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DEL COLORE**

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CULTURE
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The Associate Editors evaluate each article in order to define if the topic and content is suitable for consideration by the journal. Once the article passes the initial review, the Associate Editors select several referees in the Editorial Board based on their expertise in the particular field or topic.

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Each article is reviewed by two or three referees under a double-blind peer review process where the authors and the reviewers are kept anonymous. Referees are asked to evaluate the manuscript based on its originality, methodology and impact to research and relevance to the professional practice. After collecting the referees' reports, the Associate Editors make a recommendation on the acceptability of the article to the Editor in Chief.



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Editorial

With the 9th issue, the “Cultura e Scienza del Colore - Color Culture and Science” journal reached its fifth year of life. In order to internationalize its dissemination, the magazine has been publishing only articles in English language or bilingual since 2015. We have established these criteria for three years because in February 2018 we sent the application to be included in the Emergins Sources of Citation Index (ESCI) of Web of Science (WoS) to Clarivate Analytics. The journal is published by a *non-profit* association that has its reference point in the multidisciplinary theme of color. In order to allow a wide-ranging international appreciation, in the ordinary meeting of April 19th 2018 the members of the association decided that by the end of this year the journal will be transfer to an international organization or publisher, with the condition to maintain unaltered its scientific and cultural content, its title, its ISSN and most of its editorial board.

In this issue, as always, there are multidisciplinary contents. Maria Elisabetta Ruggiero analyzes in the article “The colour in ships: communication and identity” the function of the chromatic component within the naval liveries and its historical evolution, through the tools of study of the *representation*. In the essay “The contribution of colour in the artistic representation of the sacred. International symbolism between the nineteenth and twentieth centuries”, through a *historical* analysis, Anna Mazzanti delves into the theme of color, that assumes a symbolic value, in the context of the sacred painting between the nineteenth and twentieth centuries. Laurence Pauliac in “Restorations of the monumental polychromy of the Gothic cathedrals undertaken by Viollet-le-Duc” presents an interesting critical analysis, only for the aspects concerning color, of the *restoration* activity carried out in the nineteenth century by the French architect and restorer Eugène Emmanuel Viollet-le-Duc in the cathedral of Notre-Dame in Paris. In “Glossy Black is not actually ‘Black’: Evidence from Psycholinguistic Colour-Naming Studies in 14 European Languages”, Mari Uusküla and Martin Eessalu present an intercultural research in the area of *color naming* taking into consideration not only the aspects relating to tint, saturation and clarity, but also the lucidity of the sample of the considered material: in this case the black color. Andrea Siniscalco and Gianluca Guarini, in the essay “Digital Visualization of a Luminaire: From blueprint to Photorealistic Representation”, face

Con il n.9, la rivista “Cultura e Scienza del Colore - Color Culture and Science” ha raggiunto il suo quinto anno di vita. Al fine di internazionalizzarne la diffusione, dal 2015, la rivista pubblica solo articoli in lingua inglese o bilingue. Abbiamo introdotto da tempo questi criteri perché nel febbraio 2018 abbiamo inviato a Clarivate Analytics la domanda per essere inseriti nell’Emergins Sources of Citation Index (ESCI) di Web of Science (WoS). La rivista è edita da una associazione *no profit* che vede nel tema multidisciplinare del colore il suo punto di riferimento. Al fine di consentirne una valorizzazione a livello internazionale di ampio respiro, nell’assemblea ordinaria del 19 aprile 2018, i soci hanno deciso che entro la fine di quest’anno la rivista sarà ceduta ad un ente o editore internazionale, con la condizione di mantenerne inalterati i contenuti scientifici e culturali, il titolo, l’ISSN e la maggior parte del board di redazione.

In questo numero abbiamo come sempre contenuti multidisciplinari. Maria Elisabetta Ruggiero, nell’articolo “Il colore nei mezzi navali: comunicazione ed identità” analizza, tramite gli strumenti di indagine della *rappresentazione*, la funzione della componente cromatica nell’ambito delle livree navali e la rispettiva evoluzione storica. Nell’articolo “L’apporto del colore nella rappresentazione artistica del sacro. Simbolismo Internazionale fra Otto e Novecento”, Anna Mazzanti, tramite un’approfondita analisi *storica*, approfondisce il tema del colore, che assume un valore simbolico, nell’ambito della pittura sacra a cavallo tra il diciannovesimo e il ventesimo secolo. Laurence Pauliac in “Restorations of the monumental polychromy of the Gothic cathedrals undertaken by Viollet-le-Duc”, presenta un’interessante analisi critica, per i soli aspetti inerenti il colore, dell’attività di *restauro* condotta nel diciannovesimo secolo dall’architetto e restauratore francese Eugène Emmanuel Viollet-le-Duc nella cattedrale di Notre-Dame di Parigi. In “Glossy Black is not actually ‘Black’: Evidence from Psycholinguistic Colour-Naming Studies in 14 European Languages”, Mari Uusküla e Martin Eessalu, presentano una ricerca interculturale nell’area del *color naming* prendendo in considerazione non solo gli aspetti inerenti tinta, saturazione e chiarezza, ma anche la lucidità del campione di materiale considerato: in questo caso il nero. Andrea Siniscalco e Gianluca Guarini, nel saggio “Digital Visualization of a Luminaire:

a well-known problem in the field of lighting *design*: the representation techniques of lighting fixtures in the photorealistic renderings of lighting projects. In “Review and Comparison of Random Spray Retinex and of its variants STRESS and QBRIX”, Michela Lecca, Alessandro Rizzi and Gabriele Gianini, in the field of *digital color*, present a review and comparison of three Retinex algorithms that can be used in the color equalization of the images. Finally, Ingrid Calvo Ivanovic, in “Symbolic Color Associations in Goethe’s Farbenlehre and its application in the pictorial work of its early receptors”, presents an interesting analysis in the context of *color culture*, regarding the theoretical contributions of Johann Wolfgang Goethe in relation to the symbolic aspects of color in the context of pictorial practice.

In the column, Communications and Comments, Michela Lecca with Osvaldo da Pos continue the scientific bibliographic dissertation on the physiological chromatic sensation and on the cognitive chromatic perception, introducing also the cultural and social aspects related to color as these influence cognitive aspects.

The Editor in Chief
Maurizio Rossi

From blueprint to Photorealistic Representation” affrontano un problema ben noto nell’ambito del lighting *design*: le tecniche di rappresentazione degli apparecchi di illuminazione nei rendering fotorealistici dei progetti di illuminazione. In “Review and Comparison of Random Spray Retinex and of its variants STRESS and QBRIX”, Michela Lecca, Alessandro Rizzi e Gabriele Gianini, nell’ambito del *colore digitale*, presentano una rassegna e confronto di tre algoritmi di Retinex utilizzabili nell’ambito dell’equalizzazione cromatica delle immagini. Infine Ingrid Calvo Ivanovic, in “Symbolic Color Associations in Goethe’s Farbenlehre and its application in the pictorial work of its early receptors”, presenta un’interessante analisi nell’ambito della *cultura del colore*, in merito ai contributi teorici di Johann Wolfgang Goethe in relazione agli aspetti simbolici del colore nell’ambito della pratica pittorica.

Nella rubrica, Communications and Comments, Michela Lecca con Osvaldo da Pos proseguono la dissertazione scientifico bibliografica sulla sensazione cromatica fisiologica e la percezione cromatica cognitiva, introducendo anche gli aspetti culturali e sociali legati al colore dato che questi influenzano la percezione cognitiva.

Il direttore responsabile
Maurizio Rossi

The colour of ships: communication and identity

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ABSTRACT

The following research investigates the function of colour, within the scope of the naval liveries and the respective historical evolution. Since ancient times, in fact, the use of colour for the outer form of ships has been taking on multiple valences: identification, symbolic, apotropaic aspects. Still today this use remains in its different declinations with forms that often derive from the past tradition.

Italian translation provided:

*Il colore nei mezzi navali:
comunicazione ed identità*

KEYWORDS

Colour, ship external view, hull, identity.

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Maria Elisabetta Ruggiero. Born in Leghorn in 1969, Maria Elisabetta Ruggiero is an Architect, graduated at Genoa University (IT), and a PHD on Survey and Representation of Architecture and Landscape, held at Representation Institute – Genoa University. Now she is Associate Professor at Genoa University, Architecture and Design Department, Polytechnic School, working in the field of 'Representation for Naval Design'.

1. INTRODUCTION

The tradition of characterizing ships with signs and colours has deep roots, giving them multiple functions.

Colour in the naval field has covered a multiplicity of values and functions, from the apotropaic signs introduced by the first sailors, through the colourful liveries of the seventeenth-century warships, to the graphic compositions of contemporary commercial ships and the multitude of colours adopted in today's megayachts.

The lack of graphic documentation of the naval project up to the sixteenth century, as well as the rarity of finds, due to their physiological short life, leads the study of colour in this field to necessarily turn to forms of representation that sometimes can be heterogeneous and not for technical studies. However, the wide iconography that over the centuries has been turning to the representation of the ship in all its forms, is an important source for research on (Ruggiero, 2007).

The possibility of having documents in which the design of the decorative apparatus, and the colour used, are easily recognizable, makes it easier to identify the mode and the design intent, aimed at including one or more chromatic components in the composition. This process is carried out for various reasons: now functional, now celebrative, now commercial. The proposed study aims to investigate the early days of a specific and intentional use of colour in this sector and what were its evolutions in relation to the new painting techniques and the new available materials.

2. FIRST DECORATIVE EXPRESSIONS

The aura of mystery and adventure that has always characterized travel by sea has pushed the first sailors on unknown routes and with vehicles still not duly sure, to feel the need to decorate the hull with auspicious signs that would help the Fate. The signs that were used were common to many cultures, even distant from one other, and often proposed the image of eyes that could, therefore, help to find the right route and to distinguish in time any obstacles or enemies. The part intended to accommodate these signs was, and still is, the bow, or rather that part of the hull that must first cut the water. In subsequent evolutions this part of the hull hosted real sculptures with the function of good luck and as symbol of the ship itself: the figurehead, with its own shape and with the most varied references, represented the name of the ship in a form understandable to many sailors who could not read the name carved on

1. INTRODUZIONE

La tradizione di connotare i mezzi navali con segni e colori ha radici profonde, attribuendo ad essi molteplici funzioni: dai segni apotropaici introdotti dai primi naviganti, attraverso le livree colorate delle navi da guerra seicentesche fino alle composizioni grafiche delle navi commerciali contemporanee e alla moltitudine di colori adottati nei megayacht di oggi, il colore in ambito navale ha ricoperto una molteplicità di valori e di funzioni.

La carenza di documentazione grafica del progetto navale fino al Cinquecento, nonché la rarità di reperti, a causa della loro fisiologica breve vita, porta lo studio del colore in questo campo a doversi rivolgere necessariamente a forme di rappresentazione che, talvolta, possono essere eterogenee e non rivolte a studi di tipo tecnico. Tuttavia l'ampia iconografia che nell'arco dei secoli si è rivolta alla rappresentazione della nave in tutte le sue declinazioni, costituisce un'importante fonte per le ricerche in merito (Ruggiero, 2007).

La possibilità di disporre di documentazioni in cui il disegno dell'apparato decorativo, e del colore utilizzato, siano facilmente riconoscibili, rende più facilmente identificabile la modalità e l'intento progettuale rivolto ad includere nella composizione una o più componenti cromatiche. Questo processo si realizza per ragioni di varia natura: ora funzionale, ora celebrativa ora commerciale. Lo studio proposto vuole indagare quali siano stati gli albori di un uso specifico ed intenzionale del colore in questo settore e quali siano state le sue evoluzioni in relazione anche alle nuove tecniche di pitturazione e ai nuovi materiali disponibili.

2. PRIME FORME DECORATIVE

L'aura di mistero e di avventura che da sempre connota i viaggi per mare ha spinto i primi naviganti, rivolti verso rotte ignote, e con mezzi ancora non debitamente sicuri, a sentire l'esigenza di decorare lo scafo con segni benaugurali che aiutassero la sorte. I segni che venivano utilizzati erano comuni presso molte culture, anche lontane tra loro, e proponevano sovente l'immagine di occhi che potessero, quindi, aiutare a trovare la rotta e a distinguere per tempo eventuali ostacoli o nemici. La parte deputata ad accogliere questi segni era, ed è tuttora, la prua, ovvero proprio quella parte dello scafo che per prima deve fendere le acque. Proprio questa parte dello scafo, nelle evoluzioni successive, ospiterà vere e proprie sculture con la funzione di porta fortuna e simbolo della nave stessa: la polena infatti con la propria forma, e con i più svariati riferimenti, rappresentava il



Figure 1 - Fishing boat in Portugal. The apotropaic eye is evident combined with the black image of a fish, accompanied by the lively and brilliant bow colours.

Figura 1 - Peschereccio dell'area mediterranea. È evidente l'occhio apotropaico corredato da una colorazione vivace e brillante dello scafo.

the stern (Landstrom, 1976).

3. COLOUR AND IDENTITY OF FLEETS

In the Middle Ages, thanks to the evolution not only of naval means, but also of the possibilities of tracing complex routes and of creating the first portolans and the first nautical charts, the sea trade is became more frequent. The commercial domination in the Mediterranean was flanked by the delineation of war powers that contended its dominance. In addition to their flags, the set up fleets were recognizable on the seas for the colours of their hulls (Lavery, 2005). A case in point is the Maritime Republic of Venice connoting its galleys with red colour [1].

The galley, enjoying both rowing and sailing propulsion, lent itself well to moving around the Mediterranean, used both as a warship and for the transport of goods. She soon became one of the most widespread means and for many centuries was adopted by all peoples of sailors of this area who defined the identity of belonging of these means thanks to the aid of colour on their hulls or on its equipments (Crochet, 1991).

4. THE GREAT GALLEONS: COLOUR AND DECORATION AS A SYMBOL OF STRENGTH, POWER AND PRESTIGE

In the XVI c. the European political order saw the deployment of great empires that were facing one another and were contending increasingly extensive routes to reach the territories subject

nome della nave in una forma comprensibile ai molti marinai che non avrebbero saputo leggere il nome scolpito sulla poppa (Landstrom, 1976).

3. COLORE ED IDENTITÀ DI FLOTTE

E' in epoca medievale che, grazie all'evoluzione non solo dei mezzi navali, ma anche della possibilità di tracciare rotte complesse, e alla possibilità di realizzazione dei primi portolani e delle prime carte nautiche, i commerci via mare si fanno sempre più frequenti. Il dominio commerciale nel Mediterraneo è affiancato dalla delineazione di potenze belliche che se ne contendono il predominio. Oltre che per i propri vessilli le flotte che vengono allestite si rendono riconoscibili sui mari anche per la colorazione dei propri scafi (Lavery, 2005). Ne è un esempio emblematico la Repubblica marinara di Venezia che connota le proprie galee con il colore rosso [1].

La galea, mezzo che gode sia della propulsione a remi sia di quella a vela, ben si presta a muoversi all'interno del Mediterraneo, utilizzata sia come nave da guerra sia per il trasporto delle merci, e diviene ben presto uno dei mezzi più diffusi e per molti secoli adottato da tutti popoli di naviganti di quest'area che definiscono l'identità di appartenenza di tali mezzi grazie all'ausilio del colore sullo scafo o sui suoi apparati (Crochet, 1991).

4. I GRANDI GALEONI: COLORE E DECORAZIONE COME SIMBOLO DI FORZA, POTERE E PRESTIGIO

L'assetto politico europeo nel XVI secolo

to domination, marking a substantial change in the evolution of naval vessels (Guerout - Campodonico - Giannino, 2000). In order to secure affordable merchant traffic Spain, England, France, the Netherlands and Portugal were making great economic efforts to set up ever larger and increasingly wealthy ships fit to bloody naval battles. The need for supremacy on the sea urged the rulers to develop the art of building ships according to principles that gradually were breaking away from the millenary practices of the master carpenters, to make room for real designers who could optimize the performances of these vessels (Campodonico, 2002).

The light and fast galleys that well lent themselves to furrow the closed basin of the Mediterranean, were no longer suitable for new challenges to reach new lands overseas for which the great galleons were more suitable.

Goods, sailors and cannons found their places in the immense holds of galleons who then were relying on impressive sailing surfaces and had completely abandoned the propulsion with oars. The efforts necessary for their preparations found a figurative expression in the decorative apparatus of the hulls, which was entrusted with the task of representing the splendour and power of the ship-owners. Artists, engravers and famous decorators were hired to create the apparatus of friezes, iconography and colours that would have characterized the ship. The most frequent subjects were taken from the mythology and the heraldic symbols of the ship-owning family: these were flanked by the colours of the coats of arms and the profusion of gilding (Guilmartin J., 2002).

Le *Soleil Royal*, for which Antoine Coysevox and Jean Bérain, authors of many of the decorations and stage apparatuses of the Palace of Versailles,

vede lo schieramento di grandi imperi che si fronteggiano e si contendono rotte sempre più estese per raggiungere i territori oggetto di dominio, segnando una svolta sostanziale nella evoluzione dei mezzi navali (Guerout - Campodonico - Giannino, 2000). Per garantirsi traffici mercantili convenienti Spagna, Inghilterra, Francia, Olanda e Portogallo compiono sforzi economici grandiosi per allestire navi sempre più grandi, e sempre più ricche di armamento, così da poter affrontare cruenti battaglie navali. La necessità di supremazia sul mare spinge i regnanti a sviluppare l'arte di costruire le navi secondo principi che poco a poco si distaccano dalla pratica millenaria dei maestri d'ascia, per lasciare spazio a veri e propri progettisti che sappiano ottimizzare le prestazioni di questi mezzi (Campodonico, 2002).

Le leggere e veloci galee che ben si prestavano a solcare il bacino chiuso del Mediterraneo, non sono più idonee alle nuove sfide per raggiungere le nuove terre oltre oceano per le quali risultano più adatti i grandi galeoni.

Merci, marinai e cannoni trovano posto nelle immense stive dei galeoni che si affidano ora a superfici veliche impressionanti, abbandonata del tutto la propulsione a remi. Lo sforzo necessario al loro allestimento trova una espressione figurativa nell'apparato decorativo dello scafo a cui è demandato il compito di rappresentare lo splendore e la potenza dell'armatore. Artisti, intagliatori e decoratori famosi vengono ingaggiati per creare l'apparato dei fregi, dell'iconografia e dei colori che avrebbero caratterizzato la nave. I soggetti più frequenti sono tratti dalla mitologia e dai simboli araldici della casata armatrice: a questi si affiancano i colori del blasone e la profusione di dorature (Guilmartin J., 2002).

La *Soleil Royal* per la quale vengono ingaggiati



Figure 2 - Gouache for the stern and the bow of *Le Soleil Royal*, Jean Bérain and Antoine Coysevox, XVII c., Louvre Museum, Paris (FR).

Figura 2 - Disegni per la poppa e la prua della *Soleil Royal*, Jean Bérain e Antoine Coysevox, XVII secolo, Museo del Louvre, Parigi (FR).

were commissioned by the King, was the ship that Louis XIV wanted to represent the King and his Splendour. We can admire golden friezes on a blue field, balustrades, pilasters and swirls that marked the various orders of bridges visible at the stern, with a wealth of details. The *Roi Soleil* had always chosen as a parade a Galea, called *La Réale*, where the pomp and the insignia of France merged to give life to an unusual composition. The contemporary *Sovereign of the Seas*, commissioned by Charles I of England, with rich and complex sculptural apparatus on a black background, appeared in a different style as if to underline the austerity and the bellicosity of the British fleet. Another example of decoration of the stern of a galleon is the one offered by the Dutch ship *Beurs Van Amsterdam* where the architecture of the stock exchange building, financed by the fleet, is represented with a pictorial narrative, on the transom. The Dutch galleons often brought in that position not only heraldic symbols, but also real representations related to the name of the ship.

5. IRON AND STEEL IN NAVAL CARPENTRY: BLACK AND GREY AS AN EXPRESSION OF INNOVATION AND ROBUSTNESS

In modern times the possibility of propulsion and construction techniques with the industrial revolution undergo a considerable range of changes in the naval field. Structures and plating in metal replace the wood that had characterized the previous centuries and thus start a new era (Galliani - Pescarini, 1985).

Antoine Coysevox e Jean Bérain, autori di molte delle decorazioni e degli apparati scenici della reggia di Versailles, è la nave che Luigi XIV commissiona per rappresentare il Re ed il suo Splendore. Fregi dorati su campo blu, balaustre, lesene e volute che scandiscono i vari ordini di ponti visibili a poppa sono raffigurati, nei disegni a noi pervenuti, con dovizia di particolari. Sempre *Re Sole* aveva scelto come mezzo da parata una Galea, chiamata *La Réale*, dove lo sfarzo e le insegne di Francia si fondevano per dare vita ad una composizione fuori dal comune.

Di diverso stile invece appare la contemporanea *Sovereign of The Seas* voluta da Carlo I d'Inghilterra che qui commissiona ricchissimi e complessi apparati scultorei su fondo nero come a sottolineare l'austerità e la bellicosità della flotta britannica.

Ulteriore esempio di decorazione della poppa di un galeone è quello offerto dalla nave Olandese *Beurs Van Amsterdam* dove l'architettura del palazzo della Borsa, finanziatrice della flotta, è rappresentato con una narrazione pittorica, sullo specchio di poppa. Sovente i galeoni olandesi recavano in quella posizione non solo simboli araldici ma anche vere e proprie rappresentazioni correlate al nome della nave.

5. FERRO E ACCIAIO NELLA CARPENTERIA NAVALE: IL NERO ED IL GRIGIO COME ESPRESSIONE DI INNOVAZIONE E ROBUSTEZZA

La possibilità di propulsione e le tecniche costruttive con la rivoluzione industriale



Figure 3 - Advertising images of the French fleets and Lloyd Sabaudo, where the black colour of the hull stands out in contrast with the white hull. In the Italian Fleet the waterline and the crowning of the funnels show the colours of the Company.

Figura 3 - Immagini pubblicitarie delle flotte francesi e Lloyd Sabaudo in cui spicca la colorazione nera dello scafo a contrasto con lo scafo bianco. Nella flotta italiana la linea di galleggiamento ed il coronamento dei fumaioli riportano i colori della compagnia.

Figure 4 - Moto Nave Michelangelo, launched in 1962, entirely painted white

Figura 4 - Moto Nave Michelangelo, prima metà XX secolo, la nave si presenta interamente colorata di bianco.



Phenomena of corrosion and rust for the metal in contact with water need a specific treatment, generally characterized by the red colour. The dark colour of the hulls proposes the dark tones of iron and gives origin to a new generation of naval vessels where the decorative apparatus disappears almost completely to make room for criteria of greater functionality. Imposing dark hulls characterize merchant ships, warships and even transatlantic ships, in contrast with the generally coloured white superstructures. It is important to underline that one additional criterion for selecting a colour must consider

subiscono una notevole gamma di cambiamenti in ambito navale. Strutture e fasciame in metallo sostituiscono il legno che aveva caratterizzato i secoli precedenti ed avviano così una nuova era (Galliani - Pescarini, 1985).

Fenomeni di corrosione e ruggine per il metallo a contatto con l'acqua, così come il legno suo predecessore, rendono necessario uno specifico trattamento, generalmente caratterizzato dal colore rosso, tuttavia la colorazione scura degli scafi ripropone i toni scuri del ferro e nasce quindi una nuova generazione di mezzi navali in cui l'apparato decorativo scompare quasi del



Figure 5 - (Top) M/Y Anastasia: the black hull contrasting the white superstructure echoes the first transatlantic dark iron structures. (Bottom) M/Y Eclipse: The all-white Motor Yacht collects the legacy of the great 20th-century transatlantic liners.

Figura 5 - (In alto) M/Y Anastasia: lo scafo nero a contrasto con la sovrastruttura bianca riecheggia i primi transatlantici con struttura e fasciame in ferro dalla colorazione scura. (In basso) M/Y Eclipse: Il Motor Yacht completamente bianco raccoglie l'eredità dei grandi transatlantici del XX secolo





Figure 6 - Cruise vessel of the Moby Lines Company with a hull characterized by images taken from the world of cartoons

Figura 6 - Moto navi della compagnia Moby lines con scafo caratterizzato da immagini tratte dal mondo dei cartoons

how colour affects temperature. For example a deck painted white dramatically drops the temperature in comparison to light grey or any other colour. The colours of the shipping companies, when they appear, get the shape of thin lines of colour or the logos are directly painted on the funnels. After the II World War, trying to change the evocative image of the black and white combination, the first transatlantic liners will introduce the white colour also for the hulls, thus creating a less austere effect [2].

6. TRANSATLANTICS, PASSENGER SHIPS AND YACHTS TODAY: THE COLOUR AS AN ELEMENT OF UNIQUENESS AND IDENTITY

Today, pleasure crafts, as well as merchant and passenger ships, collect the centuries-old tradition of colour as a symbol applied to the image of naval vessels. The majesty of the great transatlantic liners is imitated by the bigger and bigger yachts often becoming more and more real ships, with the choice either of the white-black contrast or total white (Eliseo - Piccione, 2001). The lines of the designers take turns with ever more complex shapes that, to be opportunely subjected to painting cycles, must be suitably plastered to offer perfectly smooth surfaces on which to lay colours with different ranges of finishes.

And always in the wake of tradition, colour becomes an element of uniqueness, becoming the object of experimentation as in the case of Jeff Koons's intervention on *M/Y Guilty*, where he proposes the practice of *camouflage* on all surfaces as if to dematerialize the yacht and not get the true forms perceived. Or as for the Yacht R.C., where the hull has been entirely treated with iridescent painting that allows the vessel to always perceive a different colour depending on the angle of incidence of the light. Similarly, shipping companies turn to colours and designs to make their fleet immediately distinguishable and to communicate the playful spirit that animates its services.

7. CONCLUSIONS

The determination of the colour of a naval vessel, which can appear as an aspect entrusted to purely subjective or occasional choice processes, reveals, on the contrary, to be the result of a process in which a multiplicity of

tutto per lasciare spazio a criteri di maggiore funzionalità. Imponenti scafi scuri connotano navi mercantili, navi da guerra e perfino i transatlantici, a cui fa contrasto la sovrastruttura colorata generalmente di bianco. I colori delle compagnie armatrici, quando compaiono, lo fanno sotto forma di sottili linee di colore o direttamente nei loghi dipinti sui fumaioi.

Proprio per cercare di cambiare l'immagine evocativa dell'abbinamento bianco e nero, i primi transatlantici costruiti dopo la seconda guerra mondiale, introdurranno il colore bianco anche per lo scafo creando così un effetto meno austero [2].

6. TRANSATLANTICI, NAVI PASSEGGERI E YACHT OGGI: IL COLORE COME ELEMENTO DI UNICITÀ E DI IDENTITÀ

Oggi sia nei mezzi da diporto sia nelle navi mercantili come nelle navi passeggeri raccolgono la tradizione secolare del colore come simbolo applicato all'immagine dei mezzi navali.

La maestosità dei grandi transatlantici viene riproposta dai grandi yacht, sempre più grandi e sempre più vere e proprie navi, con la scelta del contrasto bianco – nero o del total white (Eliseo - Piccione, 2001). Le linee dei designer si sbizzarriscono con forme sempre più complesse che, per essere poi opportunamente sottoposte a cicli di pitturazione, devono essere opportunamente stuccate per offrire superfici perfettamente lisce su cui stendere colori con differenti gamme di finiture.

E sempre nella scia della tradizione il colore diventa elemento di unicità, diventando oggetto di sperimentazioni come nel caso dell'intervento di Jeff Koons sul *M/Y Guilty* in cui ripropone la pratica del *camouflage* su tutte le superfici come a voler smaterializzare lo yacht e a non farne percepire le vere forme. O ancora come per lo Yacht R.C. in cui lo scafo è stato interamente trattato con una pitturazione cangiante che permette di percepire la nave sempre di colore diverso a seconda dell'angolo di incidenza della luce.

Analogamente compagnie armatrici si rivolgono a colori e disegni per rendere immediatamente distinguibile la propria flotta e per voler comunicare lo spirito ludico che anima i propri servizi.

historicized factors and precise connotations contribute to determine the final result. If it is true that in the past the choice of a specific colour or of a decorative register originally corresponded to functional needs of a propitiatory type, of recognizability or of a manifestation of prestige. Today, since these needs are lacking, we are witnessing a variegated proliferation of solutions in which various kinds of conditioning emerge. There is often, with different levels of awareness, the evident desire for references to the Past even where, at first reading, it has moved from a spirit with innovative ambitions. In terms of actual innovation, therefore, the evaluation of the communicative potential of the external *facies* of a vessel can be a field of interest (Ruggiero, 2016), especially in the light of new technological opportunities both in the field of materials and in the formal solutions [3].

CONFLICT OF INTEREST

The author declares that nothing has affected her objectivity or independence in the production of this work. Neither the author has any financial interest in the people, topics or companies involved by this article. Neither the author had a professional relationship with the people and companies cited in this article. Neither the author is involved in legal dispute with the people and companies cited in this article. No conflict of interest including financial, personal or other relationship with other people and organization within three years of beginning the submitted work that could inappropriately influence or be perceived to influence this work.

NOTES

[1] In the text of B. Lavery: *Ships. 5000 years of adventures at sea* numerous images are presented concerning the galleys in the Mediterranean.

7. CONCLUSIONI

La determinazione del colore di un mezzo navale, che può apparire come un aspetto demandato a processi di scelta meramente soggettivi o occasionali, rivela, al contrario, di essere il risultato di un processo in cui una molteplicità di fattori storicizzati e con precise connotazioni concorrono per determinare il risultato finale. Se è vero che da un lato originariamente la scelta di uno specifico colore o di un registro decorativo rispondeva ad esigenze funzionali di tipo propiziatorio, di riconoscibilità o di manifestazione di prestigio, dall'altra oggi, venendo meno questi bisogni, si assiste piuttosto ad una variegata proliferazione di soluzioni in cui emergono a tratti condizionamenti di varia natura tra cui spesso – con differenti livelli di consapevolezza – spicca la evidente volontà di richiami al passato anche là dove, ad una prima lettura, si è mossi da uno spirito con velleità innovative.

In termini di innovazione vera e propria può quindi costituire un campo di indagine di interesse (Ruggiero, 2016), la valutazione del potenziale comunicativo della *facies* esterna di un mezzo navale soprattutto alla luce di nuove opportunità tecnologiche sia nel campo dei materiali che delle soluzioni formali (3).

NOTE

[1] Nel testo di B. Lavery *Navi. 5000 anni di avventure in mare*, vengono presentate numerose immagini relative alle Galee presenti nel Mediterraneo.

[2] Una ampia ed esaustiva panoramica del mondo dei grandi transatlantici del XX secolo è affrontata nel testo *Transatlantici* di M. Eliseo, P. Piccione.

[3] Ruggiero V. (2016), *Changes in design approach for large yachts*, Proceedings book, Book 4 Volume II, III International Multidisciplinary scientific conference on social sciences & arts - SGEM 2016, Wien, Sofia: Stef92 Technology Ltd,

Figure 7 - Clockwise from top - right: Study for a Maxy Yacht by Zaha Hadid; the structure of naturalistic inspiration is completely detached from the composition according to horizontal bands of classical ships. Experimental project Voronoi with decomposed superstructure in an open cage,

Study for a boat inspired by the colours of Mondrian (Vasily Klyukin design). Super-fast boat built by the Palmer & Johnson shipyard; squared lines and use of colour are elements of strong characterization.

Figura 7 - In senso orario dall'alto a destra: Studio per un Maxy Yacht opera di Zaha Adid; la struttura di ispirazione naturalistica si distacca completamente dalla composizione secondo fasce orizzontali delle navi classiche. Progetto sperimentale Voronoi con sovrastruttura scomposta in una gabbia aperta, Studio per una imbarcazione ispirata ai colori di mondrian (Vasily Klyukin design). Imbarcazione super veloce realizzata dal cantiere Palmer & Johnson; linee squadrate e uso del colore sono elementi di forte caratterizzazione.



[2] A wide and comprehensive overview of the world and the Great transatlantic liners of the XX c. is addressed in M. Eliseo, P. Piccione. *Transatlantici*.

pp 155-164. Nel testo citato viene illustrata l'evoluzione tecnica applicata a forme e scelte stilistiche nella costruzione di grandi navi da diporto.

[3] Ruggiero V. (2016), *Changes in design approach for large yachts*, Proceedings book, Book 4 Volume II, III International Multidisciplinary Scientific Conference on Social Sciences & Arts-SGEM 2016, Wien, Sofia: Stef 92 Technology Ltd, pp. 155-164. The quoted text illustrates the technical evolution applied to stylistic shapes and choices in the construction of large recreational ships.

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The contribution of colour in the artistic representation of the sacred.*

International symbolism between the nineteenth and twentieth centuries

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ABSTRACT

After a long period of crisis and repetition of past schemes, at the end of the nineteenth century the sacred theme returns to be an innovative field of interest for the arts. The interpretation of colour in its hues, which take on a symbolic value, is a basic aspect of the renewal brought by artists such as Franz Von Stuck, Max Klinger, Egon Schiele in the Austro-German environment, or Gauguin and his school in France. Those who instead settle on influences from the masters of the Middle Ages and Renaissance especially in drawings, recovering traditional iconographic models, precisely through colour and renewed gradations of industrial colours bring about a modern development in painting and especially in wall decorations, from Maurice Denis, here recalled, to Gino Severini, as we will see in the second part of the essay to be published soon.

Italian translation provided:

*L'apporto del colore nella
rappresentazione artistica del sacro.
Simbolismo Internazionale fra Otto e
Novecento*

KEYWORDS

Sacred art, symbolic colour, light, emotional state, blue, red, yellow, triune colours

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* These pages are born in relation to the research of the author as a curator for the exhibition *Divina Bellezza fra Van Gogh, Chagall e Fontana* (Divine Beauty between Van Gogh, Chagall and Fontana) in Florence, Palazzo Strozzi, September 26, 2015 to January 24, 2016, and constitute a first part of a reflection on the role of colour in the international artistic representation of the sacred theme at the end of the nineteenth century, which will be followed by a second part, soon to be published, on the Italian context between the nineteenth century and the first half of the twentieth century.

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*I have tried to explain
colour as living matter*

P. Gauguin, Scattered notes (1896-97)

*Ho cercato di spiegare
il colore come materia viva*

P. Gauguin, Note sparse (1896-97)

At the end of the nineteenth century, the sacred subjects returned to be looked at with modern sensibility and styles, after a century in which the dull imitation of past models had prevailed. Among the symbolists, for instance, the sense of the divine and of the ascesis is often manifested through the aid of luminous colours. In this sense, the painting by Belgian Ferdinand Khnopff is emblematic *Après Flaubert* [1]. *La Tentation de Saint Antoine* (1883).

A fine Ottocento i soggetti sacri tornano ad essere frequentati con sensibilità e stili moderni dagli artisti, dopo un secolo in cui era prevalsa la muta imitazione di modelli passati. Fra i simbolisti, ad esempio, attraverso l'ausilio del colore luminoso trova spesso manifestazione il senso del divino e dell'ascesi. Emblematico in tal senso è il quadro del belga Ferdinand Khnopff *Après Flaubert* [1]. *La Tentation de Saint Antoine* (1883).

Figure 1 - Ferdinand Khnopff, *Après Flaubert. La Tentation de Saint Antoine*, 1883. Brussels, Musées royaux des Beaux-Arts de Belgique.

Figura 1 - Ferdinand Khnopff, *Après Flaubert. La Tentation de Saint Antoine*, 1883. Bruxelles, Musées royaux des Beaux-Arts de Belgique



Unlike Félicien Rops and Domenico Morelli who represent the same theme in a more narrative way, Khnopff solves it in a centripetal bright dazzle (Howe, 2004). The features of the Queen of Sheba, symbol of temptation, emerge through the beam of divine light that reverberates in the saint and

A differenza di Félicien Rops e Domenico Morelli che rappresentano lo stesso tema in modo più narrativo, Khnopff lo risolve in un centripeto abbaglio luminoso (Howe, 2004). Le fattezze della regina di Saba, simbolo di tentazione, affiorano attraverso il fascio di luce divina che si riverbera nel santo e

"concentrates all the anxieties, the sufferings, the temptations of the invisible, of the dream, of the terrible, the agonies of the soul and the spirit" (Verhaeren 1884).

"concentra tutte le inquietudini, le sofferenze, le tentazioni dell'invisibile, del sogno, del terribile, le agonie dell'anima e dello spirito" (Verhaeren 1884).

With this work, we are at the origins of the representation of the immaterial and the

Con quest'opera siamo alle origini della raffigurazione dell'immateriale e dello spirituale.

spiritual.

The use of colour in sacred themes by Gauguin has a completely different meaning, but this also undermines narrative realism. Through mixed layers of solid colour, the analogical synthesist language is also adopted by those who, like Maurice Denis and the school of the Benedictine monks of Beuron, recognised in that a plain and essential message able to manifest devotion. Émile Bernard writes of having come to the synthesis of forms in the awareness that

"painting, being decorative, must above all satisfy the eye and the mind; and to this end, there are only two instruments: colour and the conception of the painting" (Bernard 1939).

These are the main compositional registers of the synthesist style of Gauguin, whose very famous *Vision after the sermon* of 1886, among the first paintings made on these foundations, was defined as the first symbolist manifestation by critic Alber Aurier in his famous article on *"Mercure de France"* (Aurier 1893).

In this early masterpiece that brings forward a vision - the struggle of Jacob and the angel - the chromatic connotations have a clear correspondence to sacred symbolism: the imagined scene is suspended against a compact background of red, combined with the blue of the garments and the gold of the angel's wings.

"I tried to talk about colour and to explain it as a living material"

the artist will write in his *Scattered notes*

"like the body of an animated being. I am left with his spirit, his elusive fluid and all that he has been able to create by means of talent and sensitivity: talking about the colour that stimulates the imagination enriching our dream and opening new horizons towards the infinite and the unknown" (Gauguin 1988).

In paintings with a sacred theme, which largely coincide with the religious self-portraits, painted between 1889 and 1890, the yellow bath is intentional. As Gauguin himself explains, it is a symbolic predominance, closely linked to the autobiographical interpretation, from the *Yellow Christ* to the *Self-portrait with the halo* [2] developed on two colour sections: red, sign of the shed blood, bounded by the energetic profiles of the snake, symbol of sin, while the face of the Christ self-portrait is immersed in the middle of the picture among an expanse of solar yellow, a divine sign to reaffirming the role that Gauguin proposes of himself as *"misunderstood messiah"* (Cachin 1968, 1988), not by chance already predominant in *Yellow Christ* (1889) and in the emblematic self-

L'uso del colore nei temi sacri di Gauguin ha tutta un'altra accezione ma anche questa va a scardinare il realismo narrativo. Attraverso stesure unite di colore, il linguaggio sintetista analogico viene adottato anche da chi, come Maurice Denis e la scuola dei monaci benedettini di Beuron, vi riconobbe un messaggio piano ed essenziale atto a manifestare devozione.

Émile Bernard scrive d'essere giunto alla sintesi delle forme nella consapevolezza che

"la pittura, essendo decorativa deve soprattutto soddisfare l'occhio e la mente; e per questo esistono soltanto due mezzi: il colore e l'ideazione del quadro" (Bernard 1939).

Sono questi i principali registri compositivi dello stile sintetista di Gauguin la cui celeberrima *Apparizione dopo il sermone* del 1886, fra i primi quadri condotti su questi fondamenti, è stata definita prima manifestazione simbolista dal critico Alber Aurier in un suo noto articolo sul *"Mercure de France"* (Aurier 1893).

In questo capolavoro giovanile che rende percepibile una visione - la lotta di Giacobbe e l'angelo - le connotazioni cromatiche hanno una palese rispondenza alla simbologia sacra: la scena immaginata è sospesa contro una stesura compatta di rosso, combinato con l'azzurro delle vesti e l'oro delle ali dell'angelo.

"Ho cercato di parlare e di spiegare il colore come materia viva"

scriverà l'artista nelle sue *Note sparse*

"come il corpo di un essere animato. Mi rimane il suo spirito, il suo fluido inafferrabile e tutto ciò che ha saputo creare per mezzo del talento e della sensibilità: parlare del colore che stimola l'immaginazione arricchendo il nostro sogno e aprendo nuovi orizzonti verso l'infinito e l'ignoto" (Gauguin 1988).

Nei quadri a tema sacro che coincidono per buona parte con gli autoritratti religiosi, dipinti fra 1889 e 1890, il bagno di giallo è intenzionale come spiega lo stesso Gauguin, predominanza simbolica, legata strettamente all'interpretazione autobiografica, dal *Cristo giallo* all'*Autoritratto con l'aureola* [2] sviluppato su due sezioni cromatiche: il rosso, segno del sangue versato, delimitato dagli energetici profili del serpente simbolo del peccato, mentre il volto del Cristo autoritratto si immerge nella metà del quadro in balia di una distesa di giallo, tono solare, segno divino a ribadire il ruolo che Gauguin propone di sé quale *"messia incompreso"* (Cachin 1968, 1988) non a caso già predominante nel *Cristo giallo* (1889) e nell'emblematico autoritratto posto fra



Figure 2 - Paul Gauguin, Yellow Christ, 1889. Buffalo (New York), Albright-Knox Art Gallery

Figura 2 - Paul Gauguin, Cristo giallo, 1889. Buffalo (New York), Albright-Knox Art Gallery

portrait placed between the crucifix and the fire-pottery in human appearance, a sort of triple portrait reflecting the profound ambivalences of the Gauguinian character: the sacred and 'sensitive' part (Messina 2006) again portrayed in shades of yellow, contrasting with the darker and earthy tones of the 'wild' and primitive part. The artist wanted a yellow colour also for the walls of the atelier in rue Vercingétorix in Paris, where he moved after his stay in Provence with Van Gogh, who had lived in the 'yellow house' in Arles. Therefore, be it the walls that surround the streets of Arles, the Provencal fields or the nature around the Javanese temples up to the complexion of Christ, it is evident that Gauguin's symbolic chromatic choice translates an 'emotional state'. As it is the case of the cold tones in the Deposition in green that, writes Gauguin to Theo Van Gogh in autumn 1889, are a sign of the pain experienced, the primordial religion and the strength of nature with its desperate cry" Paul Gauguin:

il crocifisso e la ceramica a fuoco in sembiante umano, una sorta di triplice ritratto che rispecchia le profonde ambivalenze dell'indole gauguiniana: la parte sacra e 'sensitiva' (Messina 2006) rappresentata ancora una volta nei toni del giallo, a contrasto dei toni corruschi e terrosi della parte 'selvaggia' e primitiva. Di giallo l'artista aveva voluto fossero rivestite le pareti dell'atelier di rue Vercingétorix a Parigi, abitato successivamente al soggiorno in Provenza con Van Gogh che ad Arles aveva vissuto nella 'casa gialla'. Siano dunque i muri che delimitano le strade di Arles, i campi provenzali o la natura attorno ai templi giavanesi fino all'incarnato del Cristo, è evidente che la scelta cromatica simbolica di Gauguin traduce uno 'stato emotivo'. Così come scrive Gauguin a Theo Van Gogh nell'autunno 1889, i toni freddi nella Deposizione in verde sono segno del dolore provato, della religione primordiale e della forza della natura con il suo grido disperato" (Paul Gauguin: 45 lettres à Vincent. Théo et



Figure 3 - Paul Gauguin, The Green Christ (Brittany Calvary 1889, Brussels, Musées royalux des Beaux-Arts de Belgique)

Figura 3 - Paul Gauguin, Il Cristo verde (Calvario bretone), 1889, Bruxelles, Musées royalux des Beaux-Arts de Belgique

45 lettres à Vincent. Théo et Jo van Gogh 1983), "metaphor of the eternal sacrifice" (Morice 1920), spread by Denis and the Nabis. It is indicative that Maurice Denis, among the disciples who acquired the language of signs and colours of Gauguin with Christian devotion, was the owner of the self-portrait with the yellow Christ. From the initiation received from Gauguin, he was able to gather - religious journals commented - the

"mystery in the symbol, marrying a more spiritual and synthetic composition with the results of the most modern studies on technique and colour" (Margotti 1914).

In this sense, Denis became a model of renewal also for Italian sacred art [3]. Colour for him was "a tool for expression no different than drawing and chiaroscuro" (Margotti 1914), together able to generate "order, rhythm, rule" (Margotti 1914, p.71) [4], "an expression of continuity". Thus he started

Jo van Gogh 1983), "metafora del sacrificio eterno" (Morice 1920) come Denis e i Nabis divulgarono. È indicativo che Maurice Denis, fra i discepoli che acquisirono il linguaggio di segni e colori di Gauguin con devozione cristiana, possedesse l'autoritratto con il Cristo giallo. Dall'iniziazione gauguiniana egli seppe raccogliere – si scriveva nelle riviste di indirizzo religioso – il

"mistero nel simbolo, sposando una composizione maggiormente spirituale e sintetica coi risultati degli studi modernissimi della tecnica e del colore" (Margotti 1914).

In tal senso Denis divenne un modello di rinnovamento anche per l'arte sacra italiana [3]. Il colore per lui era "tramite di espressione non meno del disegno e del chiaroscuro" (Margotti 1914), insieme atti a generare "ordine, ritmo, regola" (Margotti 1914, p.71) [4], "espressione di continuità". Così avviò il movimento

the neo-traditionalist movement following the example of Giotto and Beato Angelico who guided him to the half-tones and the luminous gradations.

"The splendour, the freshness of colours narrate the joy of the world redeemed and regenerated by the same God" (Margotti 1914, p.83)

Denis wrote in his theoretical text, *Theories*. We can therefore understand how the transition from a trestle painting to wall decoration painting in light tones of the early twentieth century sacred art represented a natural process of liturgical renewal, and the clear chromatic score reflected an homage to tradition but according to an expressive timbre renewed by colour used in half tones, from rosés to greys. Denis himself decorates churches and designed stained glass windows. In 1919, with painter Georges Desvallières, he founded the *Ateliers d'Art Sacré*, a sort of neo-medieval workshops, as well as the Benedictine school of Beuron[5], monks artists able to devote themselves to all type of arts present in religious buildings. In Italy, the latter had created the decoration of the crypt of Montecassino between 1899 and 1910 with impeccable skill in the primitive languages of the Germanic tradition (Costantini 1911, Janssens 1913). Colour here is subordinate to the tight compositional framework, but thanks to Denis, who in 1904 wrote the preface to the French translation, conducted by Nabi Paul Sérusier, the writings of the founder of Beuron, Lenz, and to the Dutch Jan Verkade, whose synthetic style passes through French synthesisism in Beuron's school, the intense colour shades and the soft outlines will transit through these schools into the re-foundation of a Catholic linguistic koinè based on the formal models of the past but united with modern chromatic gradations. And it is precisely in colour that the liturgical renewal seems to re-establish itself. Verkade had mitigated his bright and dense symbolic tones of the synthesist era following the example of Giotto and Angelico. For instance, see his first religious picture, *San Sebastiano* of 1892, conducted in the gradations of lemon yellow and acid in the manner of Gauguin but already painted in tempera, the technique that, diluted with egg white, will be used in the Beuron decorations. Celso Costantini in 1911 on Emporium, contrasts these new sacred representations to a general diffusion in Italy of the cheap

neotradizionalista sull'esempio di Giotto e Beato Angelico che lo guidavano ai mezzi toni e alle gradazioni luminose.

"Lo splendore, la freschezza dei colori dicono l'allegrezza del mondo redento e rigenerato dallo stesso Dio" (Margotti 1914, p.83)

scriveva Denis nel suo testo teorico, *Théories*. Si può intendere quindi come il passaggio dal quadro da cavalletto alla pittura decorativa murale a toni chiari nell'ambito dell'arte sacra d'inizio secolo rappresentasse un naturale processo di rinnovamento in funzione liturgica, e la partitura cromatica chiara rispecchiasse insieme l'omaggio alla tradizione ma secondo un timbro espressivo rinnovato proprio dal colore a mezzi toni, dai rosati ai grigi. Lo stesso Denis decora chiese, disegna vetrate. Nel 1919 con il pittore Georges Desvallières fonda gli *Ateliers d'Art Sacré*, una sorta di botteghe neomedievali, come anche la scuola benedettina di Beuron, artisti monaci capaci di dedicarsi a tutte le arti compresenti nelle sedi religiose. In Italia quest'ultima aveva realizzato la decorazione della cripta di Montecassino fra 1899 e 1910 con impeccabile perizia nei linguaggi primitivi della tradizione germanica (Costantini 1911, Janssens 1913). Il colore qui è subordinato al

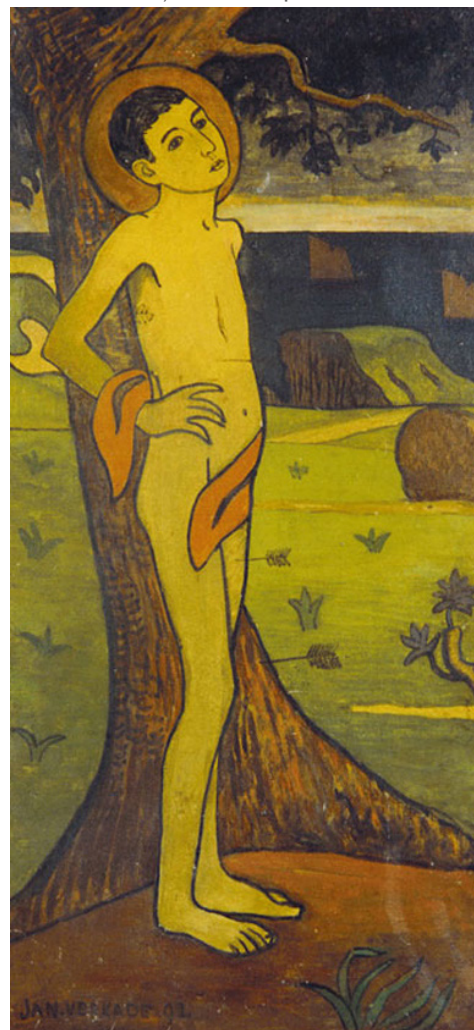


Figure 4 - Jan Verkade, San Sebastiano, 1892. Musée Départemental Maurice Denis, Saint-Germain-en-Laye Cedex

"stucco statues, drunk with colour, which are sold in bulk and disfigure our churches" (Costantini 1911, p.83) .

Figura 4 - Jan Verkade, San Sebastiano, 1892. Musée Départemental Maurice Denis, Saint-Germain-en-Laye Cedex

In German symbolist artistic circles, although



Figure 5 - Max Klinger, *Crucifixion*, 1890. Leipzig, Museum der bildenden K nst

Figura 5 - Max Klinger, *Crocifissione*, 1890. Lipsia, Museum der bildenden K nst

colour remains delimited within a rigorous design, it reaches surprising results in the representation of sacred themed scenes, independent of the confessional doctrine of the Church that by contrast the Beuron school relies on. The impressive *Crucifixion* by Max Klinger (Max Klinger, 1996; Nordic nightmares and Mediterranean myths, 2014) in the manner of Antonello or Holbain, is pervaded with natural light that enhances the very human monumentality of the characters and expands on a Golgotha symbolically transposed on the Tuscan hills - there are those who recognised Siena in the background - and therefore within a Mediterranean brightness so loved by German painters as a symbolic light of the manifestation of universal life, of history, and of religion as well. The background made of many luminous apparitions on the tones of orange and violet, like a divine reverberation that winds also among the characters on the foreground, disseminated without any realism from any specific solar source, but rather emanated by Christ. Colours that reinforce the dialogue between intense expressions, among which the central and frontal dominating presence of San Giovanni, like an orchestrator, and not by chance assuming the features of Beethoven. In 1901, Viennese collector Alexander Hummel acquired the large painting with two others of similar size and chromatic intensity with the intention of creating a temple in which this work would have had the task of representing the allegory of Christianity [6].

What is certain is that this painting became a model for his contemporaries. Franz von Stuck, a teacher at the Munich Academy and one of the founders of the Munich Secession, took up the close approach of the *Crucifixion* by Klinger, exhibited in Munich in 1891. He emphasises it rotating the body of the thief that emerges from an energetic chiaroscuro in relief on which falls the bird's eye perspective of the observer (Tiddia, 2006, sheet 44, p.144). Also the sorrowful are

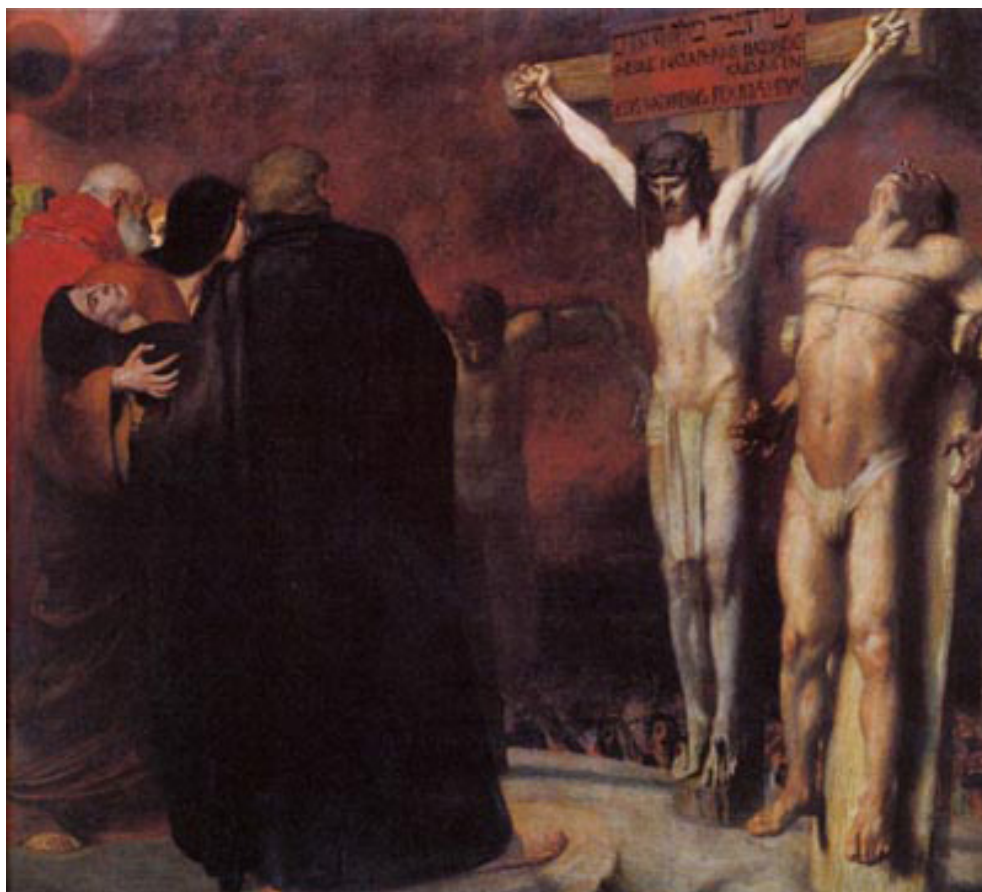
serrato impianto compositivo, ma grazie a Denis, che nel 1904 scrive la prefazione alla traduzione francese, condotta dal nabi Paul S r usier, degli scritti del fondatore di Beuron, Lenz, e all'olandese Jan Verkade, il cui stile sintetico passa attraverso il sintetismo francese nella scuola di Beuron, le intense cromie e i contorni blandi e morbidi transiteranno attraverso queste scuole nella rifondazione di una koin  linguistica cattolica basata sui modelli formali del passato ma uniti a gradazioni cromatiche moderne. E proprio nel colore sembra rifondarsi il rinnovamento liturgico. Verkade aveva mitigato i suoi accesi e densi toni simbolici dell'epoca sintetista sull'esempio di Giotto e dell'Angelico. Valga ad esempio il suo primo quadro religioso, *San Sebastiano* del 1892, condotto nelle gradazioni del giallo limone ed acido alla maniera di Gauguin ma gi  dipinto a tempera la tecnica che, stemperata al chiaro d'uovo, verr  adottata nelle decorazioni di Beuron. Celso Costantini nel 1911 su Emporium contrappone queste nuove rappresentazioni sacre ad una generale diffusione in Italia delle dozzinali

"statue di stucco, ubriache di colore, che si vendono un tanto al metro e che deturpano le nostre chiese" (Costantini 1911, p.83).

Negli ambienti artistici simbolisti tedeschi sebbene il colore resti incardinato entro un disegno rigoroso raggiunge esiti non scontati nella raffigurazione di scene a tema sacro, autonomi dalla dottrina confessionale della Chiesa dalla quale dipende invece la scuola di Beuron. L'imponente *Crocifissione* di Max Klinger (Max Klinger, 1996; Incubi nordici e miti mediterranei, 2014) alla maniera di Antonello o Holbain,   pervasa di luce naturale che esalta la monumentalit  umanissima dei personaggi e si espande su un Golgota simbolicamente trasposto fra le colline toscane - c'  chi ha riconosciuto Siena sullo sfondo - e quindi entro una luminosit  mediterranea tanto amata

Figure 6 - Franz Von Stuck, Crucifixion, 1892. Private collection

Figura 6 - Franz Von Stuck, Crocifissione, 1892. Collezione privata



a tangible presence thanks to the blood-red density of their robes, sign of the blood shed and spread on the celestial dome above a crowd that occupies the background and whose cry expands into the red sky intoxicated with blues and violet reverberations. Same setting in the *Crucifixion* in blue of 1911ca exhibited at the Leipzig Museum, which had been created for a church in Stuttgart, but it had been refused. We are on the ridge of the overturning of the space built by the academic and realistic composition, which finds in colour the *modus operandi* signifying the crisis of the realistic approach. The symbolic intensity of the painting is played on the chromatic register, from the cobalt blue of the sorrowful to the dark geometry of the cross that is denied to the light, mirroring the pure light inside the bloodless Christ. To this date, Stuck had already encouraged his students founders of the Blaue Reiter (1911-1914) to pursue their experiments probably knowing the speculations of Kandinsky engaged in the drafting of *Spiritual in art* (1909-1910). Actually, it would seem that this painting, despite its figurative layout, is affected by the perception of colours reduced to symbolic essentiality and to the scheme of tones around the sensations of heat and cold, light and dark, of which Kandinsky writes:

Colours that generally tend to yellow or blue are warm or cold. This distinction is applied, so to speak, on the same surface: the colour maintains its fundamental sound, which

dai pittori tedeschi come luce simbolica di manifestazione della vita universale, della storia, della religione anche. Lo sfondo è tutto un rimando di apparizioni luminose sui toni dell'arancio, del viola come un riverbero divino che serpeggia anche fra i personaggi del primo piano, disseminato senza verosimiglianza da alcuna specifica fonte solare, piuttosto emanata dal Cristo. Colori che rafforzano il dialogo fra espressioni intense sulle quali domina quella centrale e frontale di San Giovanni come un orchestratore, al quale non a caso presta il sembiante Beethoven. Nel 1901 il collezionista viennese Alexander Hummel, acquista il grande quadro con altri due di analoga dimensione e intensità cromatica col progetto di realizzare un tempio nel quale quest'opera avrebbe avuto il compito di rappresentare l'allegoria del cristianesimo [6].

Certo è che questo quadro divenne un modello per i contemporanei. Franz von Stuck, insegnante all'Accademia di Monaco di Baviera e fra i fondatori della Secessione monacense, riprende l'impostazione ravvicinata della *Crocifissione* di Klinger, esposta a Monaco nel 1891. La enfatizza roteando il corpo del ladrone che emerge da un energico chiaroscuro a rilievo su cui precipita il punto di vista a volo d'uccello dell'osservatore (Tiddia, 2006, scheda 44, p.144). Anche i dolenti sono una presenza tangibile grazie alla densità rosso sangue delle loro vesti, segno del sangue versato e propagato sulla calotta celeste al di sopra di una folla che

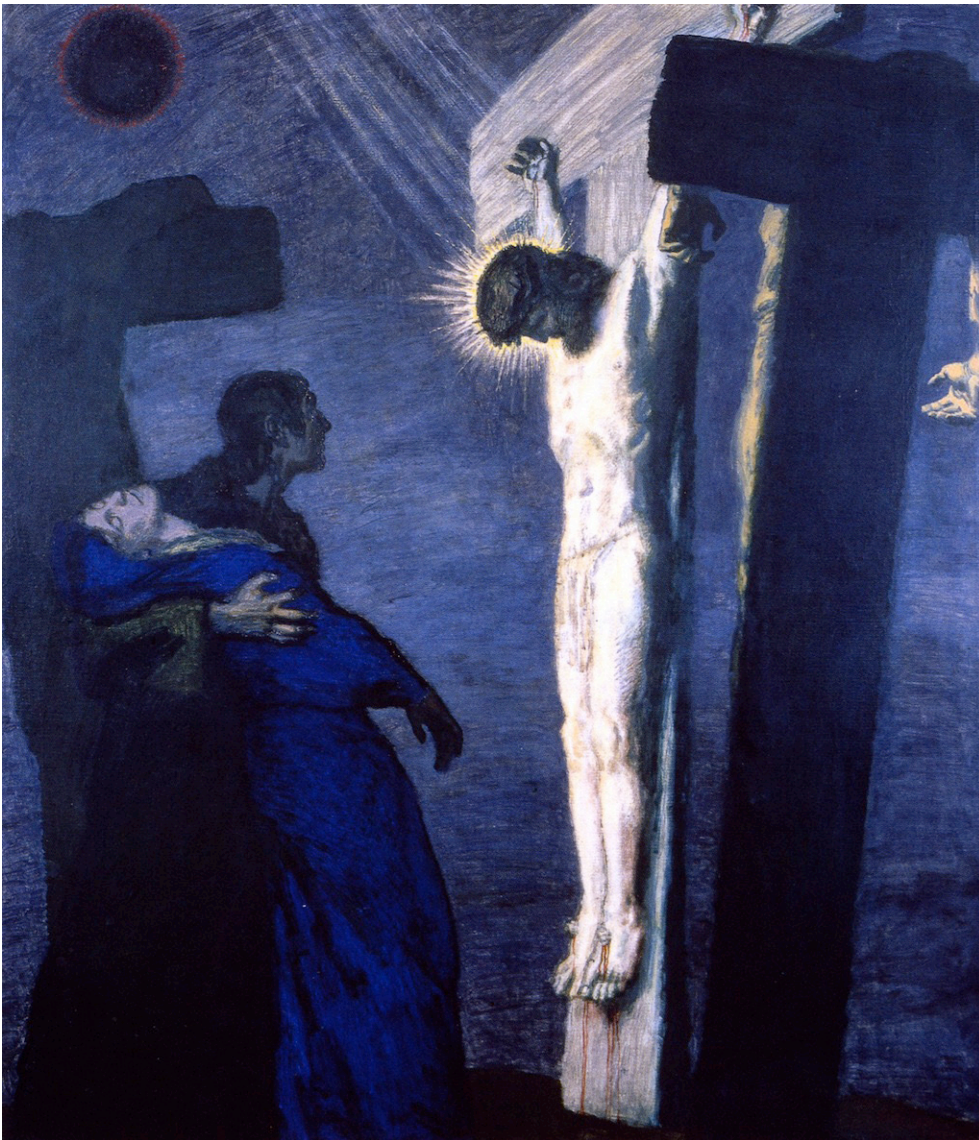


Figure 7 - Franz Von Stuck, Crucifixion, 1911ca, Leipzig, Museum der bildenden K nst

Figura 7 - Franz Von Stuck, Crocifissione, 1911ca, Lipsia, Museum der bildenden K nst

becomes however more material or more non-material. Then a horizontal movement occurs: the warm colour moves on the surface towards the spectators, the cold one moves away from them.

In addition to moving horizontally, these colours have another movement, which differentiates them on the inside. This is the origin of the first great inner contrast. The tendency of a colour towards cold or warmth therefore has an immense importance [7].

[Generally speaking, warmth or cold in a colour is respectively an inclination towards yellow or blue. This distinction appears, as it were, on one surface, colour having the constant fundamental appeal but assuming either a more material or non-material quality. As it is a horizontal movement, the warm colours move on this horizontal surface towards the spectator striving to reach him while the cold ones retreat from him.

Colours themselves, which cause this horizontal movement in another colour, are equally characterised by this same movement. Yet, they possess another movement, which

occupa il secondo piano e il cui grido si espande nel cielo rosso intossicato di azzurri e riverberi violacei. Stessa impostazione nella *Crocifissione* in blu del 1911ca conservata al Museo di Lipsia, che era stata realizzata per una chiesa di Stoccarda, ma rifiutata. Siamo sul crinale del ribaltamento dello spazio costruito dal disegno accademico e realista, che trova nel colore il *modus operandi* significativo la messa in crisi del verosimile. L'intensit  simbolica del quadro si gioca sul registro cromatico, dalla sagoma blu cobalto della dolente a quella geometrica oscura della croce negata alla luce, speculare alla luce pura interna al Cristo esangue. A questa data Stuck aveva gi  incoraggiato i suoi allievi fondatori del Blaue Reiter (1911-1914) a perseguire le proprie sperimentazioni probabilmente conoscendo le speculazioni di Kandinsky impegnato nella stesura dello *Spirituale nell'arte* (1909-1910). Si direbbe anzi che questo quadro, pur conservando impianto figurativo risenta della percezione dei colori ridotta ad essenzialit  simbolica e allo schema dei toni attorno alle sensazioni di caldo e freddo, chiaro e scuro di cui scrive Kandinsky:

strongly divides them from one another, through their inner appeal producing in this manner the first great contrast in the inner value. Therefore, the inclination of colour to cold or warm is of tremendous essential inner importance (Kandinsky (1912) 1946, p.60)].

The secessionist German circles could already be looked with interest by Egon Schiele, a young and restless Austrian, dissatisfied with the academic teaching of Vienna when he painted in 1907 his own *Crucifixion* [8]. The setting seems aware of the controversial monumental picture by Klinger already purchased by the compatriot of Schiele, Hummel: again a close-up, and a landscape emptied of characters, but saturated with colours symbolising feelings, which seems to reflect the compositional influences from the chromatic *Crucifixion* by Stuck of 1892. The future expressionist also introduces a direct reference with the halo and the eclipse of the sun, and bases its *Crucifixion* on the expressive qualities of colour even more than Stuck's emotional blue painting, in tune with the expressionist intensity of Gauguin and Van Gogh. Therefore, our analysis of the sacred art in the symbolist epoch confirms how essential the role of colour has been for this niche theme, with metaphorical values, in the

È caldo o freddo il colore che tende generalmente al giallo o al blu. Questa distinzione si applica per così dire all'interno di una stessa superficie: il colore mantiene il proprio suono fondamentale, che diventa però più materiale o più immateriale. Si verifica allora un movimento orizzontale: il colore caldo si muove sulla superficie verso lo spettatore, quello freddo se ne allontana.

Oltre a far muovere e a muoversi in orizzontale questi colori hanno un altro movimento, che li differenzia interiormente. Nasce di qui il primo grande contrasto interiore. La tendenza di un colore al freddo o al caldo ha dunque un'immensa importanza [7].

[Generally speaking, warmth or cold in a colour is respectively an inclination towards yellow or blue. This distinction appears, as it were, on one surface, colour having the constant fundamental appeal but assuming either a more material or non-material quality. As it is a horizontal movement, the warm colours move on this horizontal surface towards the spectator striving to reach him while the cold ones retreat from him.

Colours themselves, which cause this horizontal movement in another colour, are equally characterized by this same movement.

Figure 8 - Egon Schiele, *Crucifixion*, 1907. Private collection

Figura 8 - Egon Schiele, *Crocifissione*, 1907. Collezione privata



moment of the autonomy of art reached from the official Church, which corresponded to the pivotal overcoming of figuration through the expressive potential of colour.

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CONFLICT OF INTEREST

The author declares that nothing affected her objectivity or independence and original work. So any conflict of interest exists.

NOTES

[1] Flaubert's famous novel dedicated to the hermit of Thebes who fortifies his faith in response to temptations was published in 1874 and constituted one of the greatest inspirational repertoires for symbolists.

[2] It was created for the decoration of the dining room of the Buvette de la Plage tavern in Le Pouldu Brittany.

[3] The harmonic and subdued colours within a pronounced synthetic linearism in Italian art of those years are often identifiable in the influence of Denis, for instance in Elisabeth Chaplin, Carena, Bacci, Garbari.

[4] *ibid*, p.71. We can recall the famous words with which Denis defined the school he had founded "Se rappeler qu'un tableau, avant d'être un cheval de bataille, une femme nue ou une quelconque anecdote, est essentiellement une surface plane recouverte de couleurs en un certain ordre assemblées" cf. "Art et Critique", August 30th 1890.

[5] Please refer to the recent Italian edition of the founder's writings Desiderius Lenz (Lenz 2015).

[6] The other two works were the Judgment of Paris and the Christ in Olympus.

[7] W.Kandinsky, The language of forms and colours in Lo spiruale nell'arte (1909), Munich 1912 engl. ed. Concerning the Spiritual in Art

[8] I owe the indication of this picture to Alessandra Tiddia. In turn, the scholar, an expert on transitional art in the Central European area, makes reference to the interpretative studies of Christian Bauer, (2015).

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Yet, they possess still another movement, which strongly divides them from one another, through their inner appela producing in this manner the first great contrast in the inner value. Therefore, the inclination of colour to cold or warm is of tremendous essential inner importance (Kandinsky (1912) 1946, p.60)].

Agli ambienti secessionisti tedeschi poteva già guardare con interesse Egon Schiele, giovane irrequieto austriaco, insoddisfatto dell'insegnamento accademico di Vienna quando dipingeva nel 1907 la sua *Crocifissione* [8]. L'impostazione pare consapevole del discusso quadro monumentale di Klinger già acquistato dal connazionale di Schiele, Hummel: ancora un primo piano ravvicinato, e un paesaggio svuotato di personaggi, ma saturo di colori simbolo di sentimenti, che pare rispecchiare le influenze compositive dalla cromatica *Crocifissione* di Stuck del 1892. Il futuro espressionista introduce per altro un rimando diretto nell'aureola e nell'eclissi di sole, e basa la sua *Crocifissione* sulle qualità espressive del colore più ancora dell'enfatico quadro blu di Stuck, in sintonia con l'intensità espressionista di Gauguin e Van Gogh. Quindi dal nostro sguardo al genere sacro in epoca simbolista si conferma quanto sia stato paradigmatico il ruolo del colore per questo tema di nicchia, a valenze metaforiche, nel momento della raggiunta autonomia dell'arte dalla Chiesa ufficiale, che corrispose al nevralgico scavalco della figurazione attraverso la capacità espressiva del colore.

NOTE

[1] Il celebre romanzo di Flaubert dedicato all'eremita di Tebe che fortifica la sua fede in risposta alle tentazioni suadenti che incontra era stato pubblicato nel 1874 e costituisce uno dei maggiori repertori ispirativi per i simbolisti.

[2] Fu realizzato per la decorazione della sala da pranzo della taverna Buvette de la Plage a Le Pouldu in Bretagna.

[3] I colori armonici e tenui entro un pronunciato linearismo sintetico nell'arte italiana di quegli anni sono spesso identificabili nell'influenza di Denis, ad esempio in Elisabeth Chaplin, Carena, Bacci, Garbari.

[4] *Ivi*, p.71. Ricordiamo le celebri parole con cui Denis definiva la corrente che aveva fondato "Se rappeler qu'un tableau, avant d'être un cheval de bataille, une femme nue ou une quelconque anecdote, est essentiellement une surface plane recouverte de couleurs en un certain ordre assemblées" cfr. "Art et Critique", 30 agosto 1890.

[5] Si rinvia alla recente edizione italiana degli scritti del fondatore Desiderius Lenz (Lenz 2015).

[6] Le altre due opere erano il Giudizio di Paride e il Cristo nell'Olimpo.

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[7] W.Kandinsky, *Il linguaggio delle forme e dei colori in Lo spirituale nell'arte* (1909), ed. Munich 1912 ed.engl. *Concerning the Spiritual in Art*

[8] Debbo la segnalazione di questo quadro ad Alessandra Tiddia. A sua volta la studiosa, esperta dell'arte di transizione in area mitteleuropea, fa riferimento agli studi interpretativi di Christian Bauer, (2015).

Restorations of the monumental polychromy of the Gothic cathedrals undertaken by Viollet-le-Duc

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ABSTRACT

The 19th Century restoration campaigns of Viollet-le-Duc constitute the general framework of this study which is limited to the Gothic cathedrals Notre-Dame de Paris and treats only one aspect of its restoration: monumental polychromy. By monumental polychromy we refer to the medieval use of colour on the sculpture and on the architectural elements both inside and outside the building.

The goal of this paper is to ascertain whether the restorations of the monumental polychromy of the Gothic cathedrals undertaken by Viollet-le-Duc truly uphold the ideal proclaimed by the architect, namely, the restitution of the primitive aspect of the monuments. The first part resumes the concept of restoration according to Viollet-le-Duc. The second part analyses the restoration of the internal polychromy of Notre-Dame de Paris chapels taken by the architect, analysing his choices and the polychromatic system he created. The third part concerns external polychromies.

KEYWORDS

Viollet-le-Duc, Middle Ages, gothic, polychromy, colour and architecture, restorations, cathedrals.

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1. INTRODUCTION

From the 1840's onwards, Viollet-le-Duc was one of the principal, if not chief, protagonists in the establishment and execution of the conservation and restoration campaigns of historic architectural monuments in France. The number of building sites he directed in his career is impressive (more than 200) and we owe him the writing of numerous publications, among theoretical essays on the restoration and the famous *Dictionary of French Architecture from 11th to 16th Century* in 10 volumes (Viollet-le-Duc, 1854-1868).

In 1843 a competition launched to restore the cathedral Notre-Dame de Paris, victim of the torments of time and of the vandalism of the French Revolution. It was Viollet-le-Duc and Lassus who won this competition.

Through the example of the cathedral of Paris, we will try to verify if the restorations of the monumental polychromy of the Gothic cathedrals undertaken by Viollet-le-Duc really respect the ideal of restoration of the architect, namely a return to the primitive aspect of monuments.

We will see how Viollet-le-Duc went against its own convictions. No restoration of the outside polychromy was envisaged, and several of the restorations of internal painted decorations seem to make a reference to personal theories on colour in architecture rather than to Gothic chromatic conceptions.

2. RESTORATION ACCORDING TO VIOLLET-LE-DUC

The innovations brought by the architect, real theoretical, technical and historic revolutions, totally transform the world of restoration and their influence is met nowadays too.

Let's start our analysis with an extract of his - now famous - definition of restoration:

«Le mot et la chose sont modernes. Restaurer un édifice, ce n'est pas l'entretenir, le réparer ou le refaire, c'est le rétablir dans un état complet qui peut n'avoir jamais existé à un moment donné »

("The word and the thing are modern. To restore a building, it is not to maintain it, to repair it or to redo it, it is to re-establish it in a complete state which can never have existed at a certain point") (Viollet-le-Duc, 1854-1868).

Viollet-le-Duc's purpose was to restore entirely a building in a state of perfect historic, structural and stylistic coherence, such as it was, or it should have been once finished. The fact that this "complete state" did exist or not, doesn't seem

capital to him. The most important thing was to return life in the monument by restoring all the physical and material characteristics of a given period. His controversial restoration work was very much criticized over the years but this is not the purpose of this article.

We kept three major points of the architect's theories on restoration directly applicable to the restorations of the monumental polychromy: the return to an ideal state, the respect of the style and the respect of the primitive materials.

By studying the attitude of Viollet-le-Duc as for polychromy and their possible restoration, we will be able to define if he applied to the latter the same principles as in the rest of its restorations. The external factors which have influenced Viollet-le-Duc will of course be a part of our analysis: financing problems of the restorations, needs and wills of the clergy, contemporary debate on the polychromy, recent reflections and scientific publications on colours and their perception.

3. INTERNAL POLYCHROMIES: NOTRE-DAME DE PARIS'S CHAPELS

3.1 THE CHOICE OF A PARTIAL RESTORATION

Nobody can assert that, in the Middle Ages, a polychromatic decoration recovered completely the inside of Notre-Dame, but such decorations were an integral part of this period projects, and considering the importance of the building, the opposite would be very surprising.

The objective of our analysis being to verify if the restorations of the monumental polychromy of the cathedral undertaken by Viollet-le-Duc respect his ideal of a return to the primitive aspect, it is suitable, at first, to study the primitive aspect of the inside of Notre-Dame, or, more exactly the opinion of the architect on this matter.

When the restorations of Notre-Dame were undertaken, only some rare traces of its original medieval decoration remained. In its monograph on the colour setting of the cathedral chapels, Viollet-le-Duc recognizes unarguably the medieval will to conceive such polychromatic decorations. However, he supports that:

«Il est certain que les nefs des cathédrales de Paris, de Bourges, de Reims, d'Amiens, de Rouen, de Chartres, de Sens, n'ont jamais reçu de peintures sur les parois de leurs piliers & de leurs voûtes » ("It is certain that the naves of the cathedrals of Paris, Bourges, Reims, Amiens, Rouen, Chartres, Sens have never received paintings on the walls of their pillars and their vaults") (Viollet-le-Duc and Ouradou, 1876).

And adds:

«A notre avis, le temps a manqué pour compléter les conceptions premières. Quelques-uns de ces monuments reçurent seulement leur décoration translucide, les vitraux colorés, mais aucun d'eux ne se revêtit intérieurement des couleurs qui devaient contribuer à l'harmonie générale » ("In our opinion, they were short of time to complete the first design. Some of these monuments received only their translucent decoration, the coloured stained-glass windows, but none of them put on inside colours which had to contribute to the general harmony") (Viollet-le-Duc and Ouradou, 1876).

From his point of view if the project of these paintings undoubtedly existed, their execution was not thus able to be led to good port for lack of time (in 1885, the cleaning of the walls of the north and south arms of the transept allowed to discover not insignificant traces of medieval polychromy: the walls of the north arm were totally covered with a uniform coloured bottom stopping in the capitals which receive the fallout of gallery arches whereas blue, red and black colour settings underlined the reliefs of the architecture).

Further, Viollet-le-Duc specifies:

«La cathédrale de Paris [...] n'a jamais été peinte à l'intérieur, bien que nous ne mettions pas en doute que l'édifice ait été conçu pour recevoir ce complément décoratif ; mais lorsque, vers le milieu du XIIIe siècle, on établit des chapelles entre les contre-forts de sa grande nef, ces chapelles furent, en partie, décorées de peintures ; &, en effet, les murs latéraux de ces chapelles — qui n'étaient que les joues des gros contre-forts — laissaient voir, à l'intérieur, des surfaces froides et blafardes. Il fallait nécessairement que ces surfaces fussent occupées par une décoration » ("Paris Cathedral [...] was never painted inside, although we do not question that the building was designed to receive this ornamental complement; but when, by the middle of the 13th century, some chapels were established between the foothills of its big nave, these chapels were, partially, decorated with paintings; and, indeed, the side walls of these chapels - which were nothing but the "cheeks" of the big foothills - let show, inside, cold and pale surfaces. These surfaces had to be inevitably occupied by a decoration") (Viollet-le-Duc, 1854-1868).

This event explains the choice made by Viollet-le-Duc and Lassus right from their first proposals

of restoration: a restitution of polychromies in the arms of the transept, the side chapels and the chapels of the chorus only.

Let us note that this will to mask irregularities and architectural defects by polychromatic decorations corresponds perfectly to one of the missions of the medieval monumental paintings. Our purpose is not to examine the accuracy of the restorer's knowledge of the primitive aspect of the monument but his respect for what he conceived as such according to its own researches, his ideas, but also the historic knowledge of the period. We can thus consider that because Viollet-le-Duc thought that the inside of the cathedral had never completely received an entire painted decoration, the choice of a partial restoration of this decoration was justified and was corresponding actually to the logic of restoration maintained by the architect.

3.2 THE ORNAMENTAL PROGRAM

Viollet-le-Duc considered the medieval monumental polychromy as a mean to emphasize the architecture while glorifying it. The good integration of the paintings in the architecture was one of its main objectives. However far from subjecting themselves to the architectural effect, the paintings had to take actively part in it.

So he specifies:

«La peinture décorative grandit ou rapetisse un édifice, le rend clair ou sombre, en altère proportions ou les fait valoir, éloigne ou rapproche, occupe d'une manière agréable ou fatigante, divise ou rassemble, dissimule les défauts ou les exagère. C'est une fée qui prodigue le bien ou le mal, mais qui ne demeure jamais indifférente » ("The ornamental painting increases or makes a building look smaller, makes it either clear or dark, distorts its proportions or asserts them, moves away or closer, occupies the space in a pleasant way or tires, divides or gathers, hides the defects or exaggerates them. It is a fairy who lavishes the good or the evil, but who never remains indifferent") (Viollet-le-Duc, 1854-1868).

These ideas, which resume perfectly the medieval tendencies (to put into relief the existing structures and to create false volumes modulating the space), were however rather audacious for this period. Viollet-le-Duc contemporaries limited indeed the polychromy to a simple tool of architectural development.

The principle set up for the decoration of Notre-Dame was based on a more or less identical general plan in all the chapels. Their surface was systematically divided into three horizontal zones:

Zone 1: from the base up to approximately two meters off the ground (including the altar). This part of the walls was covered with dense motives in dark tones (Figure 1).

Zone 2: down from the walls up to the vault. The motives decorating the top of the walls are less dense and are executed in clear tones (Figure 1). Zone 3: the vault and the nervures. A false starry sky covers vaults. The nervures were painted with plain colours or decorated with motives such as chevrons or foliage (Figure 2).

An ornamented horizontal frieze separates zone 1 and zone 2. Vertical friezes also frame the left and right extremities of zone 2 often conferring

a wallpaper look to the set. This last detail is more important than it could seem: thanks to the industrialization, wallpapers knew a success and a phenomenal development in the 19th century.

The most important chapels, such as the side chapels of the chorus, received a more developed treatment with narrative scenes illustrating the life of the saints to whom they are dedicated. These scenes are placed over the altar and thus constitute a kind of altarpiece. They are relatively simple compositions, in tint area and without perspective.

We have already briefly mentioned that

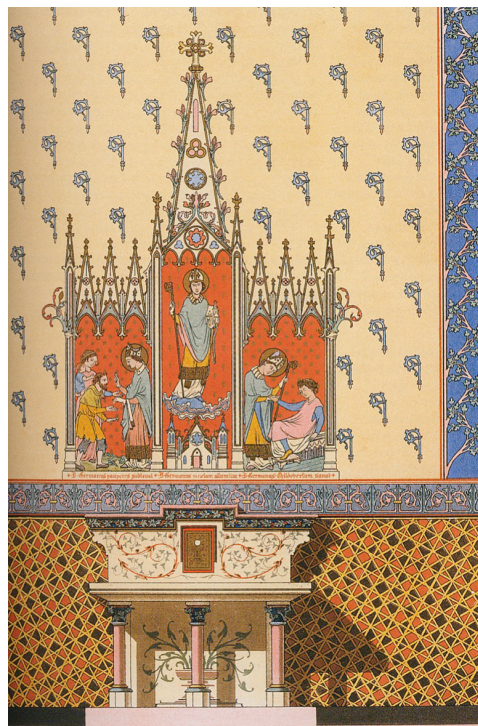


Figure 1 - (a-left) Cathedral Notre-Dame de Paris, Chapel Saint Germain, tracing of the paintings made by Mr. Ouradou. (b-right) Explanatory plan of the division in zones of the decoration of the choir chapels.

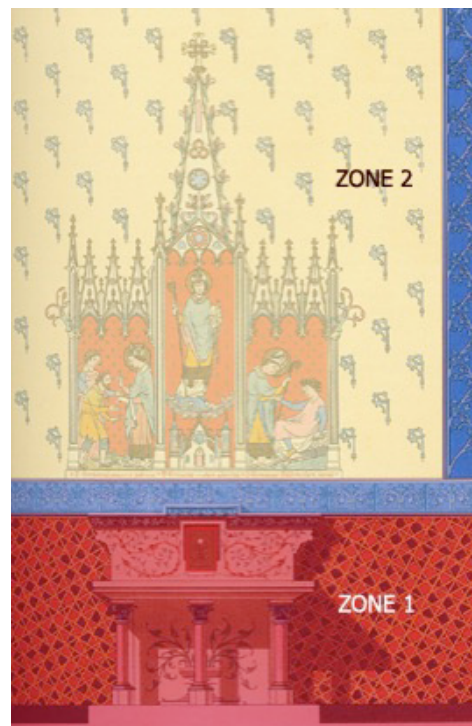
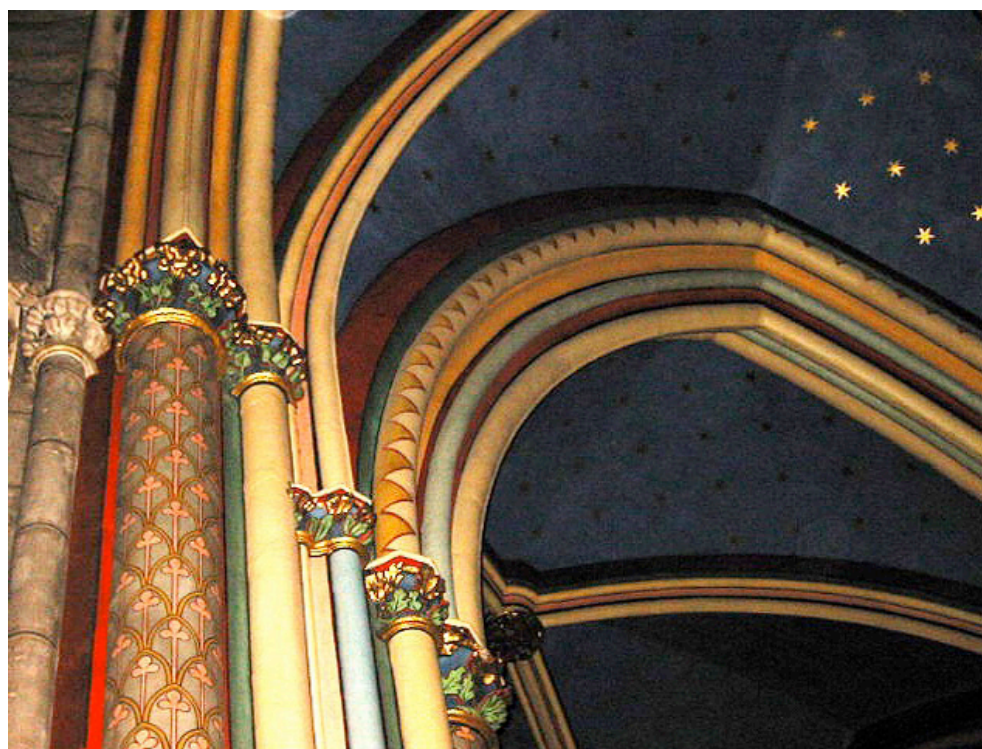


Figure 2 - Cathedral Notre-Dame de Paris, Chapel St-Georges, an example of vault with false starry sky and painted nervures.



when Lassus and Viollet-le-Duc began the restorations of Notre-Dame its internal original medieval decoration had practically completely disappeared. The most important of the rare remaining vestiges was apparently a mural from the 14th century, which decorated the right wall of the axis chapel. This painting, a Madonna with Child surrounded with Saint Denis and with bishop Matiffas of Buci in prayer (his grave was formerly situated just below), was preserved but directly inserted within the new project of decoration into the same vein as the chapels with narrative scenes.

3.3 THE POLYCHROMATIC SYSTEM

The polychromatic system adopted by Viollet-le-Duc for the decor of Notre-Dame de Paris's chapels is a very good illustration of the architect's idea regarding monumental painting. Viollet-le-Duc claims to base his entire theories on the study of medieval examples, but their analysis denounces several contemporary influences such as the modern notions of chromatic circle, primary, secondary, complementary colours and the theories of Chevreul on the perception of colours. Always on the lookout for the last scientific researches and Substitute Professor of composition and ornament since 1834 in the art school of "rue de l'École-de-Médecine", Viollet-le-Duc could not ignore these theories. The catalogue of the books of its library (Catalogue des livres composant la bibliothèque de feu M. Viollet-le-Duc, 1880) shows moreover, that he was himself in possession of a work of Chevreul (Chevreul, 1867).

Known for his studies on fat and his works on colours, Michel Eugène Chevreul (1786-1889) published his essay *De la loi du contraste simultané des couleurs* (*The principles of harmony and contrast of colours*) in 1839. Named, in 1824, Director of the dye works at the Gobelins Manufactory in Paris, he was interested in the theories on the colour within the framework of his functions which included the supervision of the manufacturing of colouring agents being in use to dye the wools of the famous factory. Confronted with various problems, he thought the colouring agents had, sometimes, nothing to do with chemistry, but more with optics: when a tint did not produce the wished effect, it did not always come from the pigments in use, but from juxtaposed or nearby coloured tones.

While developing its works, he discovered

and analysed diverse phenomena in relation to the conditions of vision of colours and their simultaneous contrasts, which influenced numerous artistic movements particularly Divisionism, Impressionism and Orphism.

In order to understand better the influence of Chevreul on Viollet-le-Duc, let us remind briefly his theory on simultaneous contrasts:

Two colours juxtaposed on the same surface modify themselves mutually in two manners: as intensity and as nuance.

Intensity: the clearest lighter seems clearer and the darkest darker.

Nuance: a colour gives to its neighbour a complementary nuance in the tone.

Therefore, an orange circle placed on a white bottom makes this one appear blue in its circumference whereas a white circle on a blue bottom seems, on the contrary, orange-coloured. In the case of an orange circle on blue bottom, both colours act mutually to deepen their tints and it is the same for two juxtaposed complementary colours (Figure 3). On the contrary, two objects whose colours are close on the chromatic circle tend to throw complementary shadows one on other: yellow takes a purple nuance when placed near green. While opposite complementary get clearer and are mutually excited, non-complementary colours thus tend to damage themselves by mutually "getting dirty".

THE HARMONIOUS BALANCE ACCORDING TO VIOLLET-LE-DUC

The system established by Viollet-le-Duc is based on the harmonious balance of the values between muted colour and pure colour (to mute a hue means reducing its purity by adding to it a certain amount of its complementary colour or a grey created from the mixture of the three primary colours). He follows a law on the hierarchy of colours intensity deduced from the analysis of several medieval paintings. This law takes as a base the yellow colour whose value corresponds to 1. The two other primary, red and blue, correspond respectively to 2 and 3, and the secondary colours, orange, green and purple, 3, 4 and 5. According to these observations, in a yellow, red and blue decoration, the yellow has to occupy twice more surface than the red and three times more than the blue so that the harmonious relations between colours are



Figure 3 - Simultaneous contrasts of nuances according to the theories of Chevreul. A colour gives to its neighbour a complementary nuance in the tone. So, an orange circle placed on a white bottom makes appear this one blue in its circumference, whereas a white circle on a blue bottom seems, on the contrary, orange-coloured. In the case of an orange circle on blue bottom, both colours act mutually to deepen their tints.

preserved. An artist who chooses to use these three colours will thus obtain logically red and blue motives on yellow bottom (with the red dominating in quantity on the blue).

Whatever are the chosen tones, some muted hues, relatively neutral, always have to cover the biggest surfaces whereas the pure colour are limited to small parts thus accentuated.

The coloured light emanating from the stained glasses, which enlightens the chapels is also at the origin of this harmonious rule which attaches a major importance to shades. According to the calculations of the architect, the coloured lights from stained glasses tend to break down the pure colours and to weigh them down. To fight this tendency, it is necessary to privilege modulated tones according to the colour of glasses:

"Thus, for example, if windows spread a slightly glazing lilac light and what we want to obtain is a tone of blue, it is necessary to turn the blue into a greenish hue" (Viollet-le-Duc and Ouradou, 1876).

The influence of Chevreul's writings is indisputable on this point.

In addition, the value of colours to be applied must be chosen according to its intensity. If we take the above example of the ornament with red and blue motives on yellow bottom, the red and the blue have to be of different values, like a red brown and a light blue.

Viollet-le-Duc lists three possibilities of harmony of tones used in the Middle Ages:

- A binary harmony red / yellow with black and white (shade and light).
- A tertiary harmony red / yellow / blue



Figure 3 - Cathedral Notre-Dame de Paris, Chapel Saint-Louis

with black and white or with only black. In order to balance the set, this harmony involves necessarily the joint use of green, purple and orange.

- A harmony obtained by all the colours with black and gold, where gold is then substituted to white, occupies an essential place to complete or even restore the harmony.

THE NECESSITY OF COLOURED OUTLINES

The systematic use of a black line as colours outlines is not only a graphic game reminding stained-glass windows but it also makes a reference to the concepts of simultaneous contrasts. Under the influence of the contrasts, we saw that colours tend to merge and mutually "get dirty". Black outlines prevent their direct confrontation and this fusion feeling. According to Viollet-le-Duc's observations, brown-red tones and strong coloured oppositions do not require it.

VARIATION OF COLOURS ACCORDING TO THE ORIENTATION OF THE CHAPELS

The choice of the range of colours decorating every chapel was dictated by their orientation and the light's quality entering in each one of them. Starting from observing that half of facing south chapels receives a much more lively and warmly coloured light than the half facing north, Viollet-le-Duc chooses to keep this difference to protect the harmonious balance. Consequently, the North chapels were provided with stained-glass windows in cold and pearly tones whereas South chapels' received windows in warm tones. In order to keep the general harmony, the pallet of the paintings of every chapel matches the colours of stained-glass windows (Figure 4).

3.4 TECHNICAL AND MATERIAL CHARACTERISTICS

Concerning the restorations materials and realization's techniques, Viollet-le-Duc favoured the use of materials similar to the primitive ones, but, if the latter revealed themselves to be of poor quality, he then used more solid modern substitutes.

The execution technique of Notre-Dame paintings is very badly documented. The only apparently existing information is in *Peintures murales des chapelles de Notre-Dame de Paris* (Viollet-le-Duc and Ouradou, 1876), where Viollet-le-Duc specifies:

«Le procédé de peinture employé est dû à M. Courtin; nous avons pu reconnaître les qualités de ce procédé, qui réunit une solidité au moins égale à celle de la peinture à la cire la transparence & la fraîcheur de tons que donne la détrempe» ("The painting process here in use is due to M. Courtin; we were able

to recognize the qualities of this process, which combines a solidity at least equal to that of wax painting and a transparency and freshness of tones like the one given by tempera") (Viollet-le-Duc and Ouradou, 1876).

In spite of in-depth researches, we did not find any document concerning this "Courtin process" so praised by Viollet-le-Duc and its exact composition remains a mystery. Maybe the techniques and materials used by the medieval painters of Notre-Dame seemed too fragile to Viollet-le-Duc and he preferred a modern process of better quality. However, perhaps the "Courtin process" indicates a method similar to old recipes. The importance that Viollet-le-Duc attached to the hard and solid character of the process, close to the final aspect of wax paintings, is not indeed fortuitous. A very wide-spread theory in the 19th century wanted that murals recently found in Pompeii were realized with wax polish, which would explain their technical qualities (hardness, resistance in time) and artistic (depth, smooth finished close to some polite marble) – further in-depth studies of these paintings proved that they are realized in fresco.

4. OUTSIDE POLYCHROMIES

All the previously studied points demonstrate a real motivation of Viollet-le-Duc to restore Notre-Dame de Paris's internal polychromatic decorations. The outside paintings did not have the same treatment, neither in Notre-Dame de Paris nor in the other construction sites managed for by the architect and his decision was never questioned.

Viollet-le-Duc described many times Notre-Dame de Paris's outside polychromy, in particular in the article "Painting" of his *Dictionary* (Viollet-le-Duc, 1854-1868):

«Ainsi, à Notre-Dame de Paris, les trois portes, avec leurs voussures et leurs tympans, étaient entièrement peintes et dorées, les quatre niches reliant ces portes, et contenant quatre statues colossales, étaient également peintes. Au-dessus, la galerie des rois formait une large litre toute colorée et dorée. La peinture, au-dessus de cette litre, ne s'attachait plus qu'aux deux grandes arcades avec fenêtres, sous les tours, et la rose centrale, qui étincelait de dorures». ("Thus, in Notre-Dame, the three doors, with their arches and their tympanums, were completely painted and gilded, four niches connecting these doors, and containing four colossal statues, were also painted. Above, the kings' gallery shaped a wide coloured

and gilded border. The paint, over this border, did attach to no more than two big arches with windows, under the towers, and the central rose window, which glistened with gilts").

Despite the numerous restorations executed on the facade of Notre-Dame, it was nevertheless never questioned to restore the polychromy nor to colour the replaced statues. This idea is not even suggested in the form of a possible future project in the Report of the restoration project (Lassus and Viollet-le-Duc, 1843), and we did not find any trace of such an intention somewhere else.

In the Middle Ages however, no difference was apparently made between internal paintings and outside paintings and nobody would have been able to imagine a religious monument with walls, architectonic decorations and sculptures were left with a stone appearance: it would have been understood as unfinished, unthinkable incomplete.

This analysis allows us to underline and notice that, asking about the attitude of the architect toward the polychromies's restorations of the Gothic cathedrals does not come down to estimate the coherence of its method with its theories. The question actually opens up the way to a problem more profoundly anchored in the ideologies of this time: a taste then almost universal for the purity of bare materials. These monochrome limits, nearly achromes, imposed to architecture and sculpture since the Reformation were so rooted in that time mentalities that the rediscovery of antique polychromy by Quatremère de Quincy in 1814 (Quatremère, 1815), far from easing the prejudices, actually re-launched the monumental polychromy debate between opponents and defenders.

The architect's differences of behaviour toward interior and exterior colour setting are completely part of this historic context. Mural interior paintings, narrative or not, were appreciated in the 19th century. Ornament was fashionable and the decorative aspect of interior paintings certainly had a positive influence. None of the detractors of polychromies "*of reliefs*" (sculptures and architectonic elements) would have thought of criticizing the internal polychromies. Unlike in the Middle Age, in the 19th century, these two practices did not belong to the same artistic categories (this concept is always true nowadays).

In this context, it is very interesting to notice the ambiguity of the architect's attitude facing monumental exterior colour setting. In spite of its numerous positions against the then used principles, Viollet-le-Duc had to compose with the prejudices of his contemporaries and external factors such as coal pollution, then very present,

and the cost of the possible restorations.

In the article "*Painting*" of its *Dictionary* (Viollet-le-Duc, 1854-1868), Viollet-le-Duc admits that

"ornamental painting [...] played an important role outside of buildings".

The totality of the paragraph dedicated to exterior monumental polychromy is written in a positive tone leaving no doubt about the architect's favourable feelings for the object of his study. Some passages clarify his opinion even more clearly. And so, he notices:

«Pourquoi nous privons-nous de toutes ces ressources fournies par l'art? Pourquoi l'école dite classique prétend-elle que la froideur et la monotonie sont les compagnes inséparables de la beauté, quand les Grecs, que l'on nous présente comme les artistes par excellence, ont toujours coloré leurs édifices à l'intérieur comme à l'extérieur, non pas timidement, mais à l'aide de couleurs d'une extrême vivacité » ("Why do we deprive ourselves of all these resources provided by art? Why does the so called classic school claims that coolness and monotony are inseparable partners of beauty, when Ancient Greeks, introduced to us as the ultimate artists, have always coloured their buildings inside as outside, not in a bashful way, but with extremely bright colours ").

However, passages from the article *Sculpture*, in the same *Dictionary* (Viollet-le-Duc, 1854-1868), suggest that Viollet-le-Duc had a more finely shaded opinion. Rather than to analyse sculptures in a global way, he separates the formal analysis and the analysis of the possible polychromies. The descriptions that he makes of Notre-Dame portal sculptures are thus very detailed, but strictly colour free. In addition, pictures illustrating the text are precise and meticulous line drawings, but without colour. It is only at the end of the article, after some long descriptions and formal studies of medieval sculptures, that some passages tackle the issue of colour. The architect's tone is then very careful, as if soaked by all the quarrels on monumental polychromy, which interested the majority of artists, architects and other intellectuals of this time:

«Les artistes qui ont fait les admirables vitraux des XIIe et XIIIe siècles avaient une connaissance trop parfaite de l'harmonie des couleurs pour ne pas appliquer cette connaissance à la coloration de la sculpture. Et, à vrai dire, cela n'est point aussi facile qu'on le pourrait croire tout d'abord. Les tentatives en ce genre qu'on a faites de notre temps, prouvent que la difficulté en

pareil cas est grande, au contraire, quant on veut conserver à la sculpture sa gravité, son modèle, qu'on prétend obtenir autre chose que des poupées habillées [...] il faut reconnaître que la peinture appliquée à la sculpture lui donne une valeur singulière, mais à la condition que cette application soit faite avec intelligence et par des artistes qui ont acquis l'expérience des effets de la couleur sur des objets modelés » ("The artists who made admirable stained-glass windows of the 12th and 13th centuries had a too good knowledge of colour's harmony for not applying this knowledge to sculpture colouring. And, in truth, it is not as easy as we could believe it at first. Attempts which have been made in our time, prove that the difficulty in such a case is big, on the contrary, when we want to preserve in a sculpture its gravity and its model, we claim to obtain something else rather than dressed dolls [...] it is necessary to recognize that paint applied to sculpture gives it a singular value, but provided that this application be made with intelligence and by artists specialized on the effects of colour on relief objects").

Viollet-le-Duc warns against the effect of "dressed dolls" which apparently characterizes the polychromatic sculptures of his time, but he does not go further than this report and does not suggest trying to restore the polychromies "decently".

When talking about interior decoration, the architect criticized some of the works of his contemporaries but proposed and carried out his own conception of things, concerning the exterior polychromies. He does not go farther than written remarks. These comments have much less eloquence and confidence than many of his writings and only prove the ambiguity of his opinion on the issue.

However, can we assume that Viollet-le-Duc's personal opinion on polychromy is the only explanation in the fact that he did not restore them? We would be tempted to answer positively. Many other components could, indeed, be considered: the financial aspect, a possible agreement (or disagreement) of the Church or some other authorities able to wreck such a project. But there is a problem: no trace of project. Nowhere in the papers of the architect is mentioned a plan, or, at least the will, to restore exterior paintings. If pecuniary or "diplomatic" motivations had delayed or cancelled the architect's desires, he would have expressed loud and clear his dissatisfaction and would have made every effort to find new solutions...

As an historian and archaeologist, Viollet-le-Duc

had to recognize and, in a way, appreciate the existence of Gothic monumental polychromy. But as a restorer, and especially as a man of the 19th century, his opinion on sculpture was soaked by his contemporaries colour free, pure and idealized view.

5. CONCLUSION

The only choice to restore a single aspect of this immense entity that we name monumental polychromy contradicts Viollet-le-Duc's own principle to give back the monument restored to its primitive state. This "no restoration" of exterior polychromies would be enough by itself to move forward a negative answer to the question that we chose to answer at the beginning of this study. Renovations of interior paintings only confirm this answer. The peculiarity of their realization (only in the choir chapels) and the flagrant use of modern theories on colour are as many "compromising" elements.

Notre-Dame de Paris's chapels paintings certainly show a very ingenious use of Chevreul's scientific theories. However, these principles do not correspond to medieval realities and their use contradicts the architect's restoration ideal. Regarding exterior polychromies Viollet-le-Duc finally never grows away from his colleagues' ideas, which explains the absence of restoration attempts. It is of course impossible for us to judge the architect's attitude, it is inscribed in a totally different context from ours and, even today, no restorer ventured to restore a whole cathedral exterior polychromies.

Despite many incoherencies, the architect's initiative was so innovative that we can only keep positive aspects for the medieval heritage protection and for monumental paintings restoration science advancement. Paintings that we hardly start to really study, more than a hundred years after Viollet-le-Duc. It would be moreover very interesting to examine the correctness, the accuracy and the relevance of any study on sculpture or medieval architecture that does not take into account polychromy.

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CONFLICT OF INTEREST

The author disclose any actual or potential conflicts of interest including financial, personal or other relationship with other people or organisations within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, her work.

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Glossy Black is not actually ‘Black’: Evidence from Psycholinguistic Colour-Naming Studies in 14 European Languages

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ABSTRACT

Since Berlin and Kay’s seminal monograph, most studies on colour vocabulary and categorization have concentrated on the three main characteristics of colour – hue, lightness and saturation – which play a major role in the semantics of colour terms. This paper addresses a rarely discussed phenomenon, the appearance and naming of the surface of the colour stimuli, and argues that researchers should pay careful attention to possible unintended consequences when selecting their materials for psycholinguistic experimental (field) work. Until recently, researchers have remained true to examining the main colour characteristics, not observing beyond, in spite of glaring evidence from some less-studied languages. Native speakers of fourteen typologically diverse languages spoken in Europe participated in two colour-naming experiments carried out with Color-Aid or Munsell stimuli. Having a single colour term black in the spotlight, the paper argues that glossiness might be an extra-linguistic feature which contributes to the semantic meaning of a colour term. According to the evidence gathered, black only seems to refer to a non-shiny, matte colour and has therefore been underused for glossy-surfaced stimuli in our datasets, resulting in a risk of elimination from the inventory of basic colour terms due to its low naming frequency and object-relatedness.

KEYWORDS

Semantics, field methods, experimental methods, colour naming, cross-linguistic comparison, colour appearance

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1. INTRODUCTION

It is widely known that colour consists of three main features – hue (or colour in non-technical English), saturation and lightness (Biggam, 2012: 3-4). However, there are languages which do not build their colour vocabulary on these particular features, but concentrate on other aspects, such as surface texture or the impression of colour. Despite the fact that these features have been discussed to a certain extent in the literature (Conklin 1955), the wider audience still concentrates on hue, lightness and saturation, especially when stimuli are selected to carry out a (psycholinguistic) colour-naming experiment. The aim of this paper is to shed some light on other features of colour which Carole Biggam has classified as *“other aspects of appearance”* and *“non-appearance aspects”* (Biggam, 2015: 5-6). Bringing examples from various languages spoken in Europe, this paper shows that certain aspects of colour affect the way the speakers of these languages perceive colours and talk about them. The purpose of the article is not to attack the theory by Berlin and Kay, as might be perceived, but to bring new understanding and fresh knowledge into the discussion on colour naming, where the emphasis is essentially placed on colour naming, appearance and semantics.

The aim of this paper is to contribute to the general controversy of psycholinguistic colour research with an emphasis on a rarely discussed feature. We investigate the selection of colour stimuli shown to subjects during psycholinguistic (field) experiments, or more precisely, the surface of the selected stimuli. Taking the category black as an example, we argue that the rather overlooked feature of surface is an important one and should be taken into account when choosing appropriate stimuli for psycholinguistic colour-naming studies.

While carrying out psycholinguistic fieldwork on the Estonian language within the project Evolution of Semantic Systems (EoSS) (Majid, Jordan, Dunn, 2015), run and coordinated at the Max Planck Institute for Psycholinguistics, we observed that subjects had difficulties recognizing and naming glossy colour chips of the darker hues. More specifically, despite the fact that colour selection contained one black colour tile, there was a remarkable lack of consensus between subjects cross-linguistically, i.e. the glossy surface of a black stimulus caused misunderstandings and confusion in the colour naming task – the black tile was not actually named *‘black’* by participants as it was probably perceived differently.

We replicated the EoSS study with Estonian subjects in 2015 keeping the exact study design and yet obtained the same results. If

we analysed the Germanic language data from the EoSS project (courtesy of our colleagues, see acknowledgement) the same pattern could clearly be identified: in only a couple of languages from the Germanic language group were the participants able to name the black stimulus with a relatively high level of consensus. By consensus we mean that at least 50% of the interviewees of one particular language named the specific stimulus using the colour term *‘black’*. In the majority of languages the black stimulus was named differently.

On the other hand, in a colour naming field experiment which was similar design-wise, but contained different stimuli based on the Ostwald colour system, no similar issue could be identified. In every language, there was at least one stimulus which was constantly named *‘black’* with high consensus among the participants. We therefore conclude that some other aspects besides the hue of the stimulus may contribute to such a vast difference in colour naming between the two studies. Leaving aside a minor dissimilarity in stimulus hue, the most notable discrepancy between the two sets of stimuli emerged in the matte vs glossy surface: Color-Aid tiles had matte surfaces, while the Munsell set was glossy.

2. PARTICIPANTS

The languages chosen for this study constitute a convenience sample: we needed a reasonable amount of data for both Munsell and Color-Aid Corporation stimuli, and were able to retrieve the data for the languages listed in Table 1. There is almost no overlap between the investigated languages, but as our goal was to exemplify a wider cross-linguistic phenomenon, we argue that the imbalance of the two groups was not an obstacle. Group I data were gathered using Color-Aid Corporation stimuli, while Group II data were collected using Munsell stimuli.

The results for Germanic languages and their colour systems have been published in (Vejdemo et al. 2014). The constitution of the two groups shown in Table 1 is comparatively different: Group I data (using Color-Aid stimuli) were gathered with the idea of keeping the internal structure of the language sample balanced in terms of age and gender. The amount of data per language was also (usually) larger. Group II (EoSS data) language samples had younger mean ages as the target groups were undergraduate students with no particular knowledge of linguistics (Majid, Jordan, Dunn 2015). Nevertheless, nearly every language sample of Group II included some older subjects too. There is a slight possibility of a bias due to EoSS studies normally having fewer subjects, but it is rather unlikely that the effect of bias

Group	Language	Number of subjects	Females / males	Mean age (W/M)	Data collector
Group I	Finnish	68	42/26	39.5 (38.4/41.4)	Mari Uusküla
	Lithuanian	51	35/16	42.3 (40.5/46.3)	Simona Pranaityte
	Italian	102	56/46	38.6 (36.8/40.9)	Mari Uusküla
	Czech	52	33/19	34.7 (32.6/38.2)	Mari Uusküla
	Hungarian	125	66/59	35.6 (37.0/34.1)	Mari Uusküla
	Spanish	38	20/18	42.7 (49.2/35.5)	Kelly Parker
	Estonian	19	10/9	32.7(33.8/31.5)	Triin Kalda
Group II	Swedish	20	10/10	27.2 (24.8/29.6)	Susanne Vejdemo
	Estonian I	29	16/13	28.7 (27.1/30.7)	Martin Eessalu, Mari Uusküla
	Estonian II	20	15/5	30.9 (N/A/N/A)	Liina Kivimets
	English	20	9/11	22.3 (22.8/21.8)	Linnaea Stockall
	Swiss German	20	10/10	25.6 (26.9/24.3)	Martina Zimmermann
	Danish	20	11/9	26.5 (27.2/25.4)	Carsten Levisen
	Icelandic	21	10/11	29.0 (33.6/24.8)	Matthew Whelpton, Thorhalla Beck
	German	20	10/10	21.1 (21.0/21.2)	Cornelia van Scherpenberg
	Norwegian	20	9/11	28.4 (26.2/31.1)	Aashild Naess

Table 1 - The sample of languages, the number of subjects, their mean age and female/male ratio.

was responsible for the entire phenomenon we describe here.

3. STIMULI AND PROCEDURES

Two experimental methods were used to gather the data: the data for Group I languages were obtained using the field method established by Ian Davies and Greville Corbett (1995); the data for Group II languages were gathered using a method devised by Majid and Levinson (2007). In the studies conducted with the field method established by Davies and Corbett (1995), the subjects were instructed to name all 65 colour stimuli that were presented to them one by one, placed on a neutral grey cloth. The order of the stimuli was random. The stimuli were 65 coloured papers from the Color-Aid Corporation 220 set. These were glued on 5x5 cm plywood squares. The colour naming was fully unconstrained. Participants' answers were recorded or written down manually as said and were not analysed or shortened any further. Color-Aid uses a modification of the Ostwald colour system, which incorporates three main characteristics: hue, blackness or shade, and whiteness or tint. Colour-Aid codes are read in the following manner: Y stands for yellow, YOY stands for yellow-orange-yellow, S in a code represents shades as in Y S2 (the scale is given from 1 to 3 where 3 indicates the darkest shades) and T represents tints, as in YOY T4 (the

scale is given from 1-4 where 4 represents the lightest tints). In the field method developed by Majid and Levinson (2007) the participants were shown 84 Munsell tiles in a single fixed random order where N2 was always preceded by 5Y 4/6 and always followed by 10P 8/6. Out of 84 Munsell chips, four were achromatic: N2, N4.5, N7 and N9.5. The remaining 80 chips varied in hue, brightness and saturation, so that there were 20 equally spaced hues in four degrees of brightness (Majid and Levinson, 2007). Saturation was generally at the maximum point. Participants were asked to name all colours shown to them with appropriate colour terms. The study used an unconstrained naming method, all answers were recorded, written down and analysed. If participants offered compound words, only the second part of the compound was used for the later analysis in the original study. Here we preserve and use all the data as originally offered by the subjects without further reductions.

Since the Munsell colour system is widely known, we refrain from an in-depth description of it here. The analysis of the results is given with the assumption that Color-Aid BLACK and Munsell N2 are perceptually similar, and the main characteristic differentiating the two stimuli is the glossiness of the surface for Munsell N2 stimulus.

Both studies were carried out in natural daylight avoiding shadow or exposure to direct sunlight.

The researchers were instructed carefully beforehand to ensure the comparability of the data. All participants were recruited volunteers. They were not introduced to the subject of the research until the beginning of the experiment in order to avoid priming effects. Unfortunately we were unable to measure the coordinates of our stimuli in CIE $L^*a^*b^*$.

4 RESULTS AND DISCUSSION

Table 2 shows the naming pattern for the black category in 14 languages with the black colour terms in the respective languages, and the overall naming frequency, the dominant frequency (both frequencies depend on the overall number of informants per language), the number of stimuli that were named 'black', and the specificity index first calculated by Davies and Corbett (1994). For technical details consult 1995 [3]. Overall, the frequency measure includes the frequency of all the stimuli that were named with the colour term 'black'. Dominant frequency indicates the summed frequency of stimuli that were mainly labelled with the colour term 'black'. Dominant frequency is calculated taking into account the consensus of 50%, i.e. at least half of the participants had named that stimulus 'black' in their respective languages. Specificity index (SI), which essentially is a measure of proportion (varying between 0 and 1), was calculated in the following manner: dominant frequency divided by the overall naming frequency (Davies and Corbett, 1995). If the index value was 1, all

participants named the stimuli with the same label, i.e. the colour term 'black' in their native language. If, however, the index value was 0, black was the label given to some stimuli, but it was not the dominant colour term for that particular stimulus (in our data N2 or BLACK). In conclusion, the specificity index is a value showing the strength of a category, with overall frequency and the number of stimuli characterising the borders.

Table 2 shows that on one hand, Group I languages had very little variation for naming black: nearly all tiles that were labelled with the colour term 'black' in their respective languages were dominant. If the number of the stimuli labelled as 'black' was 2, these two stimuli were always BLACK and GRAY 8. Any additional stimuli had very small naming frequencies. On the other hand, the Munsell data in Group II languages rarely showed any dominant naming patterns whatsoever (excluding Danish and Swiss German samples). For example, if such colour naming data was used to establish the basic colour terms in a language, black could easily be excluded from the inventory of basic colour terms. This might evoke misunderstandings and serious problems in the basic colour term inventory of any language. According to the evolutionary sequence postulated by Berlin and Kay, black, together with white, should lexicalize among the first two colour terms in any language (Berlin and Kay, 1969). In the Universality and Evolution model (Kay and Maffi, 1999) the initial hypothesis was revised into white-warm and

Table 2 - The naming pattern of the black stimuli across fourteen languages

Group	Language	Number of subjects	Colour term	Overall frequency	Dominant frequency	Number of stimuli	"strength" of category
Group I	Finnish	68	musta	97	95	4	0.98
	Lithuanian	51	juoda	77	77	2	1.00
	Italian	102	nero	173	169	5	0.98
	Czech	52	černá	86	85	3	0.99
	Hungarian	125	fekete	185	182	5	0.98
	Spanish	38	negro	59	59	2	1.00
	Estonian	19	must	33	33	2	1.00
Group II	Swedish	20	svart	25	0	5	0.00
	Estonian I	29	must	24	0	5	0.00
	Estonian II	20	must	14	0	4	0.00
	English	20	black	14	0	5	0.00
	Swiss German	20	schwarz	37	13	7	0.35
	Danish	20	sort	42	33	5	0.79
	Icelandic	21	svartur	2	0	1	0.00
	German	20	schwarz	4	0	1	0.00
	Norwegian	20	svart	13	0	4	0.00

dark-cool categories.

In Table 2, we notice that the area of variation as measured by the number of stimuli was rather similar to Group I data. As black had almost no dominance in the experiments using Munsell stimuli (Group II), other colour terms occupied the area that could be expected to be called 'black'. N2, the blackest stimulus of the data gathered with Munsell stimuli, usually co-existed with grey. The modifier 'dark' was often added to 'grey' forming a morphologically complex expression 'dark grey'. Here, as implied before, we used raw data as gathered from our participants.

Many participants labelled the stimulus N2 with the following expressions instead of naming it 'black'. For example, the Estonian participants used *hall* 'grey' and *tumehall* 'dark grey'; the Swedish participants used *mörkgrå* 'dark grey'; the English ones 'grey'; the German ones *dunkelgrau* 'dark grey'; the Icelandic interviewees *dökkgrár* 'dark grey', etc. We were also interested in which other stimuli were called 'black' instead of Munsell N2, and were able to notice that 'black' was extended to such stimuli as, for example, 5Y 2/2 or 10Y 2/2. However, 'black' was not the most commonly used colour term for either of them. The most dominant names given to 5Y 2/2 were the Estonian *pruun* 'brown' and *tumepruun* 'dark brown'; the Swedish *brun* 'brown' and *mörkgrön* 'dark green'; the Swiss German *bruun* 'brown' and *dunku bruun* 'dark brown'; the Danish *brun* 'brown', etc. Intriguingly, the stimulus 10Y 2/2, which veers towards the green area of the colour spectrum, was often named 'dark green', but also 'dark brown', e.g. Swedish *mörkgrön* 'dark green', Swiss German *dunku grünen* 'dark green' and *dunku bruun* 'dark brown', Norwegian *brun* 'brown' and *mørkebrun* 'dark brown', and Estonian *tumeroheline* 'dark green' and *tumepruun* 'dark brown'.

Above we have shown the very narrow and consensual variation of black in Color-Aid studies (Group I) and the blurry co-variation of black, (dark) brown and dark green in the Munsell group studies (Group II). Comparing Munsell N2 and Color-Aid BLACK (see Table 2), we noticed that BLACK was the conventionally established hue named as 'black'. However, N2 was probably perceived differently by the participants due to its glossy surface, resulting in unexpected naming results. We therefore argue that glossiness is a feature that influences colour perception and contributes towards difficulties naming the colour stimuli in the darker regions of the colour body. This feature can be further illustrated by the example of car colours, as cars are often painted glossy: it is easier to detect and label the colour of lighter cars than the darker ones (Anishchanka, 2013).

5. CONCLUSION

As shown by the empirical data analysis, we consider the semantic meaning of black to be extended to attributes such as the appearance of a surface. On the one hand, our study demonstrated that besides the black hue, the surface of the stimulus seems to play a certain role in seeing black tiles as black and labelling them with a colour term 'black' accordingly or, if the stimulus was glossy, participants had problems with naming it 'black'. On the other hand, the speakers of many languages seemed to expand the colour term 'black' to encode darker colours in general (dark brown, dark grey, and even dark green or dark purple), perhaps with an etymological or analogical connotation with dirt or impurity, deriving historically from the distinction of Latin *ater* vs *niger* 'shiny black'. However, this hypothesis requires further in-depth analysis. As seen from the results, the semantic meaning of black is quite restricted to rather matte colours. Quite opposite results are obtained if glossy tiles are presented, providing much wider possibilities for interpretation. We therefore call on field linguists to carefully select their stimuli kits in anticipation of a probable bias in gathered results. Nevertheless, it must be emphasised that the present study only focuses on black and some darker colours. There is no conclusive evidence to claim that the phenomenon could be extended to other colours.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest with other people or organizations.

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Digital Visualization of a Luminaire: From blueprint to Photorealistic Representation

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ABSTRACT

In this article we will discuss how to closely digital represent the aspect of a Luminaire and the photometric distribution of the light emitted by it. You will find a comparison of different modeling techniques used to obtain in a quick and efficient way a clean 3D model of a lighting fixture. A model that should also be, with minimum settings, scalable in terms of level of detail depending from the visual importance of the product in the scene. This will avoid too long rendering times and heavy geometry that could be difficult to manage. We will also investigate what could be an optimal procedure to couple the 3D model with photometric data taken from manufactures or measured in a laboratory.

KEYWORDS

Light, Color, Luminaire, Visualization, Digital Representation, 3D, Photometry

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1. INTRODUCTION

The continuous increase of the computational power of today's computers and the possibility to get fast results, contributed to the diffusion of 3D representation software used by designers to produce the so-called photo realistic renderings. The goal of these images, usually, is to show what should be the final appearance of the project.

Very often, unfortunately, these representations are the result of empirical graphic representation based in the best cases, on the experience of the designer and his ability to achieve images that should be similar enough to what he plans to realize. However, when these forecast images are produced without a precise methodology in the management of virtual materials or the importing and integration of technical data of lighting products usually the resulting digital images, although their strong visual impact, do not match the final appearance of the project a once put in place.

Having a beautiful image to present to the clients may help the designer to get the job, but in the end, if the real scene, with all of its luminaires, finishes and materials, is too different from the virtual image presented, there can be problems with the clients.

This article is part of a wider work on representation and is meant as a help for designers willing to apply modelling and representation techniques that are quick, efficient and that should better represent the appearance of selected lighting fixture.

Our aim is to describe some practical techniques of modeling and representation of lighting fixtures itself in virtual projects, rather than their impact in the whole space, while maintaining both photo-realism and photometric accuracy. To create a correct digital duplicate of the luminaire in terms of geometry, material, aspect and distribution of light is not a simple task.

These procedures can be used in the most common 3D software for modeling and representation.

2. MODELING THE LUMINAIRES

Considering the fact that there are few studies often designers, in order to speed up the modeling process, makes use of 3D models available online from the manufacturer's website or portal/libraries dedicated to 3D computer graphics.

Unfortunately, these models are not always optimized for the production of forecast images, for various reasons. Some time they are conversion of models that have been created for the CNC (Computer Numerical Control) of the objects, so with the purpose of the realization of

a physical model; or maybe with a completely different set of features. This can result in the first case in a model with excessively many polygons and in the second, a model that can have "*inverted Normals*", that results in visible "*holes*" in the surfaces of the objects.

If the model of the product found is not suitable, the better choice is to rebuild it, starting by defining the desired level of detail and therefore the modelling technique that allows the designer to obtain good results in an efficient way, always thinking to the final representation since early modelling.

The level of detail of the geometries is fundamental in order to not to waste time, needed for modeling and for rendering. The designer should be aware of the visual importance of the geometries in the images that he wants to produce, whether the objects will be represented in the foreground, the background or in an intermediate situation. A good approach is that the modelling techniques used may allow changes in the resolution of the 3D mesh of the model, increasing the detail of the geometry in relation to the importance of the model in the scene, using for instance subdivision modelling techniques.

The choice of the best modelling technique depends mainly from the geometry of the luminaire that can be made of one single piece or by multiple components. In this case it is possible to use more than one technique. If the model can be assimilated to basic geometries, it might be enough to use the CSG (Constructive Solid Geometry) modelling. The primitives available in most of the software, such as cubes, spheres, cylinders, cones, toroid, etc., are transformed with basic operations like move, rotate, scale, copy, etc.

If the model turns out to be more complex, but still can be built with operations of addition, subtraction or intersection between two or more solids, it is possible to use the so-called Boolean operations. These are very fast in order to obtain complex geometries even if they can cause two order of problems: visual continuity between the polygons that appear as unwanted shadows on the surfaces and issues in the organization of the polygonal structure of the model, the topology.

The modelling based on 2D shapes is ideal in case of long, flat, thick objects, so extrusion or taper operations can be effective.

Many lighting fixtures can be assimilated to 2D profiles that can be revolved around a specific axis. The "*lathe*" command, present in most of the modeling software, may allow the designer to obtain these geometries quite easily.

For parts such as cables, filaments, springs, it is possible to use modeling tools such as Sweep or Loft (D'Agnano, 2008).

Sweep allows the creation of 3D geometries by

making a profile, that can be generated by the user or sometimes available on a library, “run” along a curve path keeping its perpendicular aligned to the tangent of the path itself.

The operation done by the Loft tool is similar to the one of the Sweep tool, but with more options. It is possible to change the profile, scale, rotate or twist it, along the path, modifying the resulting geometry. If no one of the previous tools can be used efficiently, the modelling technique that allow the designer to reproduce the most complex shape is the Polygonal modelling (Daniele, 2008).

Generally, the easiest approach is to start from flat surfaces mapped with a raster image of the technical drawings; the so called “blueprints” used as planes of projection. It is possible to begin from a primitive solid or even a single polygon and rebuild the entire object by moving and/or adding vertices and polygons. When possible it is good practice to begin by realizing a low-poly model and then increasing the complexity of the geometry at will, by using a “Subdivision tool”. This procedure split up the interested polygons in four parts and allow the user to “relax” the adjacent polygons, also divided, creating a smoother appearance of the surfaces. The process can be repeated more times intervening on the number of iterations. It is necessary to pay attention to the number of iterations applied, because for each one, the number of polygon of geometry quadruplicates, increasing exponentially the weight of the 3D model and the time needed to calculate the renders.

In order to decide how many iterations are

needed for a model, as previously mentioned, the designer should know the importance of the object in the scene; for close objects, the number of iterations will be much greater than for objects in the background.

3. PHOTOMETRY

Once achieved the goal of a balanced 3D model in term of quality and weight, it is necessary to transform the obtained geometry into an actual light source that can be used to render the final scene.

A desirable thing should be to use the software as a verification tool and not just to produce attractive images; for instance, how my project will look like if I choose one luminaire instead of another. In order to do so, it is necessary that the software in use comes with calculation algorithms that approximate in a plausible manner, the real light distribution in space. This is possible only when indirect light is actually calculated by the interaction of the emitted light and the surfaces of the scene, and not simulated with hypothetic parameters that modulate the amount of light diffused in the scene, such as ambient light, for example.

In software used to do lighting verification, these calculations were once made by the algorithm of Radiosity, which allowed the simulation of light evenly diffused by Lambertian surfaces and soft shadows. The results, were integrated by Ray tracing algorithms that were dedicated to calculate specular reflections and sharp, defined shadows. More recently, software specialized in

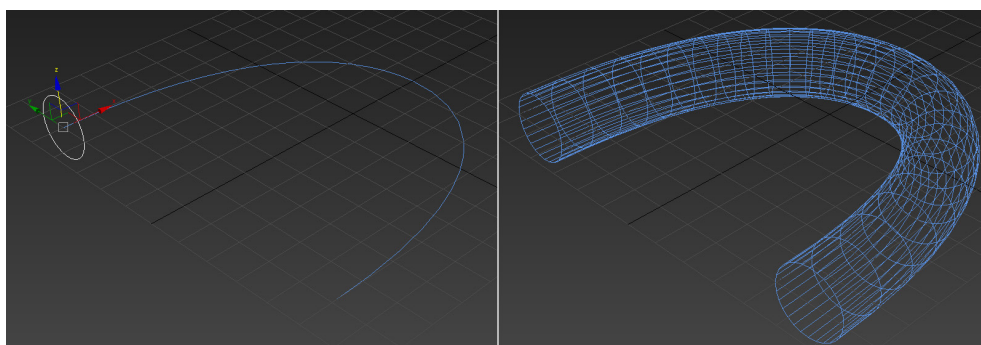


Figure 1 - SWEEP TOOL - Example of the use of the Sweep tool. On the right, it is possible to see the circle that will act as profile running on the path (in this case a curve). On the left the resulting geometry

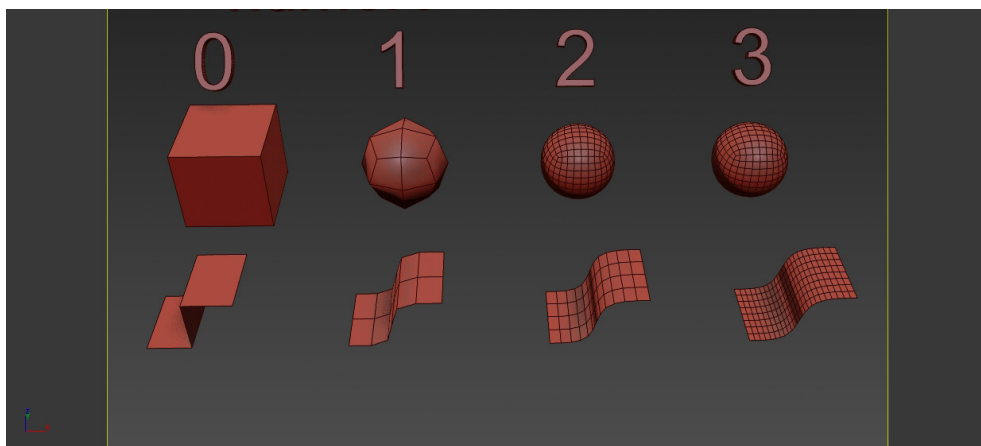


Figure 2 - ITERATIONS - Example of increase in the number of polygons in relation to the number of iterations choices for the object

light calculations have been updated with more recent algorithms such as Photon mapping or the rapidly diffusing Physically based algorithms. That said it must be clear to the designer that it is not possible to get reliable results by using the "classic" light sources of computer graphics (such as OpenGL Ambient, Point, Directional, Spot). Real luminaires, in most cases, have a spatial distribution of the lighting intensity more complex than those achievable through OpenGL lights. As an example, it is very easy to understand that the light distribution in space of a road luminaire has nothing to do with the one of a table lamp or a retail premise spotlight. Each luminaire has a specific light intensity distribution, which is the result of interaction between the lamp and the optical system of the device, generally designed to meet specific project requirements.

3.1 PHOTOMETRIC FILES

The shape of light emission in luminaires, is generally measured by using a laboratory instrument called Goniophotometer that performs an angular emission investigation and saves the results in ASCII files containing, along with other parameters, a set of coordinates and values, that put in relation spatial angles with the light intensity emitted by the luminaire. These files are generally called Photometric files or Photometric webs.

These shapes are eventually more complex than the basic OpenGL lights.

The photometric files are generated in different formats (mostly in relation to the nation in which they are acquired/crated) such as Eulumdat - *.ldt - Europe (Stockmar, 1999), IESNA - *.ies - America (ANSI/IESNA, 2008), CIBSE TM14 - *.cib - United Kingdom (CIBSE, 1988), LTLI - *.lil - Denmark (UNI EN 13032-1, 2012).

In addition to these standard files there are also several proprietary formats used by specific lighting design software, such as the format *.uld of Dialux (DIAL GmbH, 2018), the format *.oxl of Litestar (Oxytech Srl, 2018) or the format *.rolfz of Relux (Relux Informatik AG, 2018), that are often integrated with a 3D model that is usually given by the luminaire manufacturer, and unfortunately, not always properly modelled.

Obviously these latter formats are read only by their software, whose main purpose is not really the photorealistic rendering, but rather the photometric verification, and cannot be opened with the most common software used for photorealistic renderings.

The choice given to the designer is to import common photometric files such as Eulumdat, or other open formats like IESNA, CIBSE, LTLI, which can simulate the actual light distribution of the luminaire, but still, not their physical appearance.

In order to reproduce the appearance of a lighting fixture it is necessary to couple the geometric model to its corresponding photometric web that usually is available from the manufacturer or measured with a goniophotometric relief in a laboratory.

3.2 PAIRING 3D MODELS AND PHOTOMETRIC FILES

After modelling the geometry of the luminaire with the methods suggested in paragraph 2, it is necessary to place a light source whose emission properties will be those of the photometric solid. The photometric files are related to a point in space that emits light with different intensities as vectors in space.

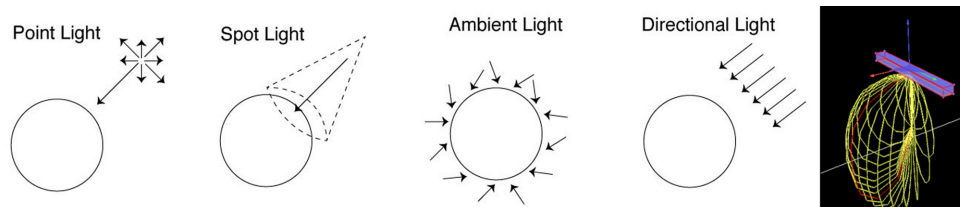
In the physical reality, these intensities are the result of the interaction between the light emitted by sources like discharge in gas, burner or LED and the optical system of the luminaire, for example: reflector, refractor, lenses, filters, etc. It is necessary to remember that the measured photometric file already considers these interactions.

Consequently, it is important that the three-dimensional model of the luminaire, does not alter the emission of the photometric web, like for instance, by cutting her off. In many software, this is possible by editing the properties of the light source so that some objects do not interact with the light; specifically, by not casting any shadow. An example of object that may be set with these properties are those of the part of the luminaire that emits light, in which the photometric web will probably be placed.

In order to complete this task correctly, the designer need to place the photometric web in a correct way according the modelled geometry. Logic would suggest placing the photometric web in the same position where the light source is found in the real luminaire. In reality, the solution is not so simple.

Considering that photometric webs are considered to be points; where to place them when the light source is widespread? What is the correct placement position when inside of the luminaire there are multiple lights sources, such in the case of LED lighting fixtures?

Figure 3 -LIGHT SOURCES - From left to right, different generic light sources commonly used in 3D software: Point, Spot, Ambient and Directional. The far right shows the photometric web of a real lighting fixture (Mellow Light IV by Zumtobel)



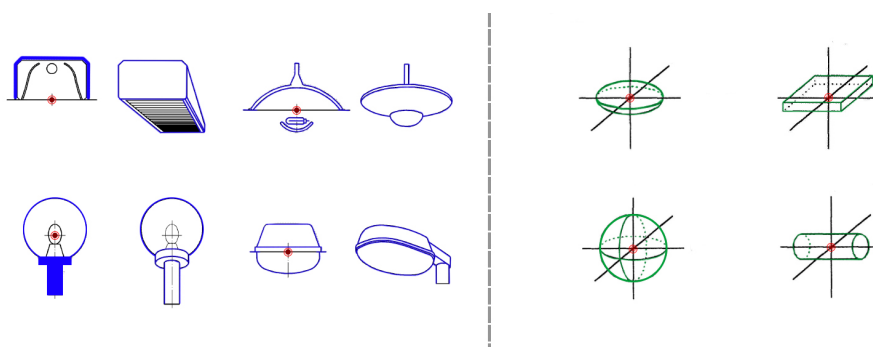


Figure 4 - PHOTOMETRIC CENTER - To the left (in blue) some guidelines for the identification of the photometric center (also called photometric zero), marked in red, as prescribed by the European standard UNI EN 13032-1. To the right (in green), some of the prescription provided by the American standard IESNA LM-63-02.

If the purpose is the photometric accuracy and the program allows you to exclude parts of the geometry from the lighting calculation, the correct position is that of the photometric center of the luminaire.

The photometric center is defined as the point where the luminaire is aligned with the goniophotometer during the relief in which the photometric file is generated. The correct position of this point is described by the standards for the measurement of light fittings, which may vary from country to country (for instance America and Europe) and result into the generation of different photometric files.

It is possible to consider the photometric center as the locus from which the light is emitted, and therefore, it should be considered as the point of junction between the geometry of the 3D model and the photometric files.

The operation of identification of the photometric center is easier for the categories described by the standard. Nevertheless, for some luminaires with very complex shapes, it is necessary to use some simplifications and adjustments, but this happens for the goniophotometric relief as well. For instance, a complex chandelier will hardly have a photometric file, but if the file exists, it will be hardly described in the standard. In this case, the designer should look at the shape of the photometric web, at the position of the light sources by looking to a catalogue or the brochure of the product, and deduce the position of the photometric center that in most cases, correspond to the center of the geometry of the light emitting part of the fixture.

4. COLOR

A fundamental problem in the representation of the luminaires and light in general, is related to the limits of the representation devices. The computer-generated images are mostly produced to be displayed on video; it can also happen that these images are printed, maybe with high resolution but still, the devices typically used for digital representation, are unable to compete with the dynamic of the physical reality and the human perception. This is true regarding both the luminance contrasts, and the spectral component of light.

Having to use a representation device as an example, a monitor, all of the colors usually are converted to RGB triplets.

A simple mix of three components it is not enough to compose light in physical reality; an electromagnetic radiation composed by different wavelengths of which, our visual system can perceive only the portion between 380 and 780 nanometers: violet, indigo, blue, green, yellow, orange and red.

Given this, it is also necessary to specify that often the light sources commonly used in luminaires, have nonlinear emission spectra that might be incomplete or in bands that peaks in certain colors; very different from that of the sun. For this reason, some light sources are less effective in color render. Under these light sources, some colors appear to be dull and grayish.

The chromaticity of a computer generated light source, must necessarily be converted into an RGB triplet in order to be represented by common monitors, which are matrices of RGB LEDs. Also, because the user have to decide the color of a light source within the modelling software, the most used method is still RGB.

Sometimes color presets are available in the software, for example relating to different sources or different color temperatures, but even if the chosen values recall the real physics in practice, the light is colored only by changing the RGB values and it is hardly able to represent different color rendering indexes.

Some rendering programs (RandomControl SLU, 2017) (Fluid Interactive Inc, 2015) (Glare Technologies Limited, 2018) (LuxRender, 2018) (NVIDIA, 2015) (Wenzel, 2010) (OTOY Inc, 2017) (Solid Iris Technologies, 2012) (Eclat-Digital Recherche, 2013) implement algorithms able to mimic the spectral behavior of light, displaying the color by simulating the spectral colors with a given spectral step, for example simulating the properties with steps of 10nm.

There are many ways to implement these algorithms, but generally, although they allow higher accuracy in the calculation of color simulating more correctly phenomena such as the spectral dispersion or the lower color-rendering index of some light sources, this cost globally in terms of greater complexity and the

need of longer computational times.

The same concepts are valid also for the materials applied in the scene, commonly called “shaders”, which by reflection, refraction and transmission, should affect the spectrum of light by dispersion or by reflecting or transmitting only certain wavelength and thus, changing the color of light.

If the will of the designer is to remain faithful to the physics of real world, it is necessary (Radziszewski et al., 2009) to use a software that calculates light and its interaction with materials with a full spectrum algorithm.

5. CASE STUDIES

Five case studies of digital representation of real luminaires will be described below, but before starting, a little premise is necessary: the described techniques, both for modelling and for rendering, are not the only ones that can be used. The focus is to achieve models that are clean, efficient and with a level of detail that can be increased or decreased at will.

The software used for these case studies purpose is 3D Studio Max 2016 by Autodesk, but these techniques can be easily reproduced in any compatible modelling software.

The choice fell on 3DSMax because it is one of the most diffuse modeling software for design visualization. It also offers a wide set of tools that allow the user to approach the modeling with different techniques. Moreover, a lot of reference and tutorial can be easily found on the web in order to help the user to learn how to use it.

Other specific software such as Dialux, Relux, Agi32 or LiteStar, specifically designed for lighting, are commonly used for the evaluation of the lighting project, but their modeling tools are very simplified and also, they usually have proprietary files that already implement the system 3D model – photometric file, as said in 3.1.

The first case is a very simple luminaire, that can be modelled with CSG, extrusion of spline and very simple polygonal modeling. The amount of detail is derived by the parameters embedded in the primitives

The second case shows how an inner part of a luminaire can be simplified because not directly and totally seen. Instead the numerous and external items are the most accurate and prepared for subdivision, done with a single instance of a sphere modified with poly modelling.

The third one lends itself to the use of Boolean operation, refined with few steps of poly modeling to obtain clean results. Also the revolution tool (lathe) to curve primitives will be the best choice.

It will be evident, that to prefer one technique

more than another will be a decision driven by the shape of the object or of its main component. When possible an approximation with parametric primitives is to be preferred. When it is not, an analysis of the geometry will tell us how to proceed. If by combining or subtracting the geometry, extruding or revolving a curve, giving thickness to lines and curves. Where all of this techniques cannot help, direct polygonal editing is the suggested approach to solve the problem. A clean topology obtained with this technique is also the best starting point to have a scalable 3D object in terms of level of detail.

5.1 EVOLUZIONE BY DISANO ILLUMINAZIONE

Evoluzione is a very common luminaire that mount fluorescent linear lamp produced by Disano illuminazione. The simple, straightforward design is also reflected on the simplicity of the modelling process. The luminaire can be replicated with five geometric shapes: a parallelepiped for the external shell, an extruded profile for the aluminum reflectors, cylinders for the lamps, other parallelepipeds for the lamp-holders and the side abutment.

The external shell is obtained by a parallelepiped, where the lower face has been refined into a new smaller polygon that has been then removed. The thickness of the shell is obtained by using a command that create a series of polygons parallel to the existing ones for simulating the thickness of the element. Usually this command is called “Shell”.

The profile of the reflector is extruded for the length of the luminaire, and closed at the sides, by the abutments, created by two parallelepipeds. These two elements are placed inside of the external shell.

The fluorescent lamps are obtained with four cylinders. The use of the standard parametric primitive gives the possibility to easily increase or decrease the number of faces in the model.

A polygonal modification of a parallelepiped, allow the designer to create the lamp holders.

After the model is created, it is necessary to find the correct photometric file to couple with the model. As in most case, these files can be downloaded from the website of the manufacturer. To place the photometric web in the photometric center, the designer should look at the standard. In this case, both the American and European standards states that the photometric center is in the lower center of the luminaire. This means in the intersection of the median axes at the height of the lower face of the external shell. It is important not to modify the values of intensity inherited by the photometric file, even if the software allow the user to do so, because these are the actual measured values of the luminaire.

A problem should be very visible at this point:

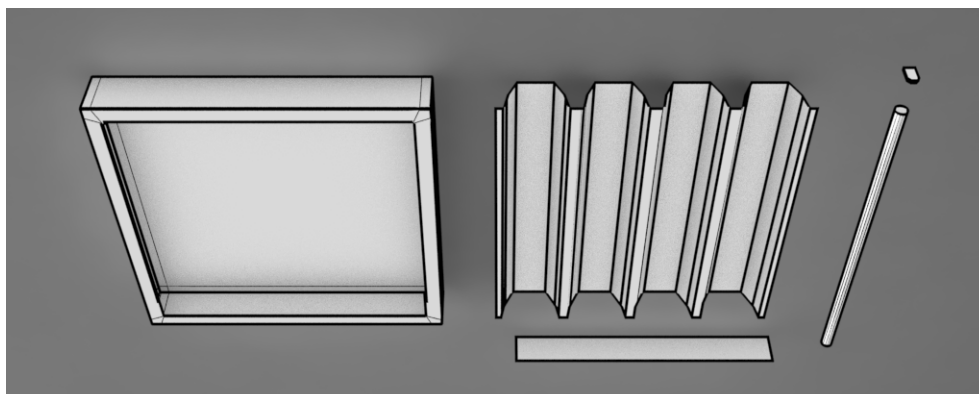


Figure 5 - EVOLUZIONE BASIC GEOMETRY - Basic geometric components for the 3D modelling of Evoluzione by Disano Illuminazione.

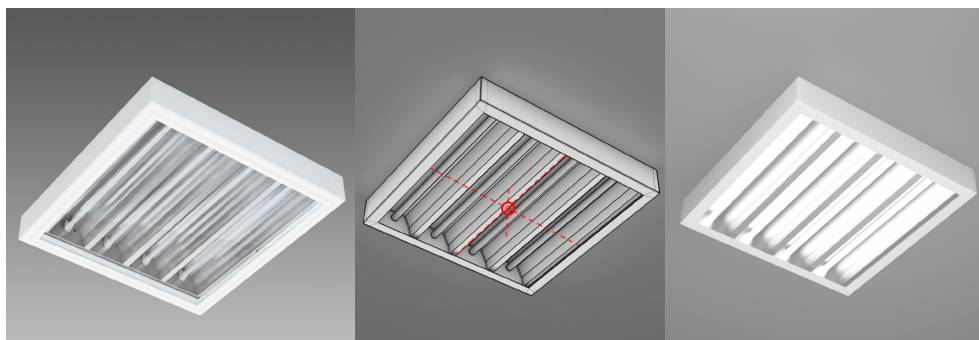


Figure 6 - EVOLUZIONE COMPARISON - From left to right: picture of the luminaire, geometric model of the luminaire (red sign indicates the photometric center) and production render of the luminaire.

how it is possible to simulate the appearance of the four luminous tubes with just one photometric file that, in this case, emits only downwards. Only by using the photometric file, this is impossible. The tubes appear dark, even if the luminaire is emitting light. To solve this, it is necessary to use a little trick. First, it is necessary to assign the correct materials to the geometry, paying attention to the energy balance of materials, because it is necessary to reproduce the right finishes and the right index of reflection/transmission/refraction of each part of the model. For Evoluzione, the external shell is a highly diffusive painted white metal with a small reflective component, around 65% diffusive and 5% reflective. Except the tubes, the other parts are made of brushed aluminum with 70% of specular reflection with glossiness lowered to 50%.

To obtain the fluorescent tubes, it is necessary to use a self-illuminating material for the simulation of the light that comes out from the tubes. Fortunately, most of the rendering engines include this kind of shader. Two important elements must be considered while using such material: first, the self-illumination effect must be visible in the reflections of the other components and second, the light emitted by the self-illuminated material must be ignored in the global calculation of the scene. This because if the light of the self-illuminated material is computed, it will invalid the luminous emission of the photometric file, producing incorrect results.

5.2 CABOCHE SUSPENSION BY FOSCARINI

Caboché is a quite complex suspension luminaire to model. It is composed by a structure made by arcs and circles, a central luminous body, many decorative refractive spheres, wires and cable and the ceiling strut.

The lattice of arcs and circle can be simulated and simplified with the use of a standard torus primitive. Once the center lower and upper faces of the toroid have been removed, the mesh topology can be converted in a wire cage with a thickness decided by the user. For example, in 3DS Max this can be done with the use of the "Lattice" modifier. In this command it is easy to fine tune the number of segments with a parametric value.

The decorative spherical elements can be modeled with the standard sphere primitive, with the lower part modified with few step of polygonal modeling. As the refraction of light trough these spheres is the core aspect of this luminaire, it is indispensable that these elements are calculated as solid thick geometry.

Since these refractive sphere are present in large amount, it is a good idea to use a subdivision technique to the instanced elements, in order to reduce the weight of the model with one single parameter in case of shoots with the luminaire far from the camera.

The luminous body is obtained with the lower part of a sphere primitive. Also in this case the polygon modeling technique helps refining the upper part of the object.

The same process defines the strut on the ceiling. The cuts in the geometry in which the electrical wires pass trough are done open chamfering a corresponding selected set of edges.

Figure 7 - CABOCHE BASIC GEOMETRY - Basic geometric components for the 3D modelling of Caboche by Foscarini.

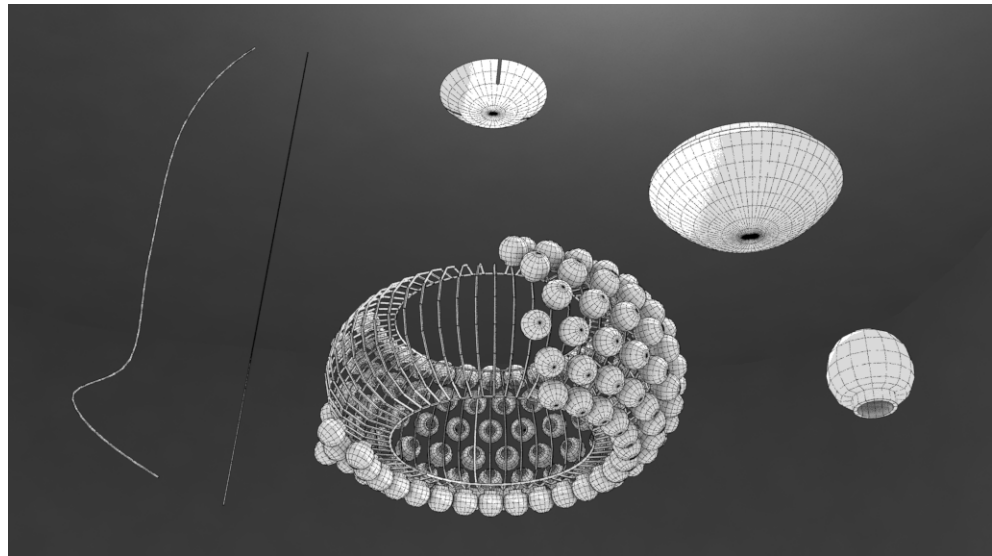


Figure 8 - CABOCHE COMPARISON - From left to right: picture of the luminaire, geometric model of the luminaire (red sign indicates the photometric center) and production render of the luminaire



Cables and suspension wires are created with linear lines and splines. It is possible to create these elements and then use a command to assign them a thickness of a given diameter or, in alternative, using the "Loft" tool.

The materials for Caboche are an opaline blown glass for the luminous body, PMMA for the spheres, polycarbonate for the arches, stainless steel for the suspension cables and transparent electrical cable for the power supply.

The crucial element of this product is the crown of spheres that refract light coming from the luminous element placed in the center. To achieve this effect, the spheres must be considered as solid geometry so it will be possible to put in evidence the refraction; the index for the PMMA is around 1.49. Other materials should not be difficult.

The position of the photometric center, following the indications (figure 5, profile 10) of the European standard, is in the center of the suspended element and not inside of the luminous body as logic may suggest. It is also important to pay attention to the orientation of the photometric web. In this case, for example, the emission of the luminaire is both direct and indirect. The designer must identify the right orientation of the emission by looking at the polar diagrams of the luminaire on the catalogue or the manufacturer's website. In this case, the higher intensities are pointing downwards, so the photometric web must be oriented accordingly.

5.3 A0Y BY FLOS

This luminaire is made by one glass cylindrical main body, a goblet, a reflector and a light bulb. The glass cylinder can be obviously replicated with the corresponding standard primitive, paying attention to the amount of segments at the base circle section. Being the main and bigger body of the luminaire, the circumference of the body should be obtained at least with 32 segments. This should be the minimum choice for a foreground / medium distance camera view.

The arch at the base of the cylinder is obtained by subtracting with a boolean operation, a second cylinder primitive. In order to clean up the topology, the resulting object should be refined with polygonal modelling, removing the unnecessary polygons and vertices created by the subtraction.

To create a more correct model, the opaline goblet inside of the cylinder need to have the same amount of segments. A fast and easy way to obtain this result is to extrude the upper part of the glass cylinder downward and then detaching it from the rest of the body.

The upper reflector is created by revolving a curve along the vertical axis, this can be done with a "Lathe" tool, taking care of setting the number of segments equal to the ones of the other parts of the luminaires.

A revolution can be also used to create the two elements that form the light bulb.

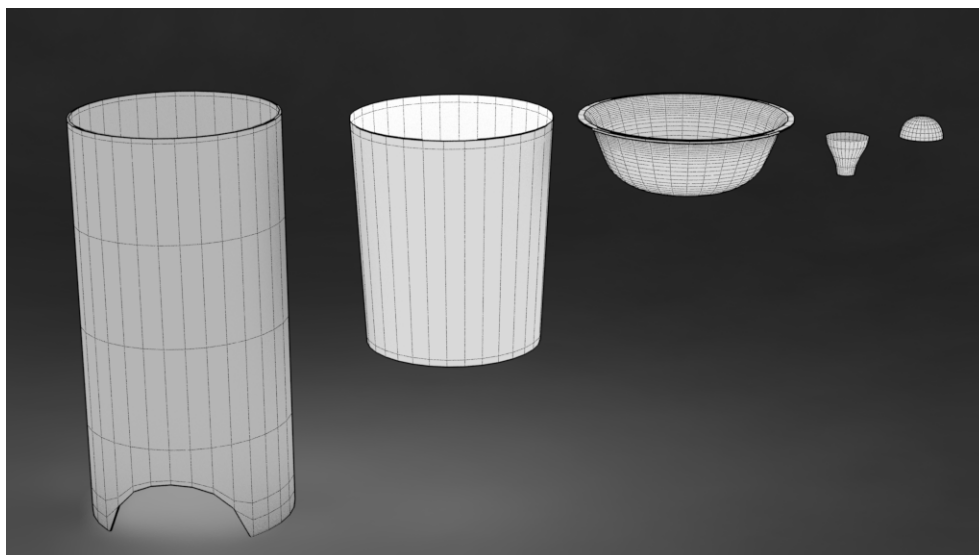


Figure 9 - AOY BASIC GEOMETRY - Basic geometric components for the 3D modelling of Aoy by Flos.

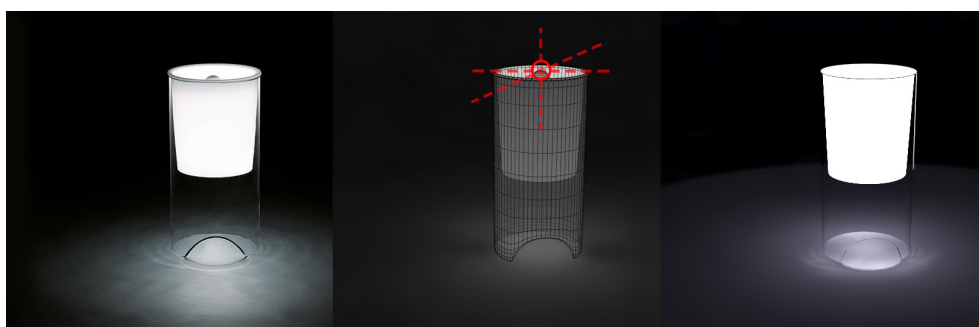


Figure 10 - AOY COMPARISON - From left to right: picture of the luminaire, geometric model of the luminaire (red sign indicates the photometric center) and production render of the luminaire

This last object aside, the first three elements need to have a certain thickness, so the *"Shell"* command must be used.

Also in this model, it is possible to use subdivisions in order to adapt the resolution of the polygonal mesh in relation to the position of the luminaire in the scene.

The external body is made of clear glass and the internal diffuser and reflector are made of white, opaline glass. The light source is a bulb, with the upper half with a chrome finish that serves as anti-glare system.

The position of the photometric web in this case is not in the center of the luminaire, but in correspondence of the light source. The European standard states that for luminaires with transparent sides or without side features, the photometric center corresponds to the lamp photometric center.

Another element to keep in consideration is that this fixture, in dark environments, creates a slight caustic effect at the base of the luminaire. In order to achieve so, the software used must have a render algorithm that is able to calculate caustics, and the effect has to be set up properly. The opaline diffuser and reflector may need a little improvement with a self-illuminated material. To achieve the caustic effect and for physical correctness, they also must be removed from the calculation of shadows together with the bulb.

6. CONCLUSIONS

The techniques described can change in relation to the software used and the shape of the luminaires as it can span from very simple to incredibly complicated. All the objects can be created in many ways, but the techniques described are efficient and allow the designer not to worry about the weight of the model, that can also directly affect the calculation time.

In synthesis, the important steps are:

- The study of the luminaire: geometry, photometry and materials, directly on the catalogues or manufacturer website.
- What to represent; hidden components, for instance, should not be modelled.
- Select the most efficient technique to model all the visible parts.
- Scalability: trying to grant the possibility to change the resolution in relation to the importance of the luminaire in the scene.
- Correct position of the light sources when coupling the photometric data with the geometry. Attention in placing the photometric web in the correct spot according with the standard in use.
- Creating the visual aspect of the object; materials and properties to set in order to respect the physics of the real world, and overcoming the limitations of the system geometry/photometry.

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CONFLICT OF INTEREST

The author declares that nothing has affected his objectivity or independence in the production of this work. Neither the author nor his immediate family member have any financial interest in the people, topics or companies involved by this article. Neither the author nor his immediate family member had a professional relationship with the people and companies cited in this article. Neither the author nor his immediate family member are involved in a legal dispute with the people and the companies cited in this article. No conflict of interest including financial, personal or other relationship with other people and organization within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, this work.

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Review and Comparison of Random Spray Retinex and of its variants STRESS and QBRIX

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ABSTRACT

In this paper, we review and compare three spatial color algorithms of the Milano Retinex family: Random Spray Retinex (RSR) and its subsequent variants STRESS and QBRIX. These algorithms process the colors of any input image in line with the principles of the Retinex theory, introduced about 50 years ago by Land and McCann to explain how humans see colors. According to this theory, RSR, STRESS and QBRIX re-scale independently the color intensities of each pixel by a quantity, named local reference white, which depends on the spatial arrangement of the colors in the pixel surround. The output is a new color enhanced image that generally has a higher brightness and more visible details than the input one. RSR, STRESS and QBRIX adopt different models of spatial arrangement and implement different equations for the computation of the *local reference white*, so that they produce different enhanced images. We propose a comparative analysis of their performance based on numerical measures of the image brightness, details and dynamic range. In order to enable result repeatability and further comparisons, we use a set of images publicly available on the net.

KEYWORDS

Retinex, Spatial Color Algorithms, Color Image Enhancement.

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1. INTRODUCTION

The human color sensation deriving from the observation of a certain point of a scene may differ from the physical luminance of that point. In fact, several experiments revealed that the color sensation at a point depends not only on the photometric properties of that point but also on the physical luminance of the colors surrounding that point and on their spatial arrangement (Albers, 2009), (McCann and Rizzi, 2012), (De Valois and De Valois, 2008).

Retinex (Land and McCann, 1971) is the earliest computational model that attempts to estimate the human color sensation by taking into account this empirical evidence. Retinex assumes that the color signal is processed separately by the retina photoreceptors and that there exists a spatial interaction among the colors of the viewed scene. In agreement with these hypotheses, when applied to a digital color picture, Retinex works separately on the three image chromatic channels and processes the color of each image pixel based on the surrounding colors. In this procedure, the digital color values of the input image undergo two so-called color calibration phases, which transform them to a scale of human color appearances and vice-versa. The resulting image is an estimate of the human color sensation. When calibrations are skipped, Retinex outputs an enhanced color image, where the chromatic dominant of the light and possible smooth shadows are lowered, while scene details and edges are enhanced.

Many implementations of Retinex are available in the literature (McCann and Rizzi, 2012). They differ from each other in the way they spatially explore the neighborhood of each pixel and in the way the colors adjacent to that pixel are processed.

Among the many variants of Retinex, here we focus on three algorithms belonging to the so-called Milano Retinex family (Rizzi and Bonanomi, 2017). Milano Retinexes are spatial color processing algorithms implementing the Retinex principles and mainly tailored to image enhancement. In this application field, Milano Retinex algorithms do not perform any calibration of the color signal. In the next, we will refer to the image output by Milano Retinexes as *color sensation* to distinguish it from the *human color sensation* computed by the original Retinex algorithm.

The first Milano-Retinex implementation, analyzed in details in (Provenzi et al., 2005), scans the neighborhood of each image pixel x by a set of random paths ending in x . The chromatic intensities of the color sensation at x are obtained as the average, among the random paths, of the relative ratios of the pixel's chromatic intensities along each path, where division by zero is of

course prevented. The one-dimensional, path-based scanning approach of the original Retinex has been adopted by many other subsequent Retinex implementations, e.g. (Marini and Rizzi, 2000), (Montagna and Finlayson, 2011), (Simone et al., 2014), (Lecca, Rizzi and Gianini, 2015), (Simone et al., 2017), (Gianini, Rizzi and Damiani, 2016). Here we describe and compare three algorithms, that implement a different scheme for image sampling and a different equation for the color sensation. These algorithms are: the Random Spray Retinex (RSR) algorithm presented in (Provenzi et al., 2007), and its two subsequent variants STRESS (Kolås, Farup and Rizzi, 2011) and QBRIX (Gianini, Manenti and Rizzi, 2014). Our attention to RSR and to its variants is justified by the success of this algorithm that has been widely used for many applications, e.g. (Rizzi and Parraman, 2010), (Fierro et al., 2013), (Banić and Lončarić, 2013a), (Banić and Lončarić, 2013b) (Gianini, Lecca and Rizzi, 2016).

In RSR, STRESS and QBRIX the color sensation is computed by processing the R, G, B channels of the input image independently. For each channel, the intensity of any pixel x is rescaled by the so-called *local reference white*, which is an intensity value depending on the spatial distributions of the intensities in a neighborhood of x .

RSR is the first Retinex implementation that replaces the random path scanning approach with a bi-dimensional random sampling. RSR originated from the need to solve some problems raised up by the use of the random paths. In fact, the path-based sampling mechanism of the original Retinex presents three main disadvantages: first, the color filtering strongly depends on the number and on the geometry of the used paths; second, the randomness of the paths introduces chromatic noise in the estimate of the color sensation; third, in order to reduce this noise, many paths have to be scanned, resulting in long computational times. RSR overcomes these problems by introducing a novel spatial sampling that explores the region around each image pixel x with a *random spray*. A random spray is a set of pixels randomly selected from a circular neighbor of x with a radially decreasing density, accounting for the fact that the pixels closer to x are more relevant to human color sensation than the others (McCann and Rizzi, 2012), (Creutzfeldt, Lange-Malecki and Wortmann, 1987). For any spray, the color sensation at x is computed as the ratio between the intensity of x and the maximum intensity in the spray. In order to reduce the chromatic noise due to the random sampling, many sprays are generated, and the final color sensation is the average value over the sprays' color sensations. Again, the algorithm precludes division by zero. STRESS (Kolås, Farup and Rizzi, 2011) (Spatio-

Temporal Retinex-inspired Envelope with Stochastic Sampling) is a variant of RSR, particularly suitable for local contrast stretching, automatic color correction, spatial color gamut mapping, and efficient color to grayscale conversion, e.g. (Islam and Farup, 2010), (Islam and Farup, 2011). As RSR, STRESS explores the neighborhood of each image pixel by the use of random sprays, but it estimates the color sensation in a different way. Precisely, for each chromatic channel, and for each image pixel x , STRESS computes the lightest and the darkest pixel in each spray centered at x and uses these values to define two functions, said the minimum and the maximum envelope, that contain the chromatic signal. The color sensation at x is obtained by stretching the chromatic intensities at x between the corresponding minimum and maximum values in the envelopes.

QBRIX (Gianini, Manenti and Rizzi, 2014) (Quantile-Based approach to RetIneX) is a probabilistic formulation of RSR. It removes the sampling procedure and models the spatial arrangement of the image colors by a suitable distribution function. There are two implementations of QBRIX. The first one is a global filter (here indicated as G-QBRIX), based on the fact that chromatic intensities rarely occurring in the image are not relevant to the color sensation, thus they can be ignored. According to this principle, the probability density function (pdf) of each chromatic channel is computed, and the intensity value corresponding to a quantile, fixed by the user, is set up as reference white. The color sensation is obtained by rescaling the chromatic values of the image by the input quantile that controls the percentage of discarded colors. The second implementation is a local filter (here termed L-QBRIX), that takes into account the spatial distance between the image colors: for each chromatic channel and for each pixel x , the algorithm computes a pdf at x , where the contribution of each image pixel is weighted by its distance from x . The color sensation at x is then computed as in the G-QBRIX. Disregarding the random sampling, QBRIX estimates a color sensation image with a negligible chromatic noise (Gianini, 2016) (Gianini, 2017).

The present paper presents a review and a comparative analysis of RSR, STRESS and QBRIX, carried out on a public dataset of color pictures (Rizzi, Gatta, and Marini, 2003b) and on an image usually employed to test color filtering algorithms. We evaluate the performance by means of different measures concerning the capability to enhance the contrast and luminance of the input image, the spatial local properties and the chromatic noise possibly generated by the filtering. The evaluation scheme and the obtained results can be used for the analysis

and the comparison of other filtering algorithms. This paper is mainly based on the work (Lecca, Gianini and Rizzi, 2016) originally presented at the 12th Colour Conference, held in Torino, Italy, in 2016.

2. NOTATION

Let I be a color image with size $A \times B$, where A, B are positive integer numbers. Let C_0, C_1, C_2 be the chromatic channels of I . Each of them is regarded as a function $C_i : \text{Supp}(I) \rightarrow [0, 1]$, where $\text{Supp}(I)$ is the image support, i.e. the set of the spatial coordinates (a, b) of the image pixels ($a \in \{1, \dots, A\}, b \in \{1, \dots, B\}$). Here we assume that the chromatic intensities of I , that in a standard RGB image range over $\{0, \dots, 255\}$, have been normalized in $[0, 1]$. This assumption is introduced for numerical reasons. Here we refer to the color sensation as to a color image L defined on $\text{Supp}(I)$ and having chromatic components L_0, L_1, L_2 .

3. RANDOM SPRAY RETINEX

Random Spray Retinex (RSR) (Provenzi et al., 2007) is an efficient implementation of Retinex, used in many applications. As pointed out in Section 1, RSR was born from the need to decrease the computational cost of Retinex and to partially remove the chromatic noise possibly introduced by the random paths in the estimate of the color sensation. These objectives have been reached by adopting a novel sampling scheme and by simplifying the equation for computing the color sensation. The algorithm works as follows.

For each chromatic channel C_i and for each pixel $x \in \text{Supp}(I)$, with $C_i(x) \neq 0$, RSR generates $N(> 0)$ random sprays centered at x . The k -th random spray $S_k(x)$ ($k = 1, \dots, N$) is a set of image pixels $\{y_k^1, \dots, y_k^M\}$, belonging to a circular neighborhood centered at x . The parameters N and M are non-null positive numbers and $M(> 0)$ is smaller or equal to the number of image pixels. The pixel y_k^j is defined as

$$y_k^j = (x_0 + \rho \cos(\theta), x_1 + \sin(\theta)) \quad (3.1)$$

where (x_0, x_1) are the spatial coordinates of x , ρ and θ are uniformly randomly chosen over the sets $[0, R]$ and $[0, 2\pi)$ respectively, and R is the radius of the spray. Experiments reported in (Provenzi et al., 2007) showed that the optimal value for R is the length of the image diagonal. Fig. 1 shows a random spray centered at the middle point of an image.

The i -th chromatic intensity of the color channel at x is computed by the following Equation:

$$L_i(x) = \frac{1}{N} \sum_{i=1}^M \frac{C_i(x)}{C_i(x_k)} \quad (3.2)$$

where x_k is a pixel of $S_k(x)$ such that

$$C_i(x_k) = \max\{C_i(y) : y \in S_k(x)\}. \quad (3.3)$$

Since we assume that $S_k(x)$ contains x , and $C_i(x) \neq 0$, $C_i(x_k)$ is greater than zero, and thus Equation (3.2) makes sense. When $C_i(x) = 0$, $L_i(x)$ is set to zero.

The parameters N and M control respectively chromatic noise and locality of color filtering. The optimal values of N and M depend on the input image and they can be empirically determined as a trade-off between good image quality and computational time (Provenzi et al., 2007).

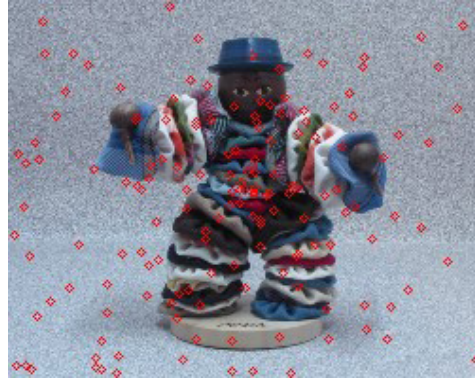


Figure 1 - A random spray centered in the middle of a color image from YACCD. The pixels of a spray are highlighted in red

4. STRESS: SPATIO-TEMPORAL RETINEX-INSPIRED ENVELOPE WITH STOCHASTIC SAMPLING

STRESS (Spatio-Temporal Retinex-inspired Envelope with Stochastic Sampling) (Kolås, Farup and Rizzi, 2011) inherits from RSR the image exploration mechanism, while it implements a different equation for estimating the color sensation.

For each chromatic channel C_i and for each pixel $x \in \text{Supp}(I)$, with $C_i(x) \neq 0$, STRESS computes N random sprays centered at x . For each spray $S_k(x)$ ($k = 1, \dots, N$), it estimates the local reference lightest and darkest chromatic intensities $E_{min}^k(x)$ and $E_{max}^k(x)$, defined as

$$\begin{aligned} E_{min}^k(x) &= \min\{C_i(y) : y \in S_k(x)\}; \\ E_{max}^k(x) &= \max\{C_i(y) : y \in S_k(x)\}. \end{aligned}$$

E_{min}^k and E_{max}^k can be regarded as two smooth functions, i.e. the *minimum* and *maximum envelopes*, defined from the image support to the chromatic intensities, and containing the entire chromatic channel. Fig. 2 shows an example of such envelopes.

The values $E_{min}^k(x)$ and $E_{max}^k(x)$ are used to compute a local chromatic sensation $v_k(x)$ from $S_k(x)$ by the following equation:

$$v_k(x) = \begin{cases} \frac{1}{2} & \text{if } R_k(x) = 0 \\ \frac{C_i(x) - E_{min}^k(x)}{R_k(x)} & \text{otherwise} \end{cases} \quad (3.4)$$

where $R_k(x) = E_{max}^k(x) - E_{min}^k(x)$.

The final chromatic sensation $L_i(x)$ is then obtained as

$$L_i(x) = \begin{cases} \frac{1}{2} & \text{if } E_M(x) = E_m(x) \\ \frac{C_i(x) - E_m(x)}{E_M(x) - E_m(x)} & \text{otherwise} \end{cases} \quad (3.5)$$

where

$$R(x) = \frac{1}{N} \sum_{k=1}^N R_k(x); \quad v(x) = \frac{1}{N} \sum_{k=1}^N v_k(x)$$

$$E_m(x) = C_i(x) - R(x)v(x); \quad E_M(x) = E_m(x) + R(x)$$

Using the mean values $R(x)$ and $v(x)$ instead of the mean values of $E_{min}^k(x)$ and $E_{max}^k(x)$ over the number of sprays emphasizes the weight of the chromatic intensity of the pixels close to x , and thus produces a less noisy image, with few haloing artifacts (Kolås, Farup and Rizzi, 2011).

4. QBRIX: QUANTILE-BASED APPROACH TO RETINEX

QBRIX (Quantile-Based approach to RetIneX) (Gianini, Manenti and Rizzi, 2014) is a probabilistic version of Retinex, based on RSR. QBRIX relies on the observation that the color sensation at any image pixel x is poorly influenced by (1) colors rarely occurring in the image and (2) colors of pixel located far from x . The observation (1) leads to an implementation of a global color filter, named G-QBRIX, while merging both (1) and (2) leads to a local color filter, named L-QBRIX. Both these versions process the chromatic channels separately and replace the random sampling of RSR with a statistic approach that suppresses the chromatic noise that in RSR is due to the random sampling.

4.1 THE GLOBAL FILTER: G-QBRIX

For each chromatic channel, G-QBRIX computes the probability density function (pdf) of the chromatic intensities. Due to the discrete nature of the data, the pdf is approximated by a histogram, normalized so that it sums up to 1.0. The pdf of a certain chromatic value C is thus computed as

$$p(C) = \frac{\#\{y \in \text{Supp}(I), y: C_i(y) = C\}}{\#\{y \in \text{Supp}(I)\}} \quad (4.1)$$



CubeAA01

G-QBRIX is grounded in the observation that chromatic intensities rarely occurring are irrelevant to color sensation, regardless of their values. The observation holds for the highest luminance pixels which are to be used as reference white values: as a consequence G-QBRIX considers only a certain percentage of image pixels, corresponding to a quantile Q of the pdf p . We remind that the quantile Q of the pdf p is a real number ranging over $[0, 1]$ that partitions $\mathcal{P}$ in two parts at a chromatic intensity q such that $\sum_{z=0}^q p(z) = Q$.

The value of Q is a user input and controls the percentage of pixels to be disregarded: more precisely, the percentage of retained pixels is the $(100 \cdot Q)\%$. The value of $L_i(x)$ (where as usual x is an image pixel) is given by the following equation:

$$L_i(x) = \begin{cases} 0 & \text{if } C_i(x) = 0 \\ 1 & \text{if } C_i(x) > q, C_i(x) \neq 0 \\ \frac{C_i(x)}{q} & \text{otherwise} \end{cases} \quad (4.2)$$

The second condition defines the chromatic sensation when q is smaller than the value of $C_i(x)$. For instance, this is the case of an image with $C_i(x) = 1$ and a low value of $p(C_i(x))$.

4.2 THE LOCAL FILTER: L-QBRIX

L-QBRIX re-implements the procedure of G-QBRIX by taking into account also the influence of the spatial arrangement of the colors in the image. For each chromatic channel C_i and for each pixel x in the image support, the algorithm computes a pdf of the chromatic intensities at x , such that

$$p_x(C) = \frac{1}{W} \sum_{y \in \{\text{Supp}(I) \setminus \{x\}, C_i(y)=C\}} \left[\frac{d(x, y)}{D} \right]^{-\alpha} \quad (4.3)$$

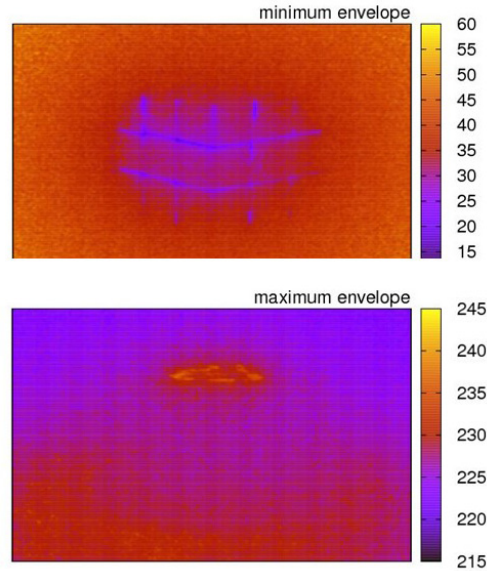


Figure 2 - The red component of an image (CubeAA01) from YACCD (Rizzi, Gatta, and Marini, 2003b) and its minimum and maximum envelopes. These results have been obtained by setting $N=35$ and $M=125$.

In this equation, $d(x, y)$ denotes the Euclidean distance between x and y , D is the length of the image diagonal, the parameter α is a real number tuning the relevance of the distance in the color sensation, and $W = \sum_A p_x(A)$ is a normalization factor where A ranges over the possible chromaticity intensities.

As in G-QBRIX, also in L-QBRIX the chromatic sensation $L_i(x)$ is computed by selecting a quantile of the pdf $p_x(C)$ and by applying Equation (4.2).

5. EXPERIMENTS

The color sensation output by the Retinex algorithms is an enhanced color image, where the chromatic dominant of the light and possible slight shadows are partially removed and the scene details are emphasized. In our comparative analysis of RSR, STRESS and QBRIX, we define a set of evaluation measures taking into account three visual properties of the color sensation, already used in previous works, e.g. (Lecca and Rizzi, 2015), (Lecca, Rizzi and Gianini, 2016): brightness, contrast, chromatic dynamic range. The analysis of these quantities allow to evaluate the image enhancement produced by the algorithms of the Retinex family. We remark that here we do not consider any pre- or post-filtering calibration of the input and output images, which is usually required by other tasks, e.g. for modeling the human vision system (Rizzi and McCann, 2007).

The proposed comparison is performed on the public dataset YACCD (Rizzi, Gatta and Marini, 2003b) that consists in 168 pictures displaying seven objects portrayed against two textured backgrounds and under seven illuminants with and without shadows (see Fig. 3 for an example). The seven illuminants are: 01 - Philips Neon Natural Daylight 6500 K (TLD965); 02 - Philips Neon Fluotone 4100 K

(TLD840); 03 - Philips Neon Fluotone Daylight 5000 K (TLD950); 04 - OSRAM Bellalux Insecta (H529); 05 - OSRAM Concentra Red R80 (H640); 06 - OSRAM Concentra Green R80 (H649); 07 - OSRAM Concentra Blu R80 (H649).

The tests have been also performed on a simple image, named Test16.255, displaying a bright square (with uniform RGB color (255, 255, 255)) over a dark background (with uniform RGB color (16, 16, 16)). Due to its simple structure (see Fig. 4(a)), Test16.255 is commonly employed to visualize the filtering effects of spatial color algorithms.

5.1 EVALUATION MEASURES

Brightness - We evaluate the brightness variation between the input image I and its color filtered version L by comparing their brightness mean values. Precisely, the mean image brightness is defined as

$$\mu = \frac{1}{\#\{y \in \text{Supp}(I)\}} \sum_{y \in \text{Supp}(I)} (B_0(y) + B_1(y) + B_2(y)) \quad (5.1)$$

where $\text{Supp}(I)$ indicates the set of the image pixels, and for any $i = 0, 1, 2$, B_i indicates the chromatic values of the input image (i.e. $B_i = C_i$) or of a filtered version (i.e. $B_i = L_i$).

Contrast - We evaluate the improvement of the details visibility by comparing the mean value of a multi-resolution contrast of the brightness of I and L , as proposed in (Rizzi et al., 2004), which accounts for local chromatic intensity variations at different scales. The contrast measure is defined operatively by constructing a pyramid of H images $I_0, \dots, I_{H-1}$ (with H an integer positive number) where I_0 is the brightness of I and for each $h = 1, \dots, H-1$, I_h is the image I_{h-1} rescaled by 0.5. For each image

I_h we evaluate the h th local contrast at a pixel $y \in \text{Supp}(I_h)$

$$c_h(y) = \frac{1}{8} \sum_{z \in N_8(y)} |I_h(z) - I(y)|$$

where $N_8(y)$ denotes the 8-connected neighborhood of y . The global contrast $\bar{c}_h$ of I_h is then obtained as the mean values of c_k over the number of pixels of I_h , i.e.

$$\bar{c}_h = \frac{1}{\#\{y \in \text{Supp}(I_h)\}} c_k(y).$$

The global contrast of I is then obtained by averaging the values $\bar{c}_h$ over h :

$$C = \frac{1}{H} \sum_{h=0}^{H-1} \bar{c}_h.$$

Histogram Flatness - The brightness and contrast enhancement of the Retinex algorithms modifies the shape of the pdfs of the chromaticity image channels. Precisely, the divisions performed by RSR, STRESS and QBRIX stretch the pdf of the brightness of the input image. We quantify this effect by computing the flatness of the pdf. Flatness is defined as the L^1 distance of the pdf p of the image brightness from an uniform pdf (Rizzi, Gatta and Marini, 2003a).

5.2 RESULTS

Figure 4 shows the filtering results obtained on the image Test16.255. These results have been obtained by using $N=15$ and $M=200$ for RSR and STRESS. As highlighted by the histogram equalizations in (f) and (g), the results obtained by using RSR and STRESS are noisy because of the random sampling.

Tab. 1 reports the values of the evaluation

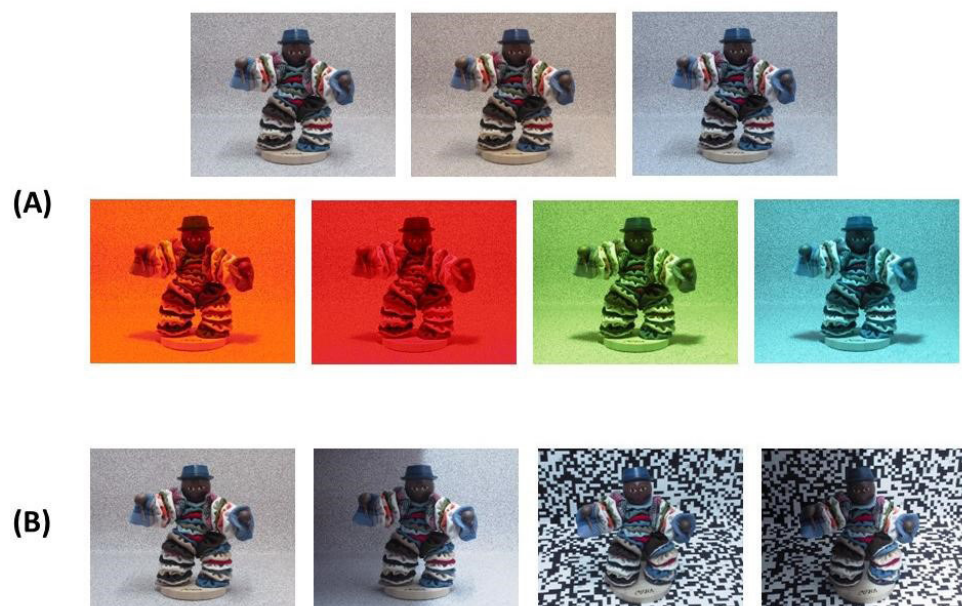


Figure 3 - An example from YACCD: (A) the same image has been captured under seven different illuminants; (B) for each illuminant, the object is displayed against two different backgrounds, with and without shadows.

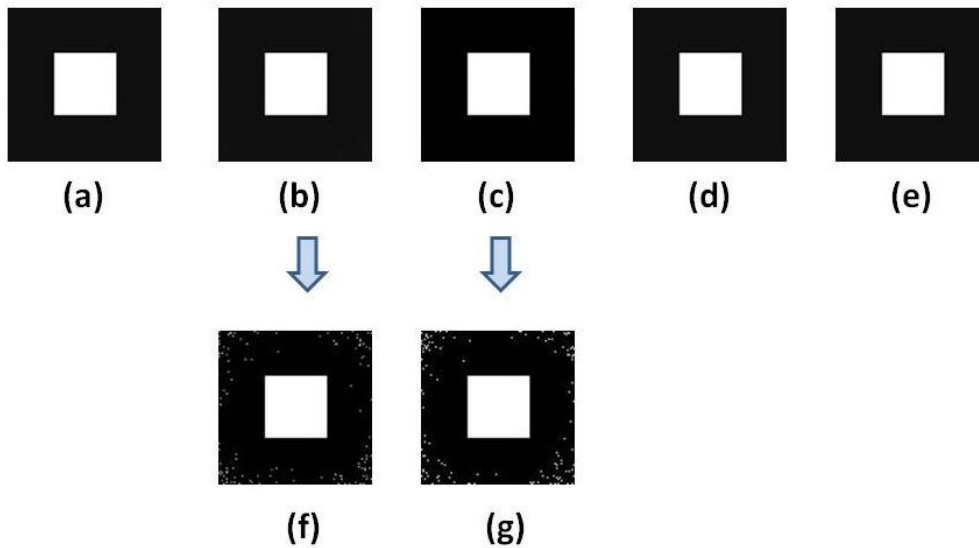


Figure 4 - Image Test16.255, and its filtered versions with (b) RSR; (c) STRESS; (d) G-QBRIX; (e) L-QBRIX). Visually the images look equal. Equalizing the histogram does not change the images (a), (d), (e) while the images (b) and (c) change: figures (f) and (g) show the chromatic noise added by the filtering process to (b) and (c) respectively.

ALGORITHM	MEAN LUMINANCE (μ)	MULTI-RESOLUTION CONTRAST (C)	FLATNESS [$\times 10^{-3}$] (F)
NONE	113.31	23.32	3.48
RSR	138.09	28.75	2.82
STRESS	126.40	32.04	2.44
G-QBRIX	138.01	28.70	2.79
L-QBRIX	143.57	30.00	2.84

Table 1 - Results on YACCD.

measures listed in Section 6.1 for the database YACCD. In these experiments, in order to reduce the computational time, we rescaled the YACCD images by 0.25, so that the size of the images considered here is 250 x 200 pixels. The parameters N and M input to RSR vary from image to image. They have been set up as suggested in [12]: each image has been processed with different increasing values of N and M , then we chose as final filtering the picture such that the CIELab difference between two subsequent filtering gets smaller than a fixed threshold. More details about the parameter set up for this dataset are provided in (Lecca and Rizzi, 2015). The pairs (N, M) used for RSR have been used also for STRESS. In QBRIX, we report the results obtained by setting $Q = 0.99$.

All the considered algorithms output an enhanced image, with increased luminance and contrast, while the histogram flatness diminishes, meaning that the filtering widens the dynamic range of the chromatic intensities. On average, the results obtained by RSR and G-QBRIX are very similar. STRESS outputs images with a lower brightness and with a higher contrast than the other algorithms. L-QBRIX produces the brightest pictures.

Some examples of the images obtained by RSR, STRESS and the two versions of QBRIX are shown in Figure 5, Figure 6, Figure 7 and Figure 8. Precisely, the figures show the

results on an image depicting a rollerskate and captured respectively under the illuminants 01, 02, 04 and 06. In Figure 5 and Figure 6 (Figure 7, Figure 8, resp.) the background is almost uniform (textured, resp.); in Figure 6 and Figure 8 shadows are present.

Figure 9 shows the results on an image acquired under a light with a considerable red component, and reports the color filtering results obtained by running QBRIX with two different values of the quantile Q . The results obtained with the highest quantile ($Q = 0.99$) are closer to those output by RSR and STRESS. We remark that L-QBRIX may produce a halo around the object borders: this is due to the spatial locality of the algorithm. In general, for a very low value of Q , many pixels satisfy the second condition of Equation (4.2), thus the algorithm provides a too bright image, where many details are lost. When $Q=1$, G-QBRIX behaves like scale-by-max, while L-QBRIX realizes a local effect, where the pixels' intensity is weighted by the spatial distance of the max.

6. CONCLUSIONS

In this paper, we have reviewed and compared three Retinex implementations: RSR, and its variants STRESS and QBRIX. RSR and STRESS share the same spatial sampling strategy, performed by random points, while they differ from each other for the mathematical equation

Figure 5 - (a) Image SkateAA01 from YACCD and its filtered versions with (b) RSR; (c) STRESS; (d) G-QBRIX; (e) L-QBRIX.



(a) Input Image



(b) RSR



(c) STRESS



(d) G-QBRIX



(e) L-QBRIX

Figure 6 - (a) Image SkateAB02 from YACCD and its filtered versions with (b) RSR; (c) STRESS; (d) G-QBRIX; (e) L-QBRIX.



(a) Input Image



(b) RSR



(c) STRESS



(d) G-QBRIX



(e) L-QBRIX

Figure 7 - (a) Image SkateBA04 from YACCD and its filtered versions with (b) RSR; (c) STRESS; (d) G-QBRIX; (e) L-QBRIX.



(a) Input Image



(b) RSR



(c) STRESS



(d) G-QBRIX



(e) L-QBRIX

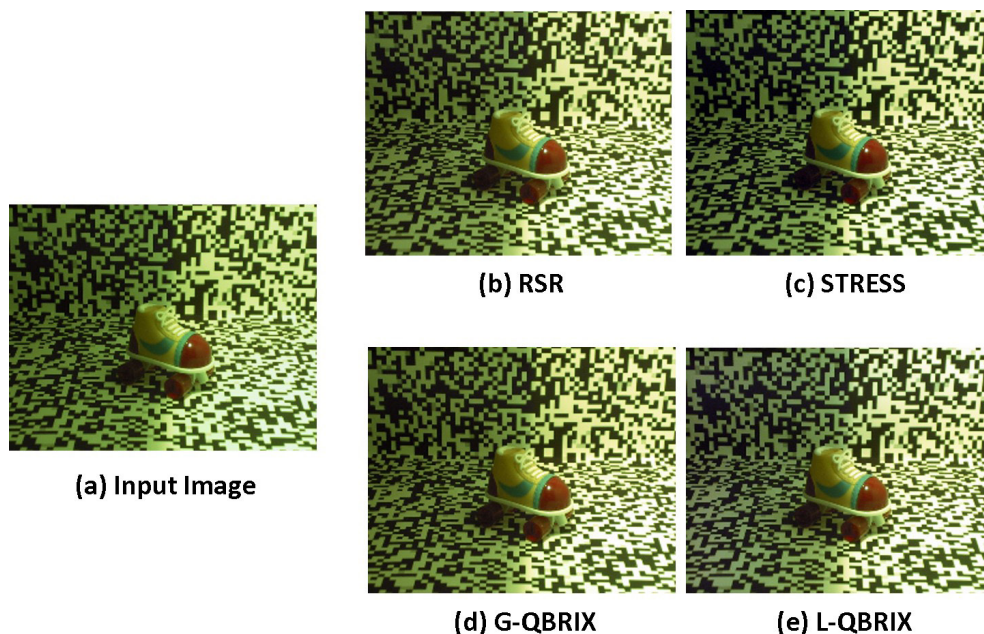


Figure 8 - (a) Image SkateBB06 from YACCD and its filtered versions with (b) RSR; (c) STRESS; (d) G-QBRIX; (e) L-QBRIX.

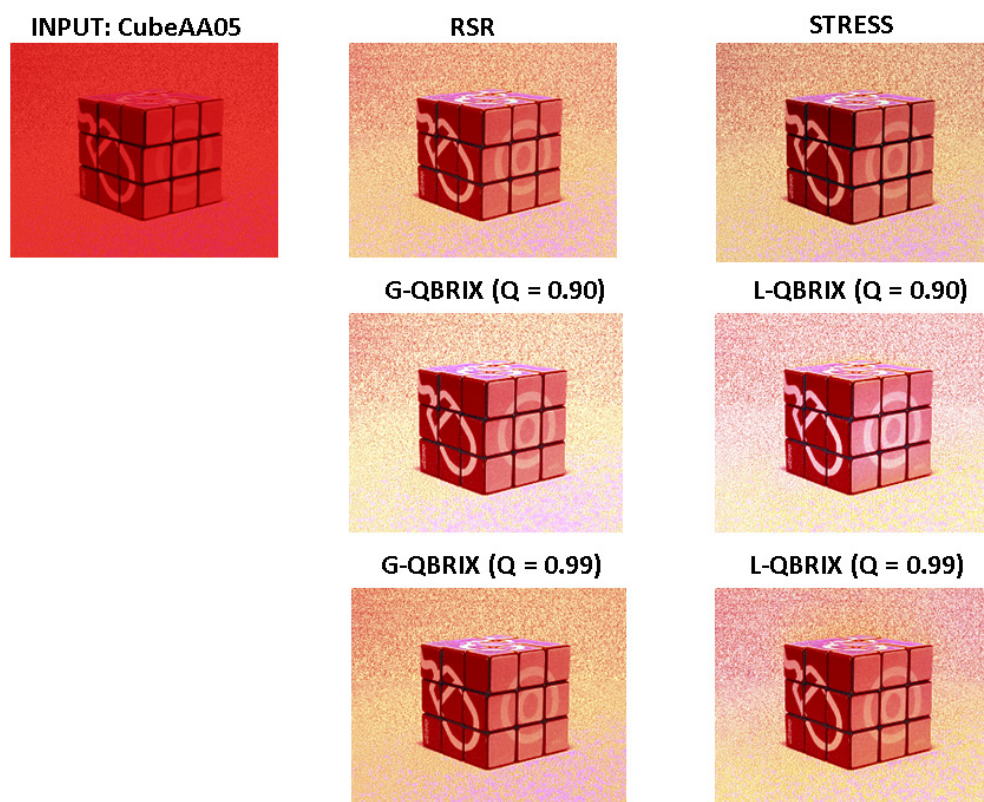


Figure 9 - Results of RSR, STRESS and QBRIX for two different values of the quantile.

used to compute the color sensation. QBRIX reformulates RSR in a probabilistic framework that avoids the random sampling, and performs color correction by considering the statistic distribution of the image chromatic channels. We have compared these methods by measuring their image enhancement capability on the public color database, YACCD that contains the pictures of six objects acquired under seven different lights, with and without shadows, and with two different background. The experiments show that all these methods enhance the input image by producing an image with higher brightness and contrast, and with a better use of the available dynamic range.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. In particular, no financial/personal interest have affected their objectivity.

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Symbolic Color Associations in Goethe's *Farbenlehre* and its application in the pictorial work of its early receptors

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ABSTRACT

In this article will be recognized the main contributions of Goethe in relation to a symbolic consideration of color for its use in the pictorial practice, from the connection of the chromatic polarities theory proposed by Goethe in the *Farbenlehre* with its section on the 'Effect of Color with Reference to Moral Associations'. A review of Goethe's *Color Circle* as the visual manifesto of his work and also to his previous *Rose of Temperaments* will be useful to understand how the German poet was visually thinking in giving a guide for the pictorial color application to the receptors of his *Theory of Colors*. Finally, the reception of this symbolical section of the *Theory* in the contemporary painters Philipp Otto Runge and J. M. William Turner will also be reviewed, and how each painter enriched the chromatic symbology proposed by Goethe from his own interest in religious and / or allegorical themes.

KEYWORDS

Goethe, Theory of Colors, Chromatic Polarities, Symbology of Color, *Farbenlehre*, Pictorial Color, Color Circle

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1. INTRODUCTION

One of the foundations of Goethe's *Theory of colors* that has been recognized as relevant for later studies is related to the aesthetic and symbolic effects of color, which the German poet describes in the Didactic Section of his theory. The section called *'Effect of Color with Reference to Moral Associations'* contains specific guidelines that correspond to an intensification of the polar associations present in his theory, and which are proportionated for the assessment and understanding of color. These guidelines are susceptible to be applied in the artistic practice, since one of Goethe's motivations when studying color as a natural manifestation was to generate knowledge about its possibilities of application as a pictorial medium. For each perceived color, Goethe associated an answer inside the human being, from two fundamental ideas: first, that vision is not a passive sense, but an active, constituent, communicative disposition; and second, that due to this condition there is a correspondence between *'external light'* (the environment) and *'inner light'* (inside of the viewer), by which vision comes into contact with things, since *'only the affine can know the affine'* (Arnaldo 1992). The aesthetic and moral effects of color that he points to, are then derived from a sensitive action that is physiologically determined and that this action is, according to the poet, independent of cultural impositions or conventions, although these are present anyway. Goethe believed that colors have a clear effect on the mind and feelings (Miguel-Pueyo 2009), semantic associations with which he will begin his reflection on the color code as a specific language for art (Arnaldo 1992), and that will be of special interest to the artists who will later read his work, the receptors. This is clearly illustrated from the following paragraph of the *Farbenlehre*:

§758. Since color occupies so important place in the series of elementary phenomena, filling as it does the limited circle assigned to it with fullest variety, we shall not be surprised to find that its effects are at all times decided and significant, and that they are immediately associated with the emotions of the mind. We shall not be surprised that these appearances presented singly, are specific, that in combination they may produce an harmonious, characteristic, often even an inharmonious effect on the eye, by means of which they act on the mind [...] Hence, color considered as an element of art, may be made subservient to the highest aesthetical ends. (Goethe 1840)

The vindication of the color over the form that Goethe raises constantly, it is based on the consideration of color as a constituent aesthetic means, with full and sovereign formal capacity; this will be possible, to a great extent, due to the universal physiological conditions that order the chromatic values. The reactions of the observer to the chromatic combinations will not be for Goethe accidental answers, but derived from a combination of effects and counter-effects of the eye. The inherent artistic values of color in painting would remain incomplete, according to Goethe's conclusions, if they are not contemplated in relation to a receiver. The aesthetic and moral effects of color are not based only in the colored object –as traditional doctrines had pointed out– but in relation to an active subject.

2. ANALYSIS: GOETHE'S PROPOSALS ON COLOR SYMBOLISM

When Goethe took his theory, the chromatic circle, to image, he considered the inclusion of the moral and sensitive effects within the circle, in a textual way, positioning the different concepts in places close to the colors that produce them. The morphology of the circle will then serve as support for the symbolism of color, and in the same way, the various chromatic-conceptual polarities will be visualized in the chromatic circle. This chromatic circle corresponds – probably– to the first color model in history that incorporates concepts or written associations of a non-technical or pictorial nature, but rather of a cultural or symbolic nature.

An antecedent for the creation of Goethe's chromatic circle was the *Rose of Temperaments* (1798-1799), a scheme he had designed with Friedrich Schiller and which was based, in part, on the fourfold system of the four elements of Antiquity and the Middle Ages: the four humors, the four cardinal points, the four seasons, the four parts of the day, the four ages of man, the four phases of the moon, etc. (Miguel-Pueyo 2009). In that theory, red, for example, was associated with air, midnight, north, winter, old age and melancholy, reason, humor and judgment, ideal and unity. The Rose also constitutes a previous reference for the visualization of the symbolic associations of color, in which the different temperaments are indicated textually and associated by their position to one of the arcs of the circle. In the same way, the different personalities also appear explicitly and associated to a certain color of the corresponding arc. Thus, in the warm or active arc of the circle, we find the *'choleric'* temperament and its personalities *'tyrants, heroes and adventurers'*, which will be associated with the colors red,

orange and a part of yellow; while the 'sanguine' temperament and its 'hedonistic, lovers and poets' personalities will also be on the active arc of the circle, mainly associated with yellow and a part of green. On the passive side of the circle, there are the 'melancholic' temperament along with their personalities 'pedants, philosophers and rulers'; and the 'phlegmatic' temperament and their personalities 'historians, speakers and teachers',

associated with purple and blue respectively. When he writes the *Farbenlehre* and publishes his chromatic circle, in 1810, Goethe takes up the structure of textual associations within the circle, present in the *Rose*. He develops his chromatic circle from two concentric rings, in which he incorporates the textual references, but this time, on the colored areas. In the outer ring, Goethe positions four concepts, dividing the

Figure 1 - Translation of the Rose of Temperaments of J.W.V. Goethe and F. Schiller, 1798.

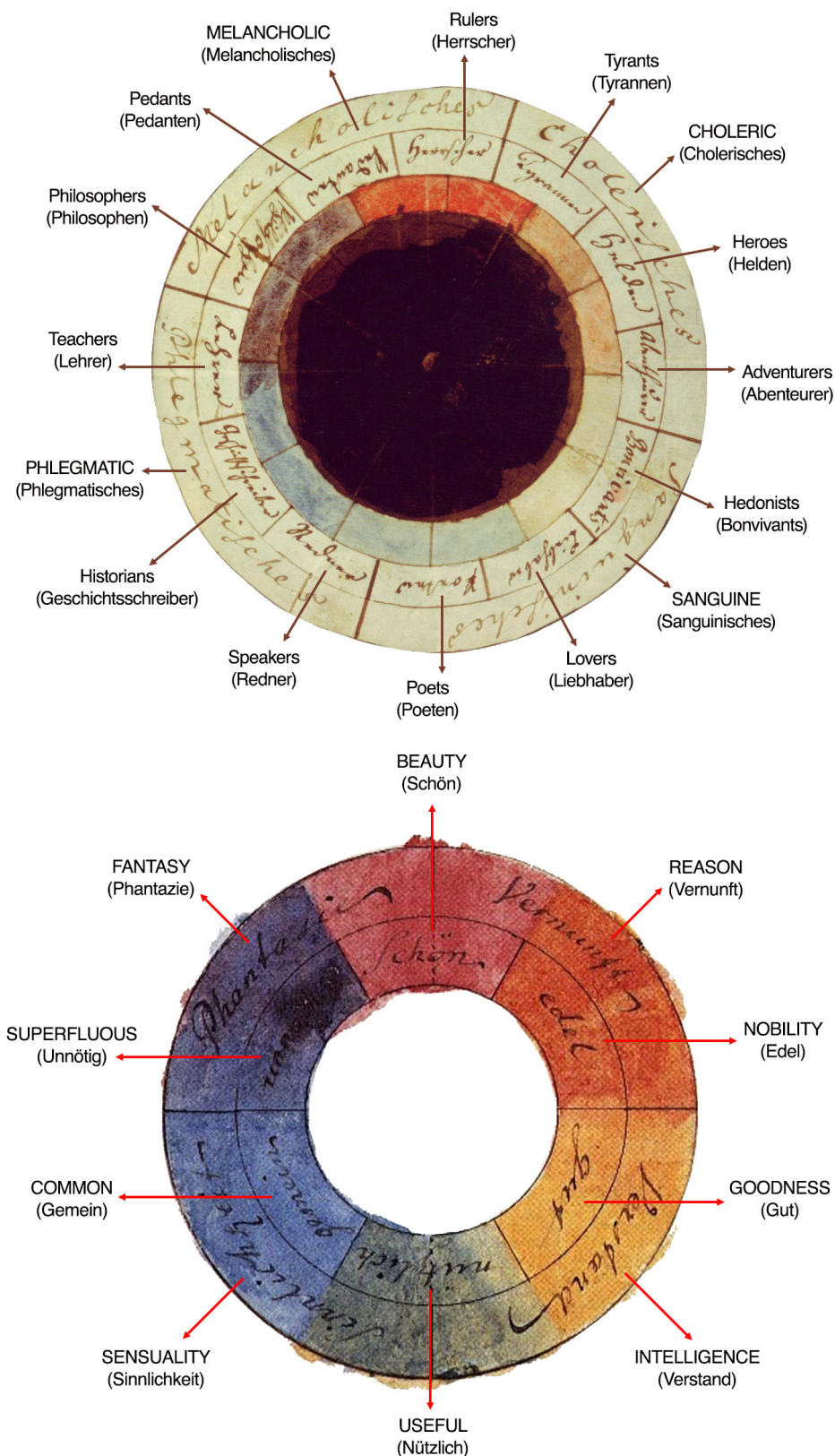


Figure 2 - Translation of the Color Circle of J.W.V. Goethe, 1810.

circle into four quarters, which are related to the concepts of the inner ring and are associated to them by their color and closeness. In this way, in the outer ring, we see the concept *'fantasy'*, associated with violet and purple colors, which contains the *'superfluous'* (in violet) and part of *'beauty'* (in purple). The *'beauty'* is also contained by the *'reason'*, purple and orange, which also contains entirely the *'nobility'* (in orange). The *'intelligence'*, of yellow and green colors, contemplates *'goodness'* (in yellow) and *'utility'* or *'function'* (in green). Finally, the *'sensuality'*, of blue and green colors, is related to the *'function'* and the *'common'* (in blue).

These associations contemplated in the circle correspond to a summary of what is stated in the *Theory*, in the *'effects'* section. These are symbolic qualities that accentuate the distinction of the two fundamental arcs of the circle. As expected, the poet will refer to the moral-sensitive effects of colors in terms of polarity, in their relation to both arcs of the circle, active and passive, yellow and blue. This polarization gives symbolic characteristics related to light and illumination to the colors that are close to yellow, and the characteristic of darkness to the colors that are close to blue (§778). On the active side, it is possible to find the qualification of yellow as the color of warmth and gladness (§773), cheerful and magnificent, especially pleasant when it has a reddish tone. Orange brings yellow to exaltation, *'intolerably powerful impression'* (§774). Of the red-purple, Goethe will say that its effect is *'as singular as its nature'*, with an impression of *'grave dignity'* at the same time as *'of serene grace'*. In his unique style, he will add that *'the dignity of age and amiableness of youth may adorn itself with degrees of the same hue'* [1] (§796). Besides the red-purple, the union of the two exalted poles –yellow and blue– will occur and therefore the calm, an ineffable satisfaction (§794). With yellow, orange and red-purple, the active side is *'in its highest energy'* (§775).

The colors of the passive side, blue, green and violet, on the other hand, *'produce a restless, susceptible, anxious impression'* (§777). Blue will be *'a kind of contradiction between excitement and repose'* (§779). Violet will have *'something lively without gladness'* (§789). In the green, on the other hand, the color resulting from the mixture of both poles, if none of them is above the other, *'the eye and the mind repose on the result of this junction as upon a simple color'* (§802).

Considering the effects of colors, Goethe introduces some reflections on the importance of tradition and conventions in the meanings that colors can acquire in different cultural contexts. This is how the poet alludes, for example, to the preferred colors of *'lively nations'* such as the French –the active side of the circle– in

comparison with the *'sedate nations'*, English and German, and people aiming at *'dignity of appearance'*, as Italians or Spaniards, who would prefer the colors of the passive side (§838); or the preferred colors of the fair-haired women in comparison with the brunettes (§840); or the disinclination of refined people to color (§841). He also makes some suggestions for the pictorial use of color in relation to harmony, classifying the combinations into *'characteristic harmonies'* and *'non-characteristic'*, and also regarding the use of complementary colors. Towards the end of the *'effects'* section, Goethe refers to different uses of color, which he names as symbolic –natural or attached to Nature–; allegorical –arbitrary or conventional–; and mystical. All these considerations were very useful for the artists who received the *Farbenlehre*, at different times. The artists were attracted by the seductive brilliance of their observations, as well as its charming writing (Kemp 2000).

3. RESULTS: RECEPTION OF THE 'EFFECTS': RUNGE AND TURNER

Two early recipients of the *Farbenlehre* were the German painter Philipp Otto Runge and the English painter J.M. William Turner. Runge had first-hand access to Goethe's chromatic studies since they were great friends and regularly exchanged correspondence. Although Runge would not be able to read the complete *Theory of Colors*, since he passed away the same year of its publication in 1810, he was perhaps the most important consultant of the work, receiving constantly commentaries and questions that the poet sent him by letter. In parallel, Runge developed his experimental series of works called *Hours of the Day*, in which is believed he was testing and applying the advances that Goethe shared with him.

Turner, in the other hand, had access to one of the copies of the first and perhaps most influential translation of the *Farbenlehre* into English, made by his friend the painter Charles Eastlake. Turner was fascinated with the work of the German poet and put it into practice in his later pictorial work, alluding to the *Theory* in the name of his series of two paintings: the first called *Light and Color (Goethe's Theory)*, *The Morning after the Deluge - Moses Writing the Book of Genesis* and the second *Shade and Darkness - The Evening of the Deluge*, both of 1843, where both names show a clear allusion to the theory of polarities –light and dark– as it is already said, one of the foundations of Goethe's work.

Returning to Runge, the German painter manifested an important interest in the symbolism of color. This was partly based on the

ideas shared with Goethe via correspondence, as well as his conviction that the pictorial work could be used to express the moods of man, through a series of natural symbols and allegories, as exemplified in the following quote, taken from a letter to his brother Daniel of 1802:

Nov. 7th, 1802: *'Color is the final art, which is and always will remain a mystery. It contains the true symbol of the Trinity. Light or white is good and the darkness is evil; that is why men were given the revelation and colors came to the world; that is, blue, red and yellow. Blue is the Father and red is the true link between earth and heaven. When both disappear, then the fire appears in the night, which is the yellow, or the Holy Spirit that is sent to us; also, for this reason, the moon is yellow'* (Runge 1982).

From the quotation, it is possible to notice that already towards 1802 great similarity existed in Goethe and Runge with regard to the symbolic association of the black-white polarity, in linking white with the light and the good, and black with darkness or evil. Although we have seen that for Goethe color acquires fundamental importance as a means to access sensitive experience, for Runge it will have a religious-mystical tint, since it *'contains the true symbol of the Trinity'* and is part of *'the revelation of God towards men'*. He also refers to the three primary nuances of Goethe's symbolism, yellow, red and blue, but these are also defined in religious terms, associating the blue color with the Father, red with *'the link between heaven and earth, between God and men'*, Jesus Christ; and yellow as the color of the Holy Spirit.

From these associations, it might seem difficult to link the rationality of Runge in the construction of his geometric-mathematical model *Die Farben-Kugel* (*The Sphere of Colors*) with the mystical intensity with which he refers to color in his letters to Daniel. However, in the same publication of *The Sphere*, the painter included another brief scheme that alludes to the symbolic qualities of colors: a six-pointed star inscribed within a circle, which will summarize some of his chromatic associations. Runge contrasts what he considers to be 'ideal colors' in the upper pole of the scheme, where the red color is placed, with the 'real colors' of the lower pole, or shades of green. Red is linked in *Die Farben-Kugel* to love (Liebe) and green with the physical world. The cold colors, blue and violet, are linked to the woman (Weib) and the feminine passions (Weibl: Leidenschaft), respectively; Warm colors, yellow and orange, on the other hand, are related to man (Mann) and male passions (Männl: Leidenschaft).

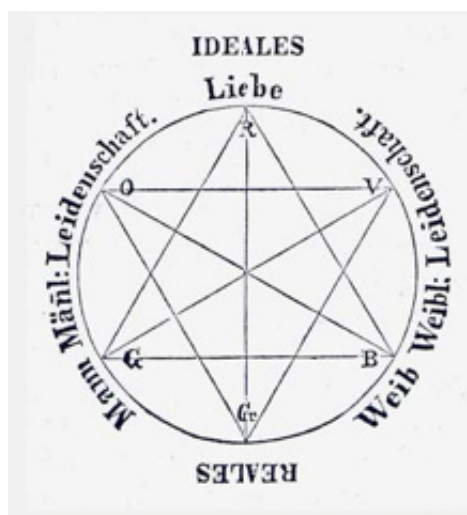


Figure 3 - Hexagram of color and correspondences of P.O. Runge, *Die Farben-Kugel*, 1810.

Some theorists, such as Martin Kemp, argue that Runge took much of the mysticism of the seventeenth century, and sought particular inspiration in the writings of Jakob Böhme. From Böhme's work, *Aurore oder Morgenrote in Aufgang*, of 1620, Runge would have adopted the divine triangle of the Trinity as an omnipresent principle of organization in the universe, as in the three fundamental primary colors –yellow, red and blue– (Kemp 2000). In another letter to Daniel in 1803, Runge again alludes to the trinity in chromatic terms:

'the one and the three, that is, the longing, the love and the will; yellow, red and blue; the point, the line and the circle; the muscles, the blood and the bones' (Runge 1982).

When trying to take its symbolism to the pictorial practice, Runge generated his project of four pictorial works called *Hours of the Day* he initiated in 1802 and that was composed by the morning, the day, the dusk and the night. For all, he developed sketches in engraving, but he only managed to paint the allegory of *The Morning* (1809-1810). This series was widely admired by Goethe and is perhaps the most representative work that links the mystical and symbolic associations of Runge with different characters and nuances. *The Morning* presents a symmetrical image with the representation of a sunrise, its Renaissance appearance is bathed with the warm brilliance of the golden light and translucent blue-purple shadows, which mark the chromatic counterpoint.

Inside and around the work sprout the flowers, the sun rises warmly from behind the earth, all the souls seem to ascend towards the ethereal blue and a baby in the center below alludes to the new day that is received by the angels. Other angels in the middle of the play surround Aurora, who is holding a white lily, symbol of purity, which *'is in the highest light'*, as Runge wrote in

another letter, combining the brightness of the symbolic trilogy, of yellows, reds and blues, which are protagonists of the painting. The warm and cold nuances are perfectly balanced, as in the background of the work where you can see an impeccable transition between the complementary blue and yellow. For Runge, color and light within the work express the progress of the earthly soul towards liberation.

In the case of Turner, his interest in symbolic representation with color dates back to his lectures prior to reading the *Farbenlehre*. For the English painter, the three primary colors constituted the epitome of all visible creation. In a lecture of 1818, he pointed out that yellow represents the medium –that is, light–, red represents material objects, while blue corresponds to distance in the landscape—or also to the air–, and the three colors are associated with morning, afternoon and night, respectively.

However, Turner was constantly skeptical about attempts to arrange colors into rigid groups of emotional or symbolic associations: 'the practice of these sentiments of color, particularly in those who follow color as sentiment [...] they must be left with those who framed them as emblematic concepts and typical allusions' (Gage 2001); in some of his lectures he even exemplified contrasting the emblematic and crude use of the color choices of artists like Carlo Dolci, among others, with more sensitive and expressive chromatic palettes like those of painters like Nicolas Poussin.

The polarity, the division of colors in Goethe's circle on the active and passive sides was one of the topics that most interested Turner in his reading of the *Farbenlehre*. His series of works *Shade and Darkness* and *Light and Color* (*Goethe's Theory*) –both of 1843–, is precisely the pictorial response of Turner to the consideration of color

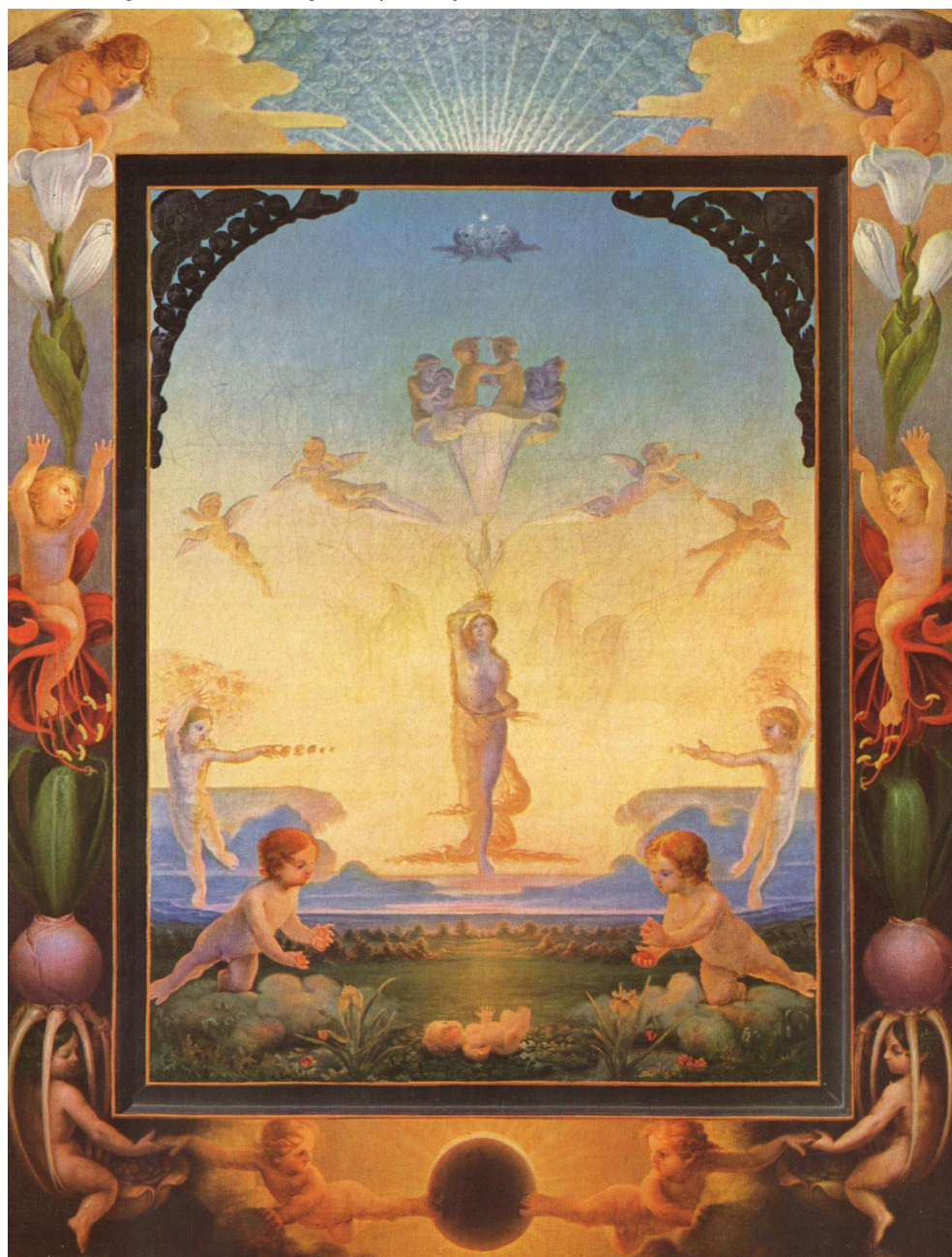


Figure 4 - Philipp Otto Runge, The Morning, 1809-10. Oil on Canvas, Kunsthalle, Hamburg.

in polar terms. But this same series of works will also be fundamental to understand how Turner granted semantic associations to colors, based on polarity but also related to his interest in linking religious allegories with the forces of Nature, from the inclusion of a poem to foot of the series of paintings, *The Fallacies of Hope*.

The painting *Shade and Darkness, The Evening of the Deluge* is accompanied by the first part of the poem, which gives an account of the 'darkness' of the Deluge:

*'The morn put forth her sign of woe
unheeded:
But disobedience slept; the dark'ning deluge
closed around,
And the last token came: the giant framework
floated,
The rous'd birds forsook their nightly shelters
screaming
And the beasts waded to the ark'.*

This work is the abstraction of a landscape that announces the disaster, dark and bluish. Turner's interest was to claim the sublimity of darkness, the sadness of the black. The greens and purple blues present in the work are taken by the painter on the passive side of Goethe's circle,

which the poet called 'restless, susceptible, anxious impressions', and which for Kemp will correspond to 'dramatic use' (Kemp 323) of the negative polarity of the *Farbenlehre*. In the case of Turner, darkness –or shadow– does not have the symbolic character of 'passive', but rather, associates a negative force or power. The Deluge is the storm that advances, where the forces of darkness threaten to hide the new dawn.

On the other hand, the iconography of *Light and Color (Goethe's Theory)*, presents a 'brightness' absolutely opposite and complementary to that of his companion:

*'The ark stood firm on Ararat: th'returning
sun
Exhaled earth's humid bubbles, and emulous
of light
Reflected her lost forms, each in prismatic
guise
Hope's harbinger, ephemeral as the summer
fly
Which rises, flits, expands and dies'.*

This work is presented with the rounded shape of a fragile sphere, a bubble like the ones with which Goethe and Turner experimented



Figure 5 - J.M.W. Turner, *Shade and Darkness, The Evening of the Deluge*, 1843. Oil on Canvas, London, Tate.

—with water and soap— in order to obtain the prismatic colors, the rainbow, on their surface. Goethe referred in the *Farbenlehre* on numerous occasions to the 'floating kaleidoscope' of the surface of the bubbles. In the poem, Turner refers textually to the 'wet bubbles' and the 'prismatic' character. *Light and Color* represents the morning after the Deluge, the sun rising after the storm, through the visual and emotional power of the reflected and refracted prisms. Turner replaced the classic pictorial figure of hope, the rainbow, with 'prismatic bubbles' expressing his interest in optical and chromatic theory.

When John Ruskin asked Turner what this work meant, the author would respond with only three words: 'red, blue and yellow' (Gage 126) that is, the foundation of color. Both works, *Shade and Darkness* and *Light and Color*, as a unique series, are a reflection on the symbolism of color, correspond to the reduction of color, in one case, and the deployment of its totality, in the other. The spectator experiences directly, due to color, the state of mind that the works manifest.

Both *The Morning* of Runge and this series of works by Turner are the consecration of the romantic tendency to a greater consideration of color as a resource to account for the feeling and subjectivity in the pictorial work. To a greater or

lesser extent, they are the test of the symbolic associations of Goethe, mediated by Runge and Turner, in a state of common thought. They deal specifically with the elemental power of color and light, as the chromatic attitude of other artists such as John Constable or Caspar David Friedrich, and later of Eugène Delacroix. All these artists contributed to raise a prosperous era for the representation with color, which wouldn't have a point of return —happily would have said Goethe— and is what makes Romanticism so important for what authors such as Manlio Brusatin, Michel Pastoureau or Ariel Jiménez have more recently defined as '*the History of Color*', an incipient and prosperous field of knowledge.

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CONFLICT OF INTEREST

I declare that no financial or personal interests have affected my objectivity, and this investigation has no conflicts of interest.



Figure 6 - J.M.W. Turner, *Light and Color (Goethe's Theory)*, *The Morning after the Deluge – Moses Writing the Book of Genesis*, 1843. Oil on Canvas, London, Tate.

NOTES

[1] In the section of the sensitive-moral effect of color it is recurrent to find poetic descriptions regarding the use of colors proposed by the poet. This is the main way in which Goethe alludes to artists, granting them exemplary literary images to promote a more conscious application of color. This can be further illustrated by paragraph §848, when he states: 'from the moral associations connected with the appearance of colors, single or combined, their aesthetic influence may now be deduced for the artist'.

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COLOUMN

Communications and Comments

Sailing on the wine-like sea towards foreign people, I finally put in harbor with ships and mates.

Νυν δ' ὥδε ξὺν νηὶ κατήλυθον ἡδ' ἐτάροισιν

πλέων ἐπὶ οἴνοπα πόντον ἐπ' ἄλλοθροὺς ἀνθρώπους

[Omero, *Odyssey*, II, v. 183,
Translated by M. Lecca]

In the last number of this column, we have discussed about the meaning of color perception. We have shown that color perception is a concept difficult to be defined and explained. The main difficulty in giving a unique, simple definition of color perception is due to the fact that there is no agreement about the relationship between sensation, perception, and cognition.

In a phenomenological frame of reference, perception is independent from cognition, although sometimes it can be affected by it (that is by past experience, memory, hypotheses, interpretations, and so on). The laws of perception are basically the same in humans and in animals.

In a cognitive frame of reference on the contrary color perception depends on high level, cognitive features, that are deeply influenced by cultural heritage and societal issues; the law of perception are essentially different in humans and in animals.

As a consequence, theories about color perception may vary from time to time and from person to person.

Basically, our perceptual system strongly couples colours and emotions, and these in turn can be influenced by culture. Let's think of many expressions, like "*red passion*", "*vie en rose*", "*blue blood*", "*black Friday*", where colours clearly denote an emotion or its strength or a particular condition or situation. Since societal, historical, cultural features vary in time, colour connotations also change.

An interesting example for this is given by the recent web discussion about the colour names and colour perception by ancient Greeks [1][2][3]. Among the many web-pages dedicated to this topic, that attracted much attention, here we mention this one:

<https://aeon.co/essays/can-we-hope-to-understand-how-the-greeks-saw-their-world>

In this page, Professor Maria Michela Sassi, expert of ancient philosophy and ancient thought from pre-Socratic to Aristo telic ages at Pisa University (Italy), reports a short analysis of the use and of the meaning of the colour terms in the ancient Greek literature, with particular attention to some parts from the well-known poem *Odyssey* by Homer. Her work starts from the observation that "*The ancient Greek experience of colour does not seem to match our own.*" For instance, in *Odyssey*, the colour term blue is never used to describe sky and sea. In particular, in many parts of *Odyssey*, the sea is pansy-like, wine-like or purple, while sky is like iron or bronze (see Figure 1). In addition, the colour term chloros denotes both green (like grass) and yellowish tones. Xanthos indicates yellow and red as well.

The description of the object colours provided by the ancient Greek is very surprising for us, who use the expressions blue sky and blue sea, green plants and grass, and distinguish the orange-reddish colour of the fire and of the amber from the yellow of the sun.



Figure 1: Were sea and sky really wine- and bronze-like in the ancient Greece?

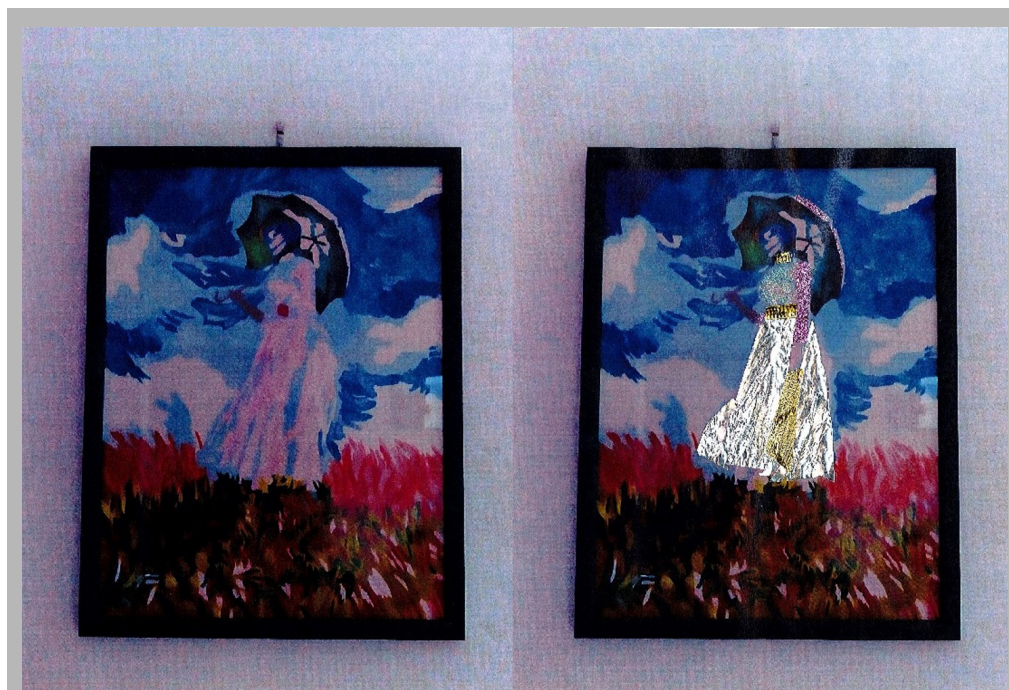
The use of colour terms can be affected by many factors: direct perception, linguistic style, stereotypes, poetic licence. Many scholars in the last two centuries defined the Greek use of colour terms a peculiar oddness, and many of them imputed the colour linguistic poverty of the Greeks to physical problems in capturing and processing the light wavebands, i.e. to colour blindness. Today, a theory about this is that the Greek colour terminology on the one side depends on perceptual experience, which was *'normal'* (not *'defective'*), but on the other side it can adapt to poetic demands, that is the colour terms are used and interpreted according the cultural Greek style of expressing poetry.

The Greek colour oddness is thus the Greek colour culture. As Professor Sassi said, Greeks perceive blue as we do, but they were not interested in using it to describe the colour of the sky and of the sea, that were described as yellowish and wine-like upon their culture, psychological feeling or expressive needs. Sky was iron or bronze-like because it was supposed to be like an up side down bowl covering the Earth [3]. In many parts of *Odyssey*, the sea is called purple. The word purple comes from the Greek word *porphyria* (πορφύρα),

which means seething, troubled [2] and refers to the procedure to produce the colorant *purpura* in the ancient world. In Homer's poetry, it may be considered a way to describe the evil sea that brings Ulysses from one coast to another, far from his family and home.

This last observation leads us to consider the problem of associating colour linguistic terms to perceived colours on the one side, and to stimulus colours on the other side. Different theories have been proposed and many experiments have been designed to disentangle the relationship between colour stimulus and colour names. In his commentary [4], Rolf G. Kuehni asserts that the first reference of colour terms is often made to colours understood as *"color stimuli"* or *"objective colors"*, while, on the basis of the fundamental distinction between perceived and stimulus colours, colour terms should primarily refer to the 'perceived' colours. Moreover, verbal colour descriptions should not be made in terms of physical properties (it would involve the stimulus error), as often happens. This error is often made because of the difficulty of verbally describing private perceptual experiences, which on the other side can be inter-subjectively communicated by verbal language despite the difficulty.

Figure 2 - On right: Reproduction by Michela Lecca of "Study of a Figure Outdoors: Woman with a Parasol, facing left" by Claude Monet (1886. Musée d'Orsay). On Left: here, the Woman modern dressed, with metallic and glittered cloths. How do the new materials change the color sensation and the color perception?



In [5]. Liliana Albertazzi and Osvaldo Da Pos describe a set of experiments to identify the references of colour categories in Italian language. In these experiments, a number of volunteers with different age and gender, were asked to produce through special software digital colours on a screen corresponding to a set of Italian colour names (Giallo/Yellow, Rosso/Verde, Blu/Blue, Arancione/Orange, Viola/Bluish Purple, Lime/Lime, Carota/Carrot, and so on ... a tentative English translation in italics). The assumption was that there is a special connection between perceived colours and corresponding colour stimuli, so that the colour perceived by the participant who produced the digital colour is about the same colour other people perceive when looking at that colour stimulus. The research showed that most colour terms among those used in the experiments refer to specific perceived colours, since the *'corresponding'* colour stimuli are significantly different. Moreover, other colour terms on the contrary refer to the same set of perceived colours, because the difference between the sets of colour stimuli is not statistically significant: the conclusion is that these terms are synonyms.

However, in [6], the same authors point out that the perceptual categorization

of colours can be *"implicit"* that is not verbally objectified: this means that grouping the colours by visual perception, i.e. ordering colours by their visual similarities, is independent on linguistic categories and provides a stable and, let's say, universal way to classify colours.

As already discussed in the previous number of this column, colour perception is something more than colour sensation, as it entails a number of interactions between different stimulated areas of the retina; moreover it can be also strongly influenced by previous experience and cultural heritage. This is an important cue to understand the colour names and the description of the object colours in the Greek literature: it explains once again the wine-like and iron-like colours of sea and sky. The ancient Greek literature is an interesting example of how the cultural features (e.g. language, material production, science conviction, ...) influence colour naming and vice-versa. Therefore, the lesson is that while colour sensation (i.e., colour seen in isolation, like through a hole on a uniform background) has an universal aspect, colour naming does not. In addition, colour perception depends on a complex set of spatial and temporal interactions which can be quite different

case by case: thus, color perception is not immutable, like the quintessence of the Aristotelic celestial spheres, but it is an extremely varying concept [7][8].

The historical problem of colour naming and the meaning of colours has been treated many years ago also by some members of the Colour Group, see [9], but it would be interesting proposing a novel discussion about this topics, also by considering how Internet and the novel, recent technologies have changed our colour culture. Another important issue is to understand how the new techniques for colour production and the invention of new materials affect colour perception [10] [11], by creating new colour effects or variations in the modes of appearance, e.g. metallic tints, glittered colours, plastic reflections, and so on (have a look at Figure 2).

Finally, we remind that these topics will be soon discussed during the Munsell Centennial Color Symposium, that will be held in Boston (MA) on June 10-15, 2018, and organized by the Inter-Society Color Council and by the International Colour Association [12].

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Claudio Oleri Memorial



The Associazione Italiana Colore, with all its members would like to express its deepest condolences for the premature death of Claudio Oleri on 23 January 2018, together with all who have known him, read his books, listened to his conferences or lectures.

He was an Eminent physics scholar and an Associate Professor at the University of Parma, at the Department of Physics and Earth Sciences. He dedicated his life to the activities of teaching with the same passion and interest that he dedicated to the researches in the context of colour, applying physics to perception and fixing its role in colorimetry. Moreover in 1995 he started the Gruppo in Colorimetria e Reflectoscopia which later became the Associazione Italiana Colore.

His availability for colleagues and students and his ability to listen and advice are proverbial: his kindness will be always remembered by everyone who has known him.

These qualities are clearly demonstrated by the message of his profile at the University of Parma "My office is at the Department of Physics (Campus, viale Usberti 7/A), phone 0521-905214, email address: claudio.oleari@fis.unipr.it. You can send me email for any request or question related to my course. I'm almost always in my office and I'm always available except when otherwise busy. Just call to check if I'm busy. I always reply to emails."

He conducted within the Italian Association, a valuable activity of information and connection of which remains a rich bibliography, always having in mind the need to invest in research and training both in Italy and abroad.

His death leaves a void difficult to fill and the world of colour loses an intellectual and an attentive and informed scholar.

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