrated that we can see that colours are more or less similar to one or several of the basic colour percepts: yellow, red, blue, green, black and white.

In the present exercise, we utilize this possibility of sorting the colours according to their main attribute. Start by spreading all the 32 colour samples, but do not show the exercise sheet. After a while, the students realize that there are several groups, with the colours in the first place showing a resemblance to each of the basic colour percepts we could observe in the previous exercises ("Hue & Nuance Differences").

In each group, there is one colour which resembles only itself. Colours which seem to have no secondary attribute may be called examples of the colours which we perceive as basic, those which we call the six elementary colours. The other colours have secondary properties, and it can be said that they also resemble other colours. Thus, gradually, we can find affinities between colours depending on the "direction" in which they are pointing, e.g. red towards blue or red towards yellow, but also towards whitish red or blackish red.

The six elementary colours have their proper place when the exercise sheet is produced. Thereafter, the other colour samples are sorted into place and they form scales between these six.

This exercise is central to the understanding of the fundamental concept of the NCS system. The students see a greater or less resemblance of the colours to one or several of the elementary colours, and characterize the colours accordingly. Focussing on primary and secondary attributes, as in this exercise, we train to describe similarities and disparities in colours.

The exercise can be developed, by letting the students work with collages of paper, textiles or other materials. Among a multitude of colours, they should select the colours according to their primary property, those which are whitish, blackish, yellowish etc (see section 4 "Some proposals for introductory teacher Activities"). Thereafter, they continue with the colours which have no direct primary attribute. How shall they be characterized and what place shall they be given?

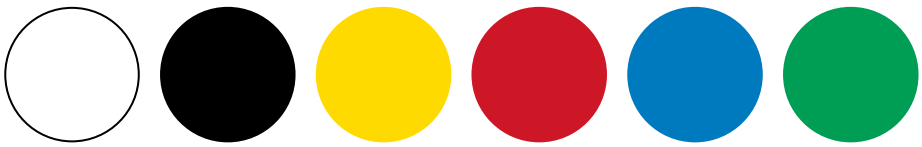
CONCLUSIONS BEFORE THE NEXT STAGE

The six elementary attributes are best represented by the so-called elementary colours. Each elementary colour is the conception of a simple colour percept which lacks resemblance to any of the other elementary colours. These are notated and described as follows:

- White W
  which is neither blackish, yellowish, reddish, bluish or greenish
- Black S
  which is neither whitish, yellowish, reddish, bluish or greenish
- Yellow Y
  which is neither whitish, blackish, reddish, bluish or greenish
- Red R
  which is neither whitish, blackish, yellowish, bluish or greenish
- Blue B
  which is neither whitish, blackish, yellowish, reddish, or greenish
- Green G
  which is neither whitish, blackish, yellowish, reddish, or bluish

The greater or lesser resemblance which other colours have with these elementary colours is a function of the elementary attributes which are designated:

- whiteness w
- blackness s
- yellowness y
- redness r
- blueness b
- greenness g



W S Y R B G

The pure elementary colour percepts cannot be produced with the help of available materials (and for this reason they are called imaginary). The colour samples in the study material are only approximate representations of these imaginary elementary colours.

8. HOW NCS WORKS, STEP 1

Training in understanding the NCS Symbols

Exercise material in this section:
Colour Circle (2.1), Colour Triangle (2.2), Colour Analysis (2.3)
Different materials for colour assessments

THE CONSTRUCTION OF THE NCS SYSTEM

All these exercises are basic to an understanding of the idea behind the NCS and the structure of the symbols with the circle and triangles. Words and concepts become defined and, with this as a basis, it is easy to understand in greater detail how the symbols describe visual phenomena and how to use NCS as a language.

COLOUR CIRCLE (2.1)

An exercise which trains the ability to assess the hues of colours and to arrange the samples in a colour circle. The exercise includes 48 different colour samples and consists of three variants.

Spread all the samples on the table and ask the students to start by sorting the colours into the different primary groups: the most whitish, the most blackish and the strongly chromatic colours. Within these groups, they then look for the four which have the hue of the elementary colours, and which will represent these in the circle symbols.

An additional task can be to find within each group the four colours which each resemble two of the chosen elementary colours to the same extent. These colours are then placed mid-way between the elementary colours.

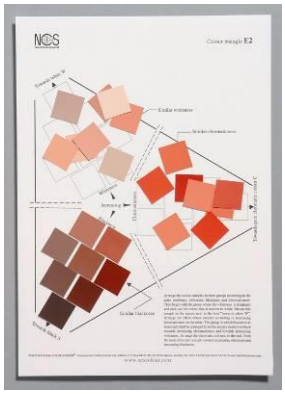
These eight colours in each group are placed on the excercise sheets when they are handed out. Thereafter, the remaining samples are placed in their respective circles.

Before the colour samples are glued into position, the students can take the colours which have the same position on the three different templates and study the similarities between them. The three colours vary in whiteness, blackness and chromaticness but have the same relationship with the two chromatic elementary colours. They are alike in hue, which is the object of this exercise: to arrange colours according to hue.

The three circles are equally large, and an important point is that, regardless of its relationship with whiteness, blackness and chromaticness, a colour has its

given place in the colour circle according to its hue. As an alternative, the samples can also be glued onto the same template, but with the samples slightly overlapping, on the same hue.

COLOUR TRIANGLE (2.2)



An exercise with 24 colour samples which trains the ability to assess the nuance of a colour and to arrange the colours in a colour triangle. The exercise is available in four different versions: yellow, red, blue or green.

The appearance of a colour is characterized both by its hue and its nuance. This exercise focuses on the nuance and arranges 24 different colours with the same hue in relation to whiteness, blackness and maximum chromaticness.

The students can work with different hues since 4 different versions of this exercise are available. Begin by spreading the colours so that they can be preliminarily sorted. Again, we sort according to the primary character. We then pick out the eight most blackish, the eight which are most whitish and the eight colour samples which are most chromatic.

When the exercise sheet is distributed, the most whitish colour is placed against white (W), the most blackish against black (S) and the most chromatic against the maximum chromaticness (C). The four least chromatic colour samples are placed from the most whitish to the most blackish along a scale which is parallel with the grey scale - the perpendicular scale between black and white on one side of the triangle.

In the same way, the four colour samples which are only slightly whitish, i.e. those which almost completely lack any resemblance to white, are placed in the blackish group and in the strongly chromatic group, These have their place on a scale between black (S) and the maximum chromaticness (C). The last group consists of four colour samples which lack practically all resemblance to black and these are placed on a scale between white (W) and the maximum chromaticness (C). This leaves three colour samples in each group. The first is more whitish than the other two, the second is more blackish and the third is the most chromatic. These samples are placed in the direction of the dominating property.

Using this step-by-step method, the scales of the triangles and the position of the colours are illustrated according to the attributes of whiteness, blackness and chromaticness. From a "chaos" of 24 different colours, we now see gradual transitions, where each colour has a given place in accordance with its nuance. It is well worthwhile to give this exercise sufficient time so that it does not become merely a colour puzzle.

Before the samples are glued onto the exercise sheet, the students can pick out samples which lie on the same scale in the four different versions of the exercise, i.e. the six colours which lie parallel with the grey scale. All these colours are different, but they have something which draws them together, they are alike in chromaticness. In a corresponding way, other scales can illustrate examples of colours which are alike in whiteness (close to the S-C scale) or alike in blackness (close to the W-C scale). This will be studied more deeply in the exercises "Hue, Blackness, Chromatiness and Whiteness Similarities".

It is also possible to group together colours which are alike in nuance, i.e. colours which have the same position in the triangles, regardless of hue. The exercise "Nuance Similarity" deals with this.

NCS NOTATION

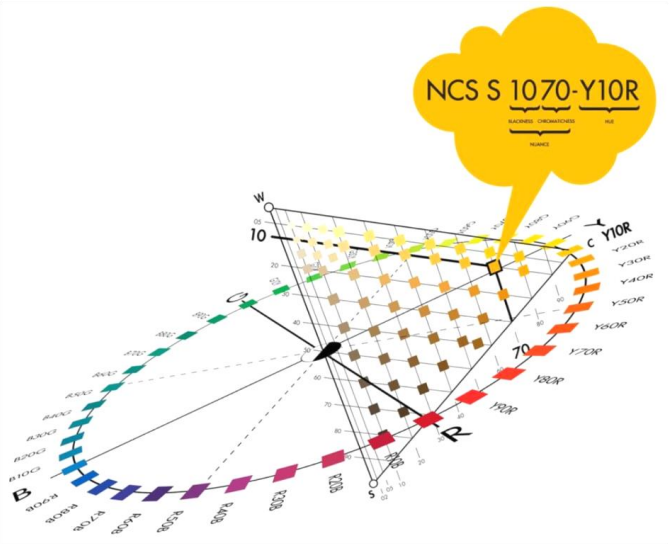
For a more exact assessment of colours and for greater precision, it is necessary to give each colour an unambiguous notation.

In NCS, the nuance of the colour is indicated by a number combination which describes the degree of blackness and the degree of chromaticness.

The hue is indicated with an alphanumeric code (e.g. R20B) which describes the relationship of the colour to its two chromatic elementary attributes (exercise Hue Similarity).

The blackness (s) is indicated by a number from 100 (pure black) to 0 (white).

The chromaticness (c) likewise is indicated by a number 100 (maximum chromaticness) to 0 (the grey scale which lacks chromaticness). The nuance of the colour is the sum of blackness, whiteness and chromaticness (= 100), but only the blackness and chromaticness are used in the notation, since the whiteness is the remainder making the total 100.



The blackness is indicated by the first two digits and the chromaticness by the last two digits.

NCS S 1070-Y10R

The colour notation S 1070-Y10R means that the colour has:

- 10 percent similarity to black.
- 70 percent similarity to the maximum chromaticness.
- 20 percent similarity to white (that which remains up to 100, but which is thus not written out).

Thus the notation describes a colour which is slightly blackish and high chromatic.
The hue is indicated with a scale (from 0 to 100) between two chromatic elementary colours in the colour circle (Y to R, R to B, B to G, G to Y). The colour notation above has:

- 90% yellowness Y
- 10% redness R

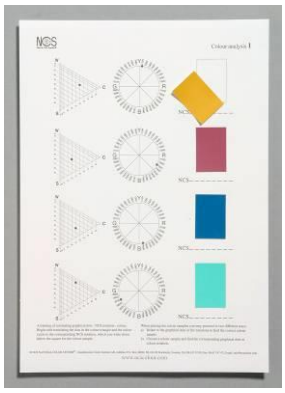
Thus, this is a colour which is yellow with a small amount of red.

The S before the notation indciates that the colour sample is a standard sample, which means that it is part of the complete NCS colour sample collections of 1 950 colour samples.

Training in colour notations can be carried out in the next exercise "NCS Colour Analysis", which trains the ability to describe colours visually with the help of the NCS system.

COLOUR ANALYSIS (2.3: 1-4)

In this exercise, all the colours are in the same bag, but the students should be instructed to wait with number 4 and begin with the others.



Start by distributing the exercise sheets number 1-3, and let the students write down the NCS notations in the intended places on each sheet so that they therafter can associate the different colour samples with its notation.

Now distribute the colour samples and try to find the 12 samples which fit the different markings on each of the 3 sheets.

Bag 4 contains the advanced version of this exercise with colour samples which lie between existing standard colour samples, i.e. they do not lie on the even 10-steps which most

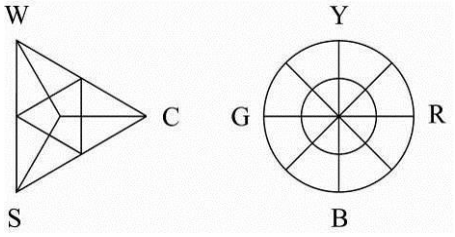
NCS samples usually do in the colour sample collections. Nevertheless, they can be indicated and described with NCS notations. A colour can, for example, have the notation 2248-Y95R, which means that it is slightly more blackish and less chromatic than 2050, and that it is slightly redder than Y90R and slightly more yellow than R.

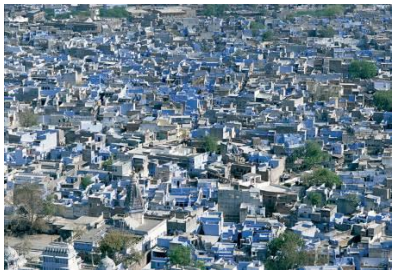
Note! The key is inside the bag. Before distributing the material for the exercise, the teacher should remove these answers to be saved until they are required when going through the results the students have achieved.

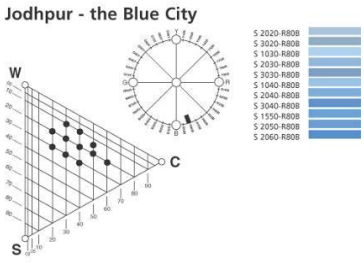
It may be valuable to have a complete colour sample collection when this exercise is carried out (the NCS atlas or even the NCS index can be a great help), so that the students can compare and see between which standard samples the special samples of the exercise lie.

The exercise can also be carried out in small groups so that the students can discuss with each other to find a solution.

With a little training, the student will soon learn to "characterize" colours without the help of other colour samples. Let the students make regional assessments of different colour samples in e.g. yarns, textiles, wallpapers, papers etc and mark the location of the colours in the colour circle and in the colour triangle.







This analysis of the blue colours of the City of Jodhpur, India is an example to show how the newly derived knowledge from this exercise in combination with the NCS can be used to analyse and map local colour schemes in architecture and city planning.

9. HOW NCS WORKS, STEP 2

Training in colours dominant and secondary attributes

Exercise material in this section:
Colour Areas (3.1)

NCS COLOUR AREAS & CATEGORIES

We all know that colours are different and they can be characterized into different colour categories/areas according to their dominant (main/primary) and secondary attribute. An example: The colour S 1555-R70B has a hue dominance of 70% blueness (R70B) and has a nuance dominance of 55 % chromaticness. The secondary attributes are 30% red in the hue and 30 % whiteness in the nuance. Read more about NCS Elementary Attributes page 22.

COLOUR AREAS (3.1)

This exercise collects and repeats what we have learnt from the previous exercises about the colour circle and the colour triangle. In this exercise, 56 different colour samples are arranged in a manner which trains the ability to judge both hue and nuance in the NCS Colour Category Scheme.

This exercise, just like others, begins with a preliminary sorting of the samples according to their primary attributes, three groups containing the whitish, the blackish and the strongly chromatic samples respectively. In addition, there are eight colour samples which have no primary attribute, but which are as whitish and blackish as they are chromatic. With all the colour samples spread, it may be a good idea to begin by searching for these eight samples.

The whitish group (16 colour samples) is then divided into two smaller nuance-alike groups: one with pale colours and another with clear, non-blackish colours. The strongly chromatic group is also divided into two smaller ones: one with whitish chromatic colours and one with blackish chromatic colours. The final group of blackish colours can also be divided into two: one group with greyish-black and one with strongly black colours.

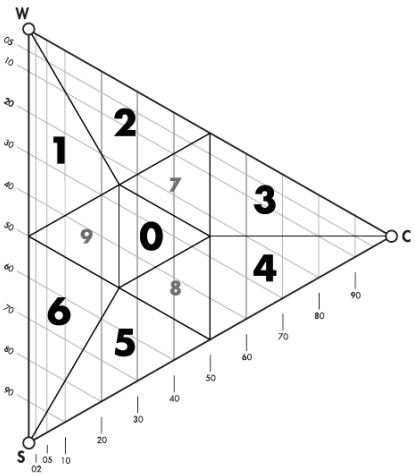
Note! Helpful exercise material to this exercise is to use a black A4 sheet as a background for the blackish colours and a white paper for the whitish colour samples.

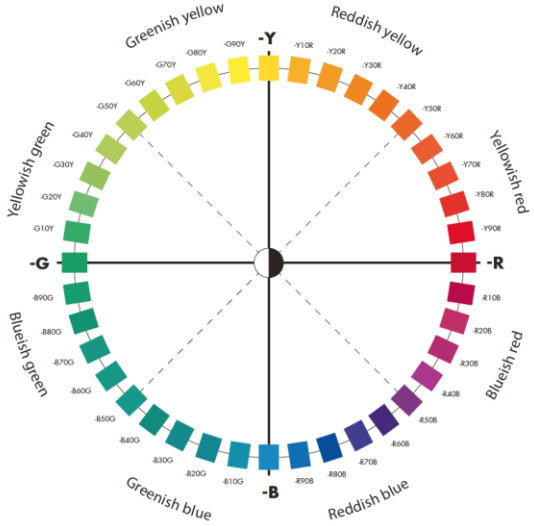
When these seven groups have been clearly established, the exercise sheet can be taken out. On this sheet, the nuance range is indicated at the top and the hue range on the left-hand side.

Colours which are alike in nuance are placed vertically in the correct hue range as indicated on the left-hand side. The colours which are alike in hue will thus be placed horizontally.

On the exercise sheet, the hue areas are numbered from 1 to 8, while the nuance areas are numbered from 1-6 and 0.

If the colour circle is divided into hue areas (categories) and these are numbered in accordance with the Colour Areas exercise sheet, we see e.g. that colours for which the yellowness is greater than the other chromatic attributes can be placed in area 1 (Greenish yellow) or 2 (Reddish yellow). If the secondary property is greenness, area 1 applies and if the secondary property is redness, area 2 applies. In a similar way, all the colours can be placed in their respective area, the so-called hue areas.



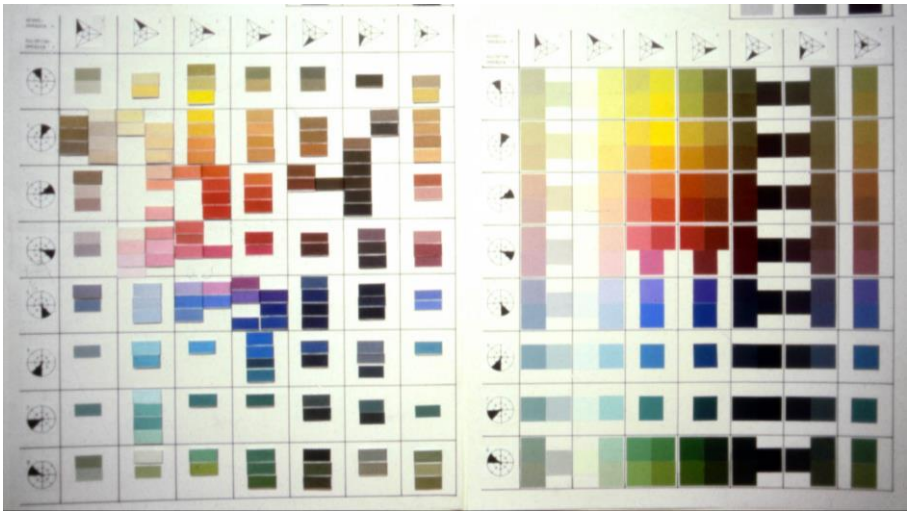


In order to describe primary and secondary attributes with respect to whiteness, blackness and chromaticness, we must use the colour triangle which is divided into nuance areas (categories) in a corresponding way. For example, colours which are chiefly whitish are placed in area 1 or 2, and the secondary attributes blackness and chromaticness determine in which of these areas the colour shall be placed. If the secondary attribute blackness dominates over the chromaticness, the colour is placed in area 1. If the secondary attribute chromaticness dominates over the blackness, area 2 applies.

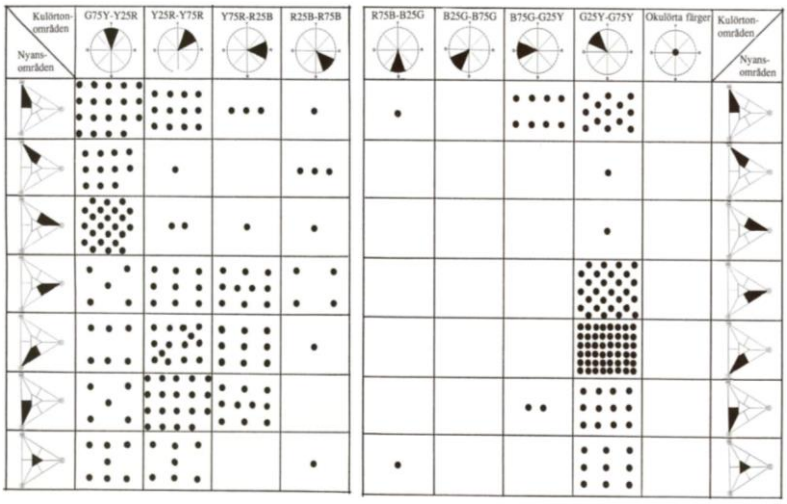
We have seen that the colour circle and the colour triangle can be used to describe colours in a simple way.

COLOUR AREAS IN PRACTICE

This way of placing and arranging the colours can also be used to sort and analyse a colour selection for a product or a collection, e.g. ceramic tiles, knitting wool, or cosmetics. With the NCS Category Scheme you easily find the distribution of colours in a colour assortment. You can see in which colour areas colours lacking and in which ones there is a good distribution already.



Analysis, based on the NCS system, of a company's sewing thread assortment.



Nature´s Colour Palette analysed in the NCS Category Scheme by Karin Fridell Anter.

10. COLOUR SIMILARITIES

Training in visual similarities among colours

Exercise material in this section:
Hue, nuance, blackness, chromaticness & whiteness similarities (4.1 & 4.2)
Demonstration material: NCS Atlas

COLOUR SIMILARITIES (4.1 & 4.2)

Studying the NCS Colour Space, one finds a number of properties which are easily identifiable as similarities of hue, nuance, blackness, chromaticness, and whiteness. One can easily study how these similarities between the colours affect the expressive quality of a colour composition. These visual colour attributes have become important tools in the colour design process.

Swedish research studies by Hård/Sivik (1989) suggest that compositions of colours with one or more of these formal similarities, also tend to be more highly appreciated (more harmonious) than others. With a visual colour system like NCS you can quickly find these harmonious colour combinations and which can bring some order to the infinite number of possible combinations of colours. It does not take away intuition and creativity, which needs some systematically way of working when investigating different colour combinations.

The basis of these 5 similarity exercises is the grouping of colours according to different criteria. The exercise consists of 5 x 12 colour samples each.

Each exercise contains 12 colour samples which represent three groups of four colours which have a related similarity with each other, according to the sorting principle which is to be illustrated.

The 12 colours can be arranged in several different ways. One variant can also be to cut the samples diagonally into two parts, and find an individual design solution with this combination inside each group.

HUE SIMILARITY (4.1 Hue)

The 12 samples in this exercise have all been taken from the same scale between two elementary colours.

First find the three groups with four colours which are alike in hue, i.e. have the same relationship to the two elementary colours. For example, in the scale between R and B, four samples have more redness than blueness, four have the same amount of blueness as redness and four samples have more blueness than redness.

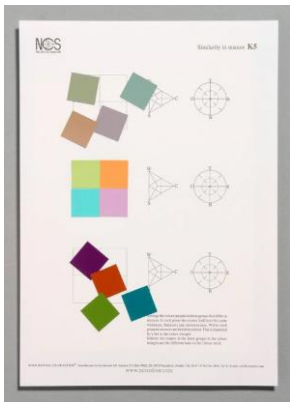
In the symbols on the exercise sheet, it is important to note what applies for the colours. Since the colours are alike in hue, they will generally have the same place in the circle while they have completely different places in the triangle, since they have different nuances.

This indicates "the correct" solution, but before they are fitted onto the sheet, the student can try to group the colours in other ways, e.g. into four groups with three colours which are alike in nuance in each group.

We could have sorted the colours into four groups with three colours in each group. But then, likeness in nuance would have been the criterion, and we shall look further at this aspect in the next exercise Nuance similarity.

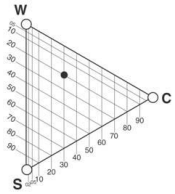
NUANCE SIMILARITY (4.1 Nuance)

When the degree of resemblance to black, white and the chromatic maximum is the same for several different colours, they all have the same nuance. It is fairly easy for the students to arrange these 12 colours into three different groups since the similarities between them are so obvious.



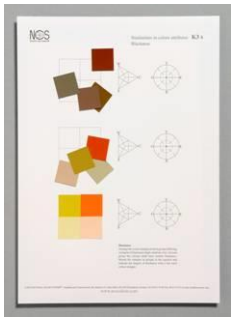
Within each of the groups, that gives the same position in the triangle. If we mark the hue of the colour samples in the circle, we see that they are extremely different (but in groups of three, they have the same hue).

In this exercise, the chosen hues are close to the middle of each of the four scales on the circle (Y – R – B – G), in order to emphasize that, even with such great differences in hue, colours can still be grouped together.



Colours which are alike in nuance have the same position in the triangle, regardless of their hue.

BLACKNESS SIMILARITY (4.2s)

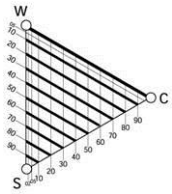


The nuance of a colour is the composition of blackness, chromaticness and whiteness. We will start with the blackness. These colours are to be grouped in accordance with their similarity to blackness. The four colours in each group have several differences; they have different hues, different degrees of chromaticness and different degrees of whiteness, but their similarity to black is the same.

This principle can be difficult to understand directly, but

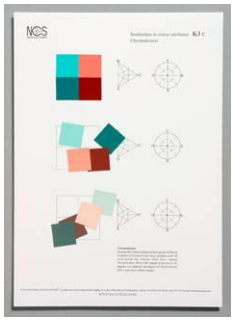
if the teacher explains clearly which criterion the students are looking for, the groups will appear gradually.

When the colours within each group have been marked in the triangle, we see that colours which are alike in blackness are placed on the scale in the triangle parallel to the scale from white to the maximum chromaticness. The less blackish, the closer are they to this clear scale.

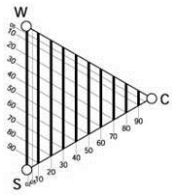


CHROMATICNESS SIMILARITY (4.2c)

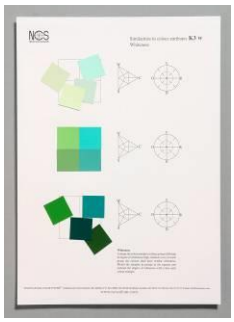
The colours are sorted in accordance with their similarity to maximum chromaticness. Three groups provide three degrees of chromaticness. The most strongly chromatic colours are far from the maximum colour, and the weakest colours are not completely achromatic. Within each group, the colours differ in hue, whiteness and blackness, but chromaticness is the attribute which they have in common.



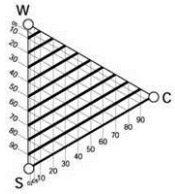
Colours which are alike in chromaticness have a place in the triangle on scales parallel to the grey scale. The less chromatic the colour is, the closer it is to the vertical W-S scale (the grey scale).



WHITENESS SIMILARITY (4.2w)



In the bag containing colours which are alike in whiteness, there are colour samples with different similarities to white. The students should first find the three groups of four colours each where the similarity to white is perceived to be similar. Within each group, there are two hues which vary in chromaticness and blackness. There is a lot which separates the colours but it is the similarity to white which they have in common.



Colours which are alike in whiteness have a place in the triangle on the scale parallel to the scale between black and the maximum colour. The less whitish, the closer they are to the S-C scale.

In the NCS notations, we already met these experiences. The degree of resemblance to black and the chromatic maximum is indicated in figures which

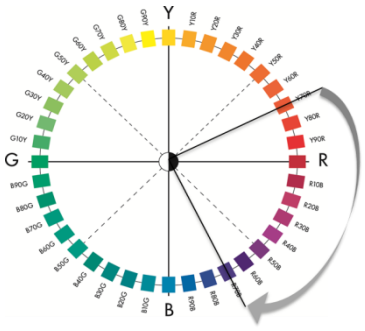
describe the nuance of the colour, and the hue is given as the relative similarity to two chromatic elementary colours. See further: Section 8 How NCS works, Step 1.

OTHER COLOUR SIMILARITIES USING THE NCS ATTRIBUTES

The already examined similarities in hue, nuance, blackness, chromaticness and whitenes are NCS elementary attributes, and are naturally find in the NCS Colour System. You find these associated exercises in the Educational material.

The NCS System gives many other opportunities to experiment with colour combinations and harmonies. You can choose two colours with the same amount of blueness (60%) like R60B and B40G.

Close related colours is another way of combining colours and is common in colour design. Close related colours are colours which are within 10 steps in the colour circle.



They don't need to be placed in the same quadrant between two colours like R and B. They can start wherever on the circle, but you have to keep the maximum distance of ten steps. You can also vary the nuances.

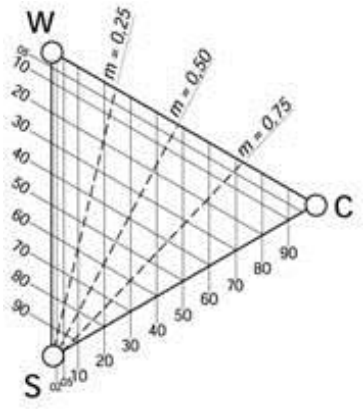
There are also other colour similarities that can be defined in the NCS System though they are not an attribute of the NCS System.

SATURATION SIMILARITY

There are different definitions of the visual attribute saturation. Historically, and especially among artists, saturation means a colour which is strong chromatic. Today however we can find many different colours named saturated colours. It is a lot of your personal preferences.

Find here two definitions of saturation:

- Saturation in general
  the chromaticness/colourfulness of a colour percept judged in proportion to its brightness
- Saturation defined in NCS
  attribute of a chromatic colour percept expressing the relationship between its chromaticness and whiteness.
  This is the same definition as an artist when he/she is working with a shadow series in a painting.



Similarity in saturation – like similarity in hue – is a similarity which describes a constant relationship between two properties. In this case, it is connected to the relationship between chromaticness and whiteness.

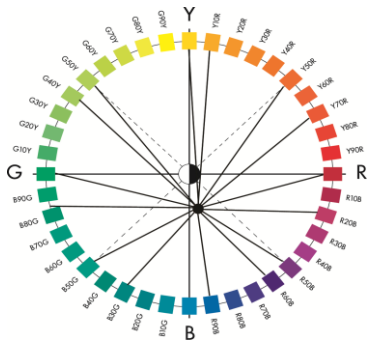
Colours which are alike in saturation have a place in the triangle on a straight line from S to a given place on the scale between W and C. The saturation, which is designated by a lower-case m, is expressed by m = c/(c+w) or m = c/(100-s).

An example: 4030-Y90R has m = 0,5 and 6020-Y90R has m = 0,5.

COMPLEMENTARY COLOURS

Complementary colours are defined in many different ways in literature and reference works. When described as after images you will find them when straight lines are drawn between the pairs of perceived hues of complementary colour stimuli, they all intersect in a point with the approximate position chromaticness = 20, hue = R75B

Complementary colours are a concept which is considered to play an important role in colour aesthetics but which is defined in many different ways in literature and reference works.



If, in the NCS Colour Circles, straight lines are drawn between the pairs of perceived hues of complimentary colour stimuli, they all intersect in a point with approximate position c=20 and the hue=R75B. So they are not exactly opposite colours in the circle since the point is not in the centre of the circle.

This is because NCS is not constructed according to the complementary colour theory. Experiments have shown that if you define complementary colours according to after images the colours will intersect this specific point

11. COLOUR CONTRASTS

Training in colour phenomena and colour influences

Material in this section:
Exercise material: Ligthness similarity (5.1),
Simultaneous contrast: Lightness (5.2) & Hue, nuance (5.3)
Demonstration material: NCS Lightness Meter,
NCS Atlas, NCS Navigator

COLOUR CONTRASTS

These three exercises train the ability to record and explain different colour phenomena and how colours are influenced by each other. The exercises give a deeper understanding of the similarities and differences between colours and clarify the different colour phenomena which arise in certain situations.

LIGHTNESS SIMILARITY

In exercise "Lightness Similarity", we will meet the phenomenon of lightness, and along the grey scale in the triangle, we can generally use the word "lightness" in the same way as we use the word "whiteness". In a chromatic colour, however, the concept of lightness describes something else, and it is important that the student develops a clear understanding of the difference.

Whiteness and blackness are elementary attributes which we can judge in accordance with the built-in references which we have about what is white and what is black. Lightness in this context is not an elementary attribute, but a relative attribute. A colour can be light in relation to one colour and dark in relation to another. We need a scale to be able to make a comparison. In contrast to its being a scale in the triangle which describes the transition between white and black, we can regard a grey scale as being the transition from the lightest of all colours, white, to the darkest, black.

LIGHTNESS SIMILARITY (5.1)

Among the 24 colour samples in this exercise, there is a group of achromatic samples between white and black which can be arranged in a grey scale having eight steps. This can be used as a lightness scale.

The chromatic colours are linked together with this scale by placing each colour directly in contact with the grey colours, making an assessment of how clearly we perceive the borderline between the two colours. Where the border is least distinct, we say that the colour has the same lightness as the grey scale sample.

When all the colours have been arranged in this way, we see that on each step in the scale there are colours with different hues and different chromaticness. Colours which are placed on the same step on the grey scale in this way have the same lightness.

Here, it is possible for the students to arrange the colour samples so that the strongest chromatic colours are placed at the right-hand edge of the exercise sheet, while the weakest chromatic colours are close to the grey scale. Among the strongly chromatic colours, we see that the position of the yellow colour is highest up in relation to the grey scale while the red and the blue are placed further down. These strongly chromatic colours have different lightness values, although they have the same whiteness value.

We also see that in the next to uppermost row there is a strongly yellow and a very whitish slightly chromatic blue colour. The yellow and blue colours are completely alike in lightness although there is a large difference in nuance.

Lightness is not the same as whiteness. Whiteness and blackness are quality attributes in the same way as yellowness, redness, blueness and greenness which will characterize a colour. Lightness is not a quality of a unique colour but can be determined by comparing it to a grey scale or through instrumental measurement. A yellow colour has an inherent lightness and a blue colour has an inherent darkness.

LIGTNESS IN PRACTICE

Since the lightness is not an elementary attribute, it is not described by the NCS notation nor is it directly indicated by the NCS symbols. In the NCS Atlas, the colours which are alike in lightness are indicated with lines in each colour triangle. The NCS lightness value is indicated with a ν in the NCS Atlas between W and S on the left hand side of the triangle. There is also a lightness scale (NCS Lightness Meter) with 18 different steps which is a good aid in assessing the lightness of different colours.

A difference in lightness between two colours is probably the most important factor contributing to the visual experience of a pattern or a form. Ligthness shows how two colours contrast to each other. It is also vital for the design and colour schemes of exterior and interior environments, not least for weak-sighted persons (e.g. the elderly) who need lightness contrast between different surfaces to be able to orientate themselves.

Requirements concerning lightness contrasts

Sweden has stipulations for lightness contrasts in public buildings and public places. A lightness contrast of at least 0,40 (differences in lightness value ν) as per NCS enables many visionimpaired persons to perceive a marking. Skirting boards, door frames, handrails and handles are examples of details which can be used as contrast markings. The shape of a room should be made clear by marking the point of contact between wall and floor.

SIMULTANEOUS CONTRAST/INDUCTION

When we use coloured materials together (in advertising, patterns, interiors etc), it is often found that the colour appearance of a material changes due to the influence of surrounding colours. A very light colour sample is perceived to be whiter when it is placed against a black background. If we place the same light colour sample against an even lighter background than the sample, the colour sample appears to be darker. In other situations, the hue may change.

A bluish-green sample which is placed against a blue background is perceived to be green, while the same sample against a green background is perceived to be bluer. This phenomenon is called contrast amplification or induction (in this case hue induction, since the hue changes with different backgrounds). The phenomenon of induction affects all the elementary attributes, i.e. also chromaticness, whiteness and blackness.

The simplest way to describe the phenomenon is that the colours strive to move away from each other - to increase the difference which exists. It is then easier for the brain to distinguish between and separate the samples.

The smaller the difference between two colours, the greater is the contrast amplification. If the difference between two colours is very large, we perceive hardly any contrast amplification at all.

COMPENSATION FOR CONTRAST AMPLIFICATION

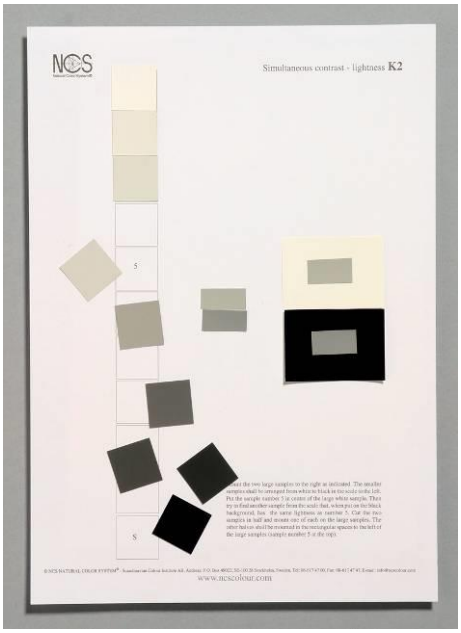
If we know how induction works, we can compensate for its effects and choose the correct colours to obtain a desired result, i.e. so that the colours look alike against different surrounding colour surfaces.

If, for example, we want a grey colour seen against a white background to look the same against a black background, we must choose a darker grey colour against the black background.

If, for example, we want a bluish-green colour seen against a blue background to look the same as a bluish-green colour against a green background, we must choose a colour which is less green and place it against the blue background.

SIMULTANEOUS CONTRAST: LIGHTNESS (5.2)

This exercise includes 11 small and two large colour samples.

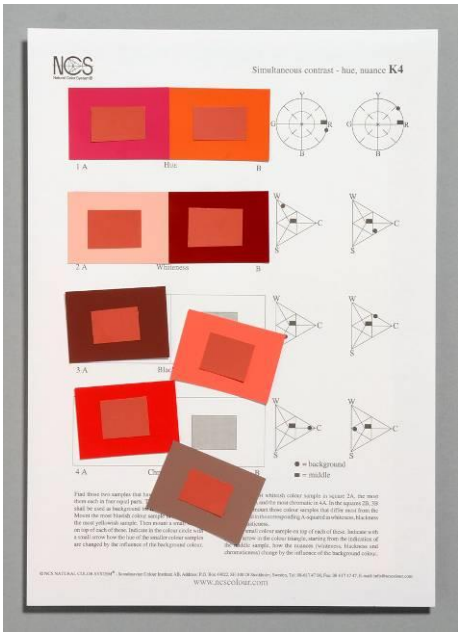


Start by gluing the two larger colour samples, white and black, onto the exercise sheet. The 11 small samples are then to be arranged on a scale from white to black. Before they are glued onto the sheet, the students can experiment by chosing colour sample no 5 and placing it on to the large white sample. Continue by testing which of the other small colour samples look alike regardless if they are placed against a white background or a black background.

We thus see that the background leads to a change in the colour. Against a dark background, the colour becomes lighter and, against a light background, it becomes darker. But we also see that the colour looks more whitish against the black background and more blackish against the white one. The different degrees of whiteness and blackness which we register can be described by the grey scale of the triangle.

SIMULTANEOUS CONTRAST: HUE, NUANCE (5.3)

This exercise contains 10 large colour samples, two of which are identical.



The students should begin by cutting these two each into four parts, which gives eight test pieces of the same colour which can be placed against different backgrounds.

Eager students gladly solve the puzzle on their own following the markings in the symbols on the exercise sheet, but for a deeper study, it is better to proceed step by step.

Of the eight remaining colours, six are alike in hue, and two of them deviate in hue.

The bluish-red sample is placed in the left-hand square and the yellowish sample in the right-hand square (follow

the markings in the circle). When one of the test pieces is placed on these, we see that its hue changes from what it was originally. The student should indicate with arrows in the circle what has happened in relation to the original colour.

The next example shows a nuance change. The student should place the strongly whitish colour in the square to the left, and the colour which lacks whiteness and lies on the scale between black and maximum chromaticness in the square to the right. If one of the test pieces is placed on top of these, the student sees what happens to the whiteness and indicates this with arrows in the triangle.

In the next exemple, the blackish colour is placed to the left and the clear, chromatic colour to the right. Here, the student sees how the blackness in the small test piece is affected and can describe this with arrows in the triangle.

In the last row, the student sees changes in chromaticness with the strongly chromatic colour placed to the left and the slightly chromatic colour to the right. The student draws arrows to indicate how the chromaticness is changed.

In these tests, the student understands that the difference between the colour of the surroundings and the colour field inside it is increased. These changes can be illustrated graphically in the symbols for hues and nuances on the template.

12. ADVANCED COLOUR SIMILARITIES

Training in high ability to distinguish between colours

Material in this section:
Exercise material: Hue, nuance, blackness, chromaticness, and whiteness similarities advanced (6.1 - 6.5)
Final colour circle test (6.6)
Demonstration material:
An NCS Atlas can be a support for the teacher

These exercises are advanced tasks in analysing and grouping colours according to visual similarities within a certain group.

The degree of difficulty in these exercises is considerably greater than in the previous exercises, and it is therefore important that the teacher/course-leader is thoroughly acquainted with the material so that he/she can guide and correct the students' work.

The way the material is composed; there are many different possible ways of sorting the samples. This results in a deeper understanding of the characteristic appearance of the colours, at the same time as it leads to a better understanding of the content of the symbols. NCS notations for the different degrees of similarity are indicated in the text so that the teacher may acquire a larger understanding of the attributes which the NCS notation describes. The differences in degree and relationship are thus given a verbal expression, at the same time as the colour similarities within the groups become verbally and visually understandable.

Alternative solutions are proposed for each exercise. The degree of difficulty varies, and it is the level of attainment of the target group that determines what is the most appropriate.

HUE SIMILARITY, advanced (6.1 Hue)

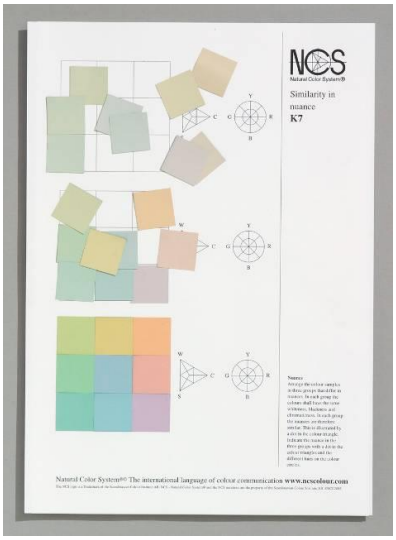
An exercise with 27 colour samples that can be tackled in a variety of ways:

Alternative 1
The 27 colours can be sorted into three groups, within each of which the colours have the same hue.

The difference in hue between these groups is small: R90B, B and B10G. The student should nevertheless try to make a direct grouping in accordance with the similarities that can be seen in the relationship between blueness, greenness and redness in the colours.

Alternative 2
The students sort the colours into nine different groups according to nuance, so that in each group the three colours have the same degree of similarity to white, black and chromaticness. In a direct comparison between these three, it is relatively easy to see which hue they have, and to group them into three grids with colours which are alike in hue.

NUANCE SIMILARITY, advanced (6.1 Nuance)



The exercise contains 27 different colour samples.

This type of similarity is perhaps the one that is most spontaneously perceived. The student can sort the samples directly into three groups which are alike in nuance, without any other valuation than the similarity which the colour exhibits to whiteness, blackness and chromaticness. The three nuances are 2005, 2010 and 2020.

Each group contains nine different hues. A possible starting point for the students can be to find these nine different groups, each containing three hue-alike colours.

This is particularly difficult in the whitish and the slightly chromatic groups, but a trained eye can do this in a direct comparison between the colours.

BLACKNESS SIMILARITY, advanced (6.2s)

Alternative 1
The students begin by spreading all the colours, and looking at their different degrees of similarity to black. The nine most blackish colours are placed in one group, the "medium" blackish in a second group, and the remaining nine which are only slightly blackish in a third group.

Further to this primary sorting, the colours in each group are placed in those squares on the exercise sheet that are most appropriate considering the similarity in hue and similarity in chromaticness.

This exercise is difficult, but given it time, the

students will learn how to do it. When the sorting is completed, the different groups show degrees of similarity to black which are: s = 40, s = 30 and s = 20.

Alternative 2
The students begin by sorting the colours into three main groups, a red, a blue and a yellow group with nine colours in each.

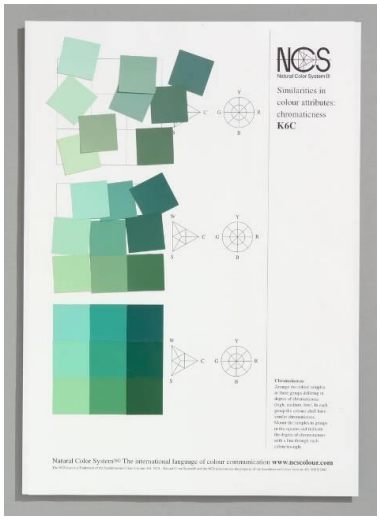
The students then find the three sub-groups of three colours which are alike in blackness in each of these groups, the three least blackish, the three medium blackish and the three most blackish.

The difference in blackness is relatively small so it may be easier for the student first to select the three least chromatic colours in each group, e.g. the blue group, and arrange them according to their similarity to black.

The students can then do the same with the red and yellow groups, and determine the degree of blackness.

The three colours in each hue group which are equally blackish are now placed in each square, so that the nine colours which lie in the same group represent three different hues and different degrees of whiteness and chromaticness, but they are related by sharing the same degree of similarity to black.

CHROMATICNESS SIMILARITY, advanced (6.2c)



Alternative 1
The students begin by finding the nine colours which appear to be the least chromatic (almost grey). The strongest chromatic colours are then sorted into a second group, and the medium chromatic colours into a third.

It is very difficult to distinguish between these degrees of similarity to the maximum chromaticness since the differences between the three groups is very small: c = 40, c = 30 and c = 20.

After having collected the colours in the three groups, it is possible to see that it is the degree of chromaticness that separates the groups from each other. The hue, whiteness and blackness separate the colours within each group, but the colours are related through the attribute of chromaticness.

WHITENESS SIMILARITY, advanced (6.2w)

Alternative 1
The students find the nine colours which appear to have the greatest degree of similarity to white, nine colours that have practically no similarity to white and the nine which are "medium" whitish. The degree of similarity to whiteness is what makes the colour belong to one of the three groups of related colours, although they vary in hue, blackness and chromaticness.

Alternative 2
The student should first sort the 27 colours into three groups which are alike in hue: bluish-red, greenish-yellow and bluish-green. From each group, the student then chooses the three most whitish which are placed in a square grid. The three least whitish colours are placed in another square grid and the remaining three in a third grid.

Note that the difference in the degree of similarity to white is very small: w = 50, w = 30 and w = 20, and it is the degree of similarity to white within each group which is the same for the colours in each square grid, although they vary in hues, blackness and chromaticness.

Alternative 2
The 27 colours are close to each other in hue, and the students begin by sorting them into three groups which are alike in hue: the most bluish in one group, the most greenish in a second and the most bluish-green in a third group. This may prove difficult for the weakest chromatic colours.

The students then find the three least chromatic colours in each group and place these together in one of the square grids, followed by the three most strongly chromatic colours in another and the three medium chromatic in a third.

Before the colours are glued in place, it may be a good idea to move a colour from one of the groups to another group in order to see to what degree this colour is perceived to contrast in chromaticness with the rest of the group.

FINAL COLOUR CIRCLE TEST (6.3)

The exercise includes a total of 121 different colour samples with an excercise sheet in A3-format. It is the largest and most exacting exercise, which a trained eye even may have difficulty with. A very absorbing exercise, it may favourably be solved in small groups, where the students can discuss and help each other.

It is important that the students should have plenty of time and that a strategy be devised before starting the exercise. The following proposals usually work well.

After spreading all the 121 colour samples on the table, the students try to find the colour sample which is the most achromatic and place it in the middle of the exercise sheet. From the "chaos" on the table, they then choose the 40 most strongly chromatic colours (c = 60). They are alike in nuance, i.e. equally slightly blackish and slightly whitish. Then search for the four samples which best illustrate the chromatic elementary colours and place them in the indicated corners, then place the remainder of the colours along lines between these four.

The next group consists of 32 colours which are also alike in nuance, but are less chromatic and more whitish than the first group. The students then place these inside the first group. Note that the middle and corner colours in the two groups shall be alike in hue.

The next group of 24 colours is slightly less chromatic and slightly more whitish than the previous group. Among these, it can be an advantage to take the eight least chromatic colours and place them around the grey colour in the middle.

Thereafter, the last group of 16 colours can be put into place.

In order to check the result, imagine a diagonal line, and a line from the medium colour on each scale towards the grey sample in the middle. Are they alike in hue?

This exercise can create both merriment and anxiety, but it usually provides great satisfaction for the students to transform the chaotic collection of colours with which they start into an order with a pleasing transition from strongly chromatic to grey. In addition, the exercise trains to a high degree each student's ability to distinguish between colours, to set words to similarities and differences, and to arrange the colours systematically.

13. REPETITION & NCS NAVIGATOR

Material in this section:
Exercise material: Colour Areas,
Different chromatic materials (e.g. textile samples, wallpapers)
Demonstration material: Colour Areas, NCS Colour Atlas, NCS Navigator

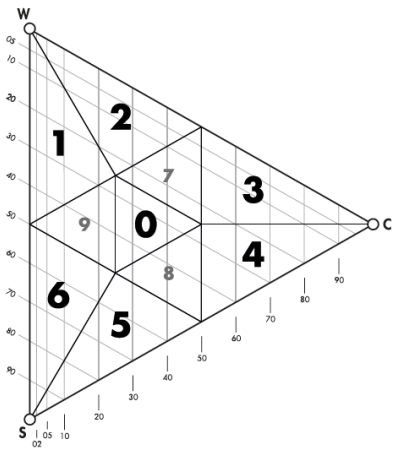
It is appropriate that the training in colour science should end with a summary and a repetition. Note that a repetition can also be very useful as a quick introduction on the occasion of advanced colour education.

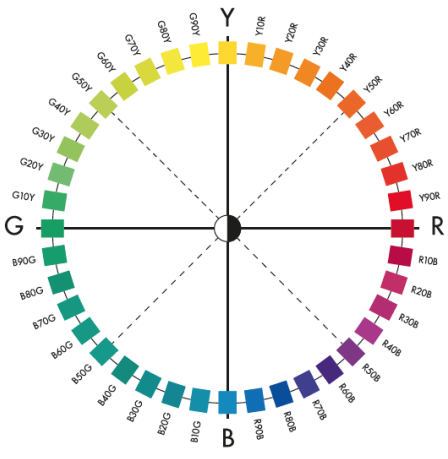
This can be done in the form of

a) A review of the exercises which the students have carried out. At the same time as the knowledge content of the exercises is reviewed, it is also possible to make a final check to make sure that the exercises have been performed correctly. (This is particularly important, as some of the exercises may be used later as aids, standards in further application exercises, a future professional activity where colour is used, creative work etc.)

b) An exercise where colour samples, as in exercise Colour Areas, colour ranges, are placed in 56 hue and nuance areas as an illustration of the world of colour with the exception of the pure achromatic colours.

As a complement and follow-up to this exercise, the students can collect samples of e.g. textiles, wallpapers, yarns and different natural materials, analyse and verbally describe their colours, and place them in the different colour areas. Moreover, the students should mark the location of the colours in the colour circle and in the colour triangle.



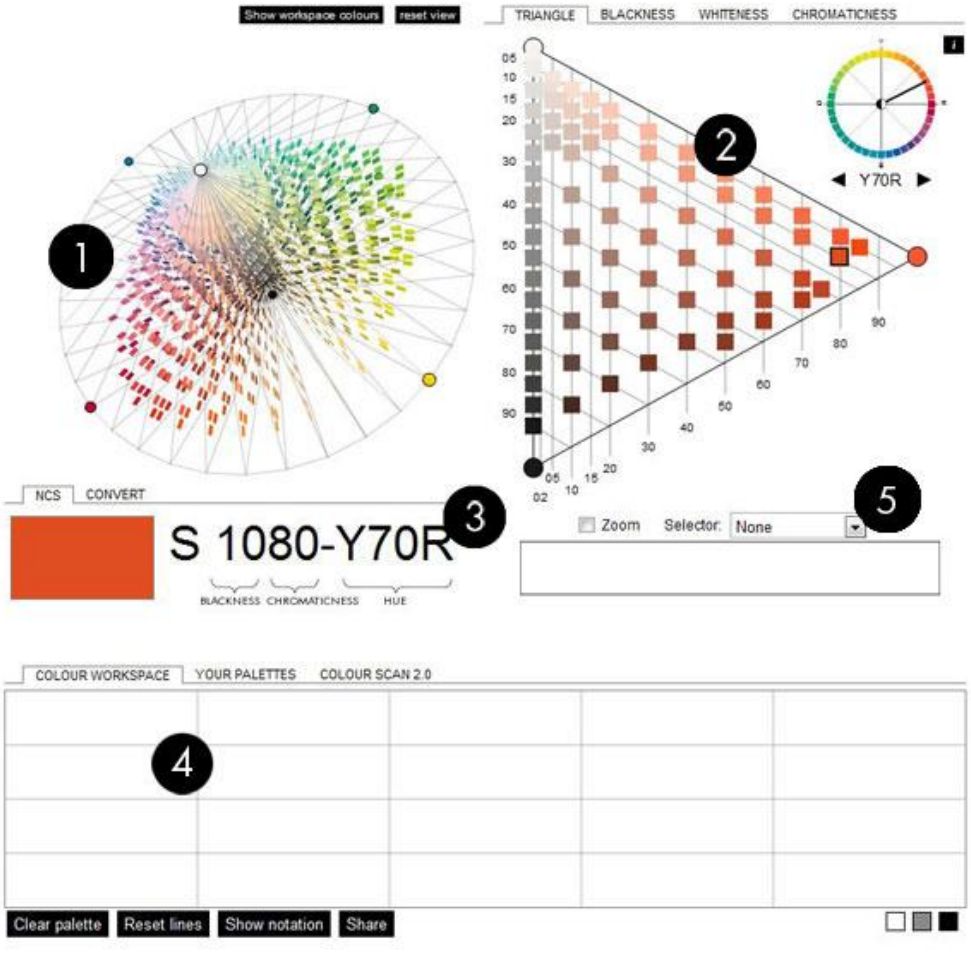


WORKING DIGITALLY WITH NCS NAVIGATOR

Now when the students are familiar with the NCS System it would be great working digitally with NCS Navigator. This web application featuring the full range of NCS 1950 Standard colours in an interactive 3D-space. Here the students can create matching colour palettes and import them to different graphical software, such as Adobe Creative Suite. For each selected colour, its NCS Notation, CMYK, RGB and lightness values will be displayed. When taking colours from 'screen' into the colour project, it is recommended to use a physical NCS Colour Sample as a reference for the best possible accuracy. NCS Navigator can be found on ncscolour.com.

NCS Navigator is split into five parts:

1. **NCS Colour Space** showing all 1950 NCS Original Colours in 3D
2. **NCS Colour Triangle** showing each hue triangle found in the NCS 1950 Original Collection with tab links to blackness, whiteness and chromaticness
3. **Colour Information viewer** below the 3D Colour Space
4. **Colour Workspace** at the bottom of the screen
5. **Colour Selectors** which can be used to find matching colour combinations**.**



14. THE DEVELOPMENT OF THE NCS SYSTEM

The NCS System is based on decades of interdisciplinary research and development, carried out by architects, designers, psychologists and physicists. It is based on the use of colour in our environment and on how the human being sees colour, and it has been developed by NCS Colour AB (former Scandinavian Colour Institute AB).

SCIENTIFICALLY BASED AND DOCUMENTED

NCS is regarded by the leading experts in the world as one of the few current systems which maintains a highly scientific level. It has been shown to be practically useful and to qualify as an international standard for colour description. It is also integrated with recognised colorimetric systems such as that developed by CIE, and it is widely used in education, science and colour research all over the world.

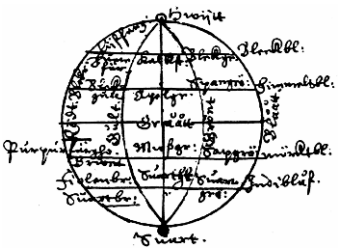
COLOUR ACCURACY

Modern society demands great accuracy in colour communication and thereby also in colour standards. The colourist's design may perhaps have to be produced in several different stages and it may be combined with other products. The eye is able to see very small colour differences. Exact colour accuracy is therefore very important if the final result is to be guaranteed to be correct.

NCS colour sample collections maintain ISO 9001 certified colour quality and thanks to supreme Quality Management by the world leading NCS Quality Centre.

HOW NCS WAS DEVELOPED

In 1611, the scientist A S Forsius published the embryo to NCS in his book "Physica" in which he stated:



"among the colours, there are two primary colours, White and Black ... the four excellent Intermediate Colours, which are red, blue, green and yellow, grey from white and black and they gradually approach either white through their paleness, or black through their darkness ..."

In the 1930s, the physicist Tryggve Johansson became interested in the 19th century German physiologist Ewald Hering's theories regarding colours and colour perception.

"Theories shall not bind the artist to any doctrines of taste but they shall provide the freedom which a secure knowledge about the means of expression gives."

Johansson's development of Hering's theories was later complemented by other scientists.

HESSELGREN'S COLOUR ATLAS

One of these scientists was Sven Hesselgren, Professor of Architecture, who, together with other leading Scandinavian architects and designers of that time devoted himself to working with colour and form as a visual phenomenon. In 1952, his work resulted in Hesselgren's colour atlas, a predecessor of the NCS.

At this time, architects, designers, artists, teachers, manufacturers of coloured products and scientific institutions realized the need for a permanent and generally useful colour system.

THE NCS COLOUR NOTATION SYSTEM

Dr Anders Hård is the originator of the modern NCS. He led 100 man-years of research work together with primarily Dr Lars Sivik (psychology) and Prof Gunnar Tonnquist (physics) and a number of leading designers and architects. This work has been acknowledged and rewarded by AIC (Association International de la Couleur), a worldwide organisation that is active in the promotion of knowledge and research on colour.

The NCS System was introduced in 1979. This colour system which can describe any surface colour was complemented by a colour atlas which today contains 1 950 specified and high-quality colour samples.

THE SWEDISH COLOUR CENTRE AND THE COLOUR SCHOOL

In the early 1960s, The Swedish Colour Centre Foundation was founded as an independent R&D institution on the joint initiative of the Royal Swedish Academy of Engineering Sciences (IVA) and the Swedish Society for Industrial Design (now the Swedish Society of Crafts and Design) together with the Swedish export industry.

The results of the Swedish Colour Centre's research work encouraged the Swedish Standards Institute (SIS) to develop NCS into a Swedish Standard in 1979.

The Swedish Society for Industrial Design was also behind the Colour School's summer course which as early as the 1940´s began to be arranged each year for architects, designers, artists, teachers and technicians. There, the teaching system was founded, and large parts of the exercise material presented in this manual were developed during these courses. The Colour School was also the name of the Colour Institute's subsidiary company providing education in colour for professionals.

NCS TODAY

Today NCS Colour Academy (the Colour School) is a natural part of NCS Colour AB (former Scandinavian Colour Institute). The Colour School's summer course is today an established international summer workshop. For one week in summer every year it attracts participants from all over the world.

The system and its colour samples are used all over the world in architecture, design, production, control, education and research. The NCS system has become one of the world's most widely used colour notation systems and it is referred to in a great number of international research reports.

In practice, this means for example that the NCS System is used in the decorate paint industry and within manufacturing industry. Products are also designed with the help of the system, such as cars, houses, bicycles, mobile telephones, aircraft, curtains and many of the products and environments which we meet every day.

The NCS System is today the national colour standard in Sweden, Norway, Spain and South Africa.

For more information on our complete range of colour sample collections as well as your nearest NCS Distributor anywhere in the world, please visit our homepage at www.ncscolour.com

15. COLOUR GLOSSARY

Accent
A colour element in a colour gestalt which deviates in colour, often to underline some character in the rest of the composition.

Achromatic colour
A colour which resembles white and black but lacks a chromatic element.

Adaptation
The adaptation of the visual sense in accordance with the special character of the surrounding light (darkness adaptation and colour adaptation).

Additive colour
Summation of the light energy of different wavelengths into a joint stimulus which reaches the eye's retina, e.g. the adding together of light emission via projectors, display screens or a coloured spinning-top.

After-image
A phenomenon which arises when one regards a fixed point on a surface intensely for a long time and thereafter transfers one's attention to another surface, whereby in general the colours of the observed surface seem to be transformed according to a direct contrast relationship (yellow becomes blue, black becomes white etc). At the same time, the colour's mode of appearance is changed.

Basic colour
See *primary colour*.

Blackness
The degree of affinity of a colour with pure black.

Blind spot
The region of the retina where the optic nerve enters the eye, and thus lacks cones and rods.

Blinding
A contrast relationship between two coloured surfaces, e.g. through different intensities of illumination, which is so great that an observer is no longer able to distinguish all the details on one of the surfaces.

Chromatic colour
A colour where elements of one or more of the elementary properties yellowness, redness, blueness and greenness can be seen.

Chromaticness
Also colour strength. The clarity with which the hue is apparent, i.e. the degree of affinity with the maximum chromaticness of the hue in question.

CIE-system
An agreement reached on an international basis as to how colour stimuli can be specified with instrumental measurement methods, taking into consideration the intensity and composition of the radiation.

Clarity
Previously used expression which has a meaning opposite to the degree of blackness (a colour which lacks observable blackness is called a clear colour).

CMYK
A colour mixing system for printing inks (C = cyan, M = magenta, Y = yellow, K = black).

Colour
A word with many different meanings:
1. Colour observation in general.
2. Characterization of the specific radiation which gives rise to a colour observation (physical term).
3. Material with the help of which one colours something (cf. paint, ink).
4. Colour in contrast to non-colour in e.g. compilations such as colour film, colour TV versus black-white.
5. The actual observation, the colour percept.

Colour atlas
A collection of colour samples arranged in accordance with a defined system with the intention of illustrating this and for use as a practical aid.

Colour blindness
Defect, anomaly, in human colour perception.

Colour circle
A horizontal section through the colour body seen from above, where the maximum chromatic colours are indicated around the circumference and where the centre represents completely achromatic colours.

Colour constancy
The fact that an object seems to be of one colour although the stimulus is different in different parts of the object, or seems to have the same colour in spite of different illumination conditions.

Colour element
The surface region in a colour gestalt which has a uniform colour and the contour line of which delimits the shape of the surface.

Colour gestalt
That part of the field of vision to which one restricts one's observation.

Colour region
A part of colour space which is obtained if the elementary scales are divided in the middle. Primarily, the colour circle will be divided into eight regions and the colour triangle into six nuance regions.

Colour sensation
Colour observation, colour perception, colour experience (what you see).

Colour space
A three-dimensional geometric model showing the relationship between all the observable colours.

Colour strength
This term has different meanings:
1. An earlier word for what is here called chromaticness.
2. General expression to indicate the colouring ability of a dye.
3. The intensity in the colour sensation related to the intensity of illumination.

Colour system
A way of describing the relationships of colours with each other in accordance with a specified systematic arrangement. A colour system can build on:
1. observations (perceptive colour system)
2. physical mixing proportions (physical colour system)

Colour temperature
A measure of the temperature in degrees Kelvin (based on the absolute zero - 273°C) to which a black object must be heated to produce a radiation of a certain character. Light from an electric bulb light has a colour temperature of about 2300°K, and the light from a northern sky approximately 6700°K.

Colour tone section
Previous concept for the arrangement of colours of the same hue (vertical section through the colour space).

Colour tone
Previous word for hue.

Colour triangle
Graphical symbol for a vertical section through the colour space where the maximum colour, white and black are indicated as the corners in an equilateral triangle.

Complementary colours
Two colour stimuli which in additive and subtractive colour mixing give rise to an achromatic colour percept. The word is also used to describe colours which are each other's opposites with respect to hue. Also after-image colours and the hue which a grey colour sample obtains through induction when it is observed against a chromatic surrounding.

Cones
The recipient organs in the retina of the eye which are responsible for normal colour vision.

Contour amplification
An effect which is similar to contrast amplification and expresses itself in the fact that a colour surface which borders onto another seems to change colour close to the border, so that the contour becomes clearer (the Macband effect).

Contrast amplification
The result of induction, i.e. two colour surfaces which are observed at the same time influence each other so that the difference between them appears to be greater than when they are seen separately.

Contrast
The difference between colours.

Corresponding colours
Earlier expression for similarity in nuance. Colours which vary in hue but have the same nuance, i.e. colours which have the same degrees of whiteness, blackness and chromaticness. Within the NCS system, these are called colours which are alike in nuance.

Elementary attribute
The degree of affinity of a colour to an elementary colour, e.g.whiteness, blackness, yellowness and redness.

Elementary colours
These are six in number and are characterized by the fact that they lack visual similarity with each other, whereas all other colours have a greater or less resemblance to two, three or four of these six.

Elementary scale
A scale which can be created between two elementary colours (no scale can be created between Y and B or between R and G).

Grey colour
A colour percept which resembles white and black and lacks a chromatic element. They can be arranged according to the degree of similarity with white and black into a grey scale. In a scale of grey colours, the difference in lightness is the same as the difference in whiteness and blackness.

Grey scale
A series of colours which lack a chromatic element and vary in whiteness and blackness - should preferably be called a lightness scale or a white-black scale.

Harmonization
Can in this context indicate some kind of balanced relationship (different from harmonious).

Hue
The relationship of a colour to the two elementary attributes of the colour, e.g. Y80R.

Hue circle
Arrangement of colour samples in accordance with hue so that they form a circle.

Induction
See *contrast amplification*.

Irradiation
The enlargement of surface that is percieved when a highly radiating or very light object is seen against a very dark background.

Light
An expression for the radiation energy which we observe visually.
1. The perception of light in contrast to darkness.
2. The opposite to dark, e.g. light blue.

Lightness
A contrast property which characterizes the difference between two colours. The lightness of a colour can only be determined through a direct comparison with a reference scale from white to black, the two colours which represent the lightest and the darkest positions.

Light source
The source from which radiant energy flows.

Luminous colour
A colour percept which is perceived to come from a light source.

Macband-effect
See *contour amplification*.

Maximum colour
1. A colour which is solely chromatic, i.e. lacks resemblance to either white or black.
2. A common expression for the most chromatic colour that can be produced with the help of a given pigment.

Metamerism
The phenomenon which means that two colour samples with different characteristics can appear the same in one lighting situation although they are completely different in other situations.

Middle colour
Colours which are perceived to have the same degree of similarity to two elementary colours (in the middle of an elementary scale).

Mode of appearance
The way in which we perceive a colour. See surface colour, volume colour and luminous colour.

NCS
Natural Colour System. A visual arrangement and notation of colours as visual percepts taking into consideration their varying degrees of affinity with the six elementary colours. Since 1979, NCS is the Swedish Standard for colour notations (SS 19102:2004).

Nuance
1. NCS: the relationship between the elementary attributes of whiteness, blackness and chromaticness independently of the hue, e.g. 2050-.
2. Can also mean a small difference in comparison with a colour.

Object colour
The intrinsic colour which an object is perceived to possess, in principle independently of the observation condition which applies.

Percept
Sensation, observation, experience.

Primary attribute
An elementary attribute which dominates in a colour. (The resemblance to one elementary colour is greater than the resemblance to any of the other elementary colours.)

Primary colours
The smallest number of colour stimuli or colour materials, as a rule three, which constitute the basis for producing an almost unlimited number of variants within the material with which one is working. Different ways of mixing colour have different starting points in different primary colours (light, pigment etc).

RGB
The primary colours for light, e.g. for a monitor screen.

Rods
The recipient organs in the retina of the eye which are chiefly responsible for so-called night vision. Give essentially information only about light and darkness.

Saturation
The relationship of a colour to chromaticness and whiteness regardless of the degree of blackness.

Secondary attribute
An elementary attribute which can be observed in a colour but which is not dominant.

Spectrum
A continuous band with varying properties, e.g. energy spectra of different wavelengths, but in a colour context often limited to visible electromagnetic radiation. It is often used for the coloured band which can be observed when light passes through a prism and is projected onto a white surface. Also a rainbow.

Stimulus
The light radiation which reaches the retina of the eye when an object is observed or which is related to the radiation emitted or reflected by the object.

Subtractive colour mixing
Mixing of pigments or other colour materials. The reflected radiation is reduced by absorption, so that a new colour percept arises.

Surface colour
A mode of colour appearance where the colour seems to belong to the surface of a non-transparent object.

Synaesthesiae
Combined perception, e.g. one feels warmth when a given colour is observed or colours seen when one hears music.

Transpose
To transfer a colour gestalt from one expression to another, e.g. pattern transposition where the same pattern gestalt is transferred from one colour register to another.

Volume colour
A mode of colour appearance where the colour appears to belong to the interior of a translucent or transparent object, e.g. liquid in a bottle.

Warm colours
Yellowish-red colours in contrast to cold bluish-green colours - in reality an association with another area of perception.

Wavelength
The distance between the peaks of two consecutive waves in the radiation which is here called electromagnetic. A change in the wavelength of the radiation leads to a difference in the observed hue.

Whiteness
The degree of affinity of a colour to pure white.

16. EDUCATIONAL MATERIAL AND LITERATURE LIST

EDUCATIONAL MATERIAL

Exercise material for the students: Colour Theory (section 7): 1.1-1.3; How NCS works, step 1 (section 8): 2.1-2.3; How NCS works, step 2 (sektion 9): 3.1; Colour Similarities (section 10): 4.1-4.2; Colour Contrasts (section 11): 5.1-5.3, consisting of colour samples and a template with instructions.

For advanced studies (section 12), Hue, Nuance, Blackness, Chromaticness & Whiteness Similarity (6.1-6.2) and Final Colour Circle Test (6.3) can be used. These are advanced exercises and excellent for use as extra tasks, preferably in groups.

Other materials, which are needed, are glue or tape which is adhesive on both sides for fixing the exercise material onto the templates. Scissors, plastic folders, a file and a note pad can also be useful.

Material for colour assessments in the form of e.g. textile samples, yarns, wallpaper samples, advertisements, packaging, cuttings from newspapers & magazines, etc.

Course documentation: *Colour Choices. A practitioner's guide to colour scheming and design.* Berit Bergström
T7:2008, Formas, Stockholm

NCS Navigator www.ncscolour.com

BOOKS AND ILLUSTRATIVE MATERIAL

NCS Atlas 1950 Original

NCS Block 1950 & NCS Lightness Scale

LITERATURE SUGGESTIONS

Albers, Josef
Interaction of Color
Revised and Expanded Edition 2006
Nicholas Fox Weber

Derefeldt, G.
The perception of Colour. Chapter: Colour Appearance Systems
1991 Volume 6 in the series Vision and Visual Dysfunction. Edited by John Cronly-Dillon

Fridell Anter, K.
What colour is the red house? Perceived colours of painted facades
2000 Royal Institute of Technology (KTH) Stockholm, Sweden

Fridell Anter, K.
Nature's colour palette - Inherent colours of vegetation, stones and ground
1996 Scandinavian Colour Institute AB, Stockholm, Sweden

Fridell Anter, K. & Svedmyr, Å.
Colour scales of traditional pigments for external painting
1996 Scandinavian Colour Institute AB, Stockholm, Sweden

Hering, Ewald
Outlines of a theory of the light sense
1964 Cambridge, Massachusetts

Porter, T. & Mikellides, B.
Colour for Architecture Today
2008 Taylor Francis Ltd

Smedal, Grete
Longyearbyen in colour - status and challenges
2001 Eide forlag, Norge

Swirnoff, Lois
Dimensional Colours
2003 W.W. Norton & Company, New York & London

Tonnquist, Gunnar
25 years of Colour with the AIC – and 25 000 without.
An offprint from Color Research & Allication, Volume 18, No 5, June 1993.

Wright, WD.
The rays are not coloured
1968 Hilyer, London

COLOUR REPORTS

C8 The NCS Colour Order and Scaling System
Anders Hård 1969

F22 On studying colour combinations - Some reflexions and preliminary experiments
Lars Sivik och Anders Hård 1983

F26 The Forsius Symposium on Colour Order Systems
AIC 1983, Antologi

F27 Distinctness of border - a concept for a uniform colour space
Anders Hård och Lars Sivik 1984

F28 The Forsius Symposium on Colour Order Systems
Antologi

F33 Differences in colour appearance between matt and glossy coloured objects and how to measure them - a comparison between visual appearances and instrumental measurements
Anders Hård 1988

F49 NCS Natural Color System – from Concept to Research and Applications, part I and II
Anders Hård, Lars Sivik och Gunnar Tonnquist

F50 Colour and Psychology from AIC
Interim Meeting 96 in Gothenburg
Antologi. Redaktör Lars Sivik

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