A Color Graphic Icon Informing on the Impact of Electric Lighting and Coated Glazing on Colors in Complex Architectural Scenes

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CONTEXT & OBJECTIVES

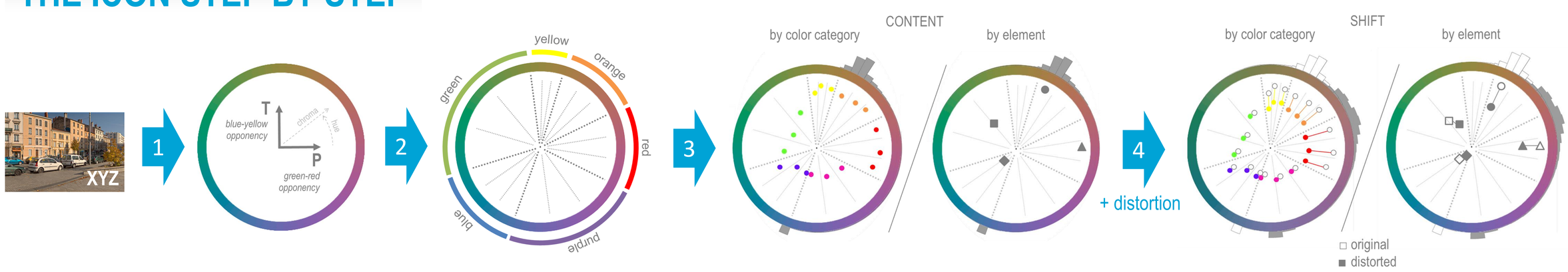
A color graphic icon which serves the decision-making process in building design
- based on recent developments in lighting color quality and adapted for real complex scenes
- providing descriptive information about the color content of a real scene and color shifts due to illuminant and/or glazing changes

For better understanding (and predicting) preferences of people regarding tint of glazing / electric lighting according to the context

DEVELOPMENT OF THE ICON

1. Application of iCAM06[1] color appearance model for predicting visual appearance of the complex scene and representation of the scene's color content in the PT plane of IPT color space
2. Division of the PT plane in 18 bins (6 principal color categories [a] divided in 3 equal parts)
3. Construction of a circular histogram to inform on scene's color distribution and calculation of mean P and T for each color category/element to inform on chroma/hues of the scene
4. Superposition of the color content of the original scene and that distorted by a glazing/light source change

THE ICON STEP BY STEP



APPLICATION

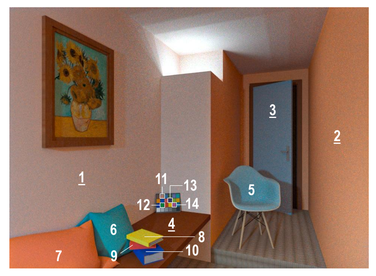
Example #1
Hyperspectral photography
Daylighting
View through glazing
Ref = clear glazing

In the original scene (clear glazing):
- a large unsaturated bluish component (~sky)
- a more saturated orange component (~buildings/roofs)

With the blue tinted glass:
- sky = more saturated and bluish
- buildings = less saturated and pinkish

With the bronze tinted glass:
- sky = low saturated green-yellow
- buildings = saturated orange

Example #2
Computer-generated image [b]
Electric lighting
Lighting retrofitting
Ref = ID 65

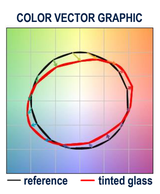


Two similar IES Rf but the color graphic icon highlights:
- a large increase of chroma in red/orange bins with the LED source
- a loss of chroma for the element #8 (yellow book) with the LED source

Architectural elements (#1 to #4) are:
- less impacted than other objects
- less impacted by the fluorescent source than by the LED source

#1a : blue tinted glass

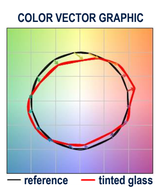
COLOR VECTOR GRAPHIC



CCT (K)	11297
IES Rf	73
IES Rg	95

#1b : bronze tinted glass

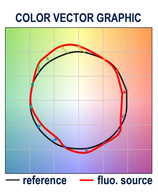
COLOR VECTOR GRAPHIC

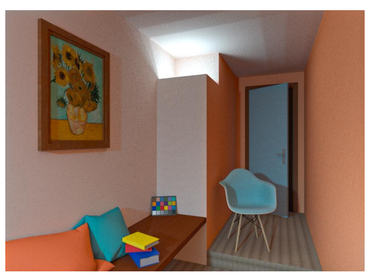


CCT (K)	4115
IES Rf	71
IES Rg	94

#2a : fluorescent source

COLOR VECTOR GRAPHIC

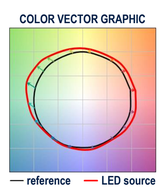


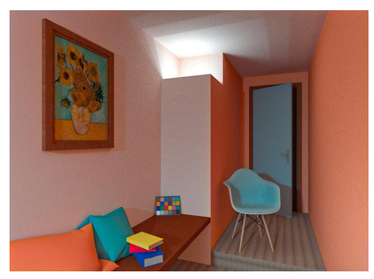


CCT (K)	2954
IES Rf	77
IES Rg	102

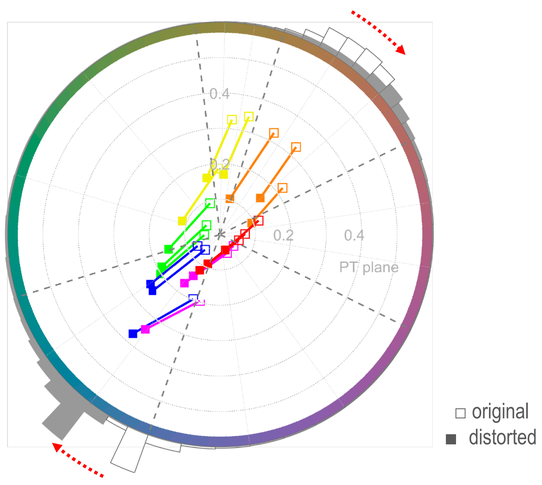
#2b : LED source

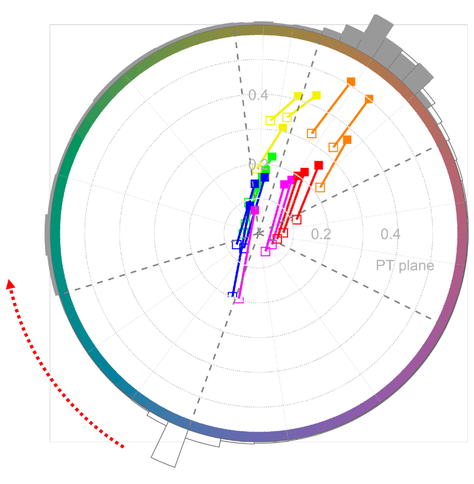
COLOR VECTOR GRAPHIC

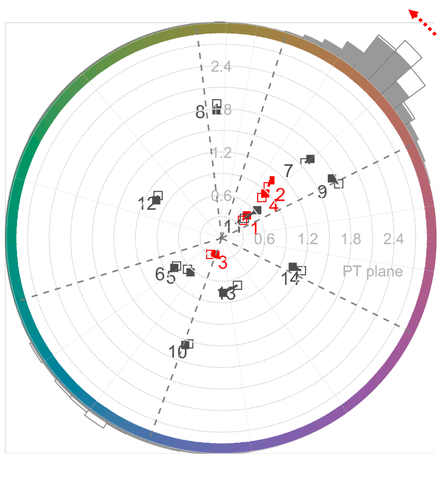


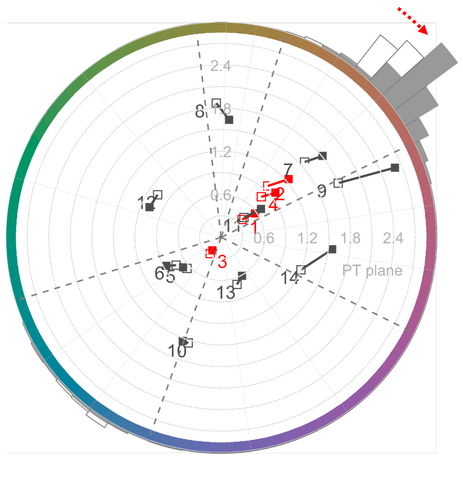


CCT (K)	2712
IES Rf	78
IES Rg	116



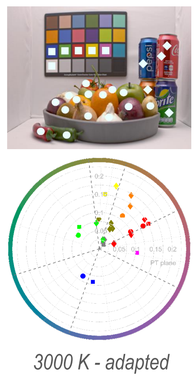






VALIDATION WORKS

1. Objective analysis of typical colored objects
   > *Some objects not in the right bin – orange-red boundary KO*
2. Color content experiment
   > *Some objects not in the right bin – yellow-green boundary KO*
   > *Context and memory color effect*
3. Color listing experiment
   > *11 basic color categories instead of 6 (+brown, pink, gray, white, black)*
   ~ *Berlin and Kay's basic color terms* [3]



3000 K - adapted

CONCLUSIONS

The present study raises questions about:
- division of the color space in color categories
  - link with color naming and memory color effect
  - normalization of tristimulus values (*Which ref. white in non-uniformly lit scenes?*)
- parametrization (and validity) of available CAMs (color appearance models) for complex environments (*Which level of chromatic adaptation?)*

Further work:
- re-definition of bin boundaries + validation with familiar objects in various contexts
- objective analysis of color shift (color graphic icon) versus people's preferences

Note.
[a] The boundaries of the 6 color bins were first determined in Munsell Notation based on the work by Hansen et al.[2]. XYZ and IPT coordinates of Munsell color chips were then calculated under D65, based on their reflectance spectra. Resulting hue angle of the boundaries are: 26° for red-orange (5R), 72° for orange-yellow (10YR), 97° for yellow-green (10Y), 197° for green-blue (5BG), 250° for blue-purple (5PB) and 334° for purple-red (10P).
[b] Ocean 2017 R4, http://www.eclat-digital.com/.

References.
[1] Kuang, J., Johnson, G. M., & Fairchild, M. D. (2007). iCAM06: A refined image appearance model for HDR image rendering. Journal of Visual Communication and Image Representation, 18(5).
[2] Hansen, T., Walter, S., & Gegenfurtner, K. R. (2007). Effects of spatial and temporal context on color categories and color constancy. Journal of Vision, 7(4).
[3] Berlin, B., & Kay, P. (1991). Basic color terms: Their universality and evolution. Univ of California Press.