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International Colour Association
The Color Science Association of Japan

IN COOPERATION WITH:
Ministry of Foreign Affairs
Ministry of Education, Science, Sports and Culture
Ministry of Construction
Agency of Industrial Science and Technology, MITI
Kyoto Prefectural Government
Kyoto Municipal Government

SUPPORTED BY:
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The Illuminating Institute of Japan
The Institute of Electrical Engineers of Japan
The Institute of Electronics and Communication Engineers of Japan
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Japan Ergonomics Research Society
Japanese Institute of Landscape Architecture
Japanese Ophthalmological Society
The Japanese Psychological Association
The Japanese Psychonomic Society
Japanese Society for the Science of Design
The Japanese Society of Printing Science and Technology
Japan Society for Interior Studies
The Japan Society of Image Arts and Sciences
The Japan Society of Home Economics
Optical Society of Japan
The Society of Fiber Science and Technology, Japan
The Society of Photographic Science and Technology of Japan
Japan National Tourist Organization

This International Scientific Congress, which is held with participants from both home and abroad is jointly supported by The Ministry of Education, Science, Sports and Culture who provided a Grant-in-Aid for Publication of Scientific Research Results and a Grant-in-Aid for Scientific Research for the fiscal year 1996.

<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONGRESS INFORMATION</td>
</tr>
<tr>
<td>CONGRESS SCHEDULE</td>
</tr>
<tr>
<td>HOW TO DECIPHER SESSION NUMBERS</td>
</tr>
<tr>
<td>SCIENTIFIC PROGRAM</td>
</tr>
<tr>
<td>INSTRUCTIONS</td>
</tr>
<tr>
<td>For Chairpersons</td>
</tr>
<tr>
<td>For Speakers</td>
</tr>
<tr>
<td>FLOOR PLAN</td>
</tr>
<tr>
<td>GENERAL INFORMATION</td>
</tr>
<tr>
<td>REGISTRATION</td>
</tr>
<tr>
<td>HOTEL ACCOMMODATION</td>
</tr>
<tr>
<td>SOCIAL PROGRAM</td>
</tr>
<tr>
<td>TECHNICAL TOURS</td>
</tr>
<tr>
<td>OPTIONAL TOURS</td>
</tr>
<tr>
<td>RELATED MEETINGS</td>
</tr>
<tr>
<td>TRAVEL INFORMATION</td>
</tr>
<tr>
<td>LIST OF CONTRIBUTORS</td>
</tr>
<tr>
<td>ORGANIZATION OF THE AIC</td>
</tr>
<tr>
<td>COMMITTEES OF AIC COLOR 97 KYOTO</td>
</tr>
<tr>
<td>ABSTRACTS</td>
</tr>
<tr>
<td>CORRESPONDENCE</td>
</tr>
<tr>
<td>MAP OF KYOTO</td>
</tr>
</tbody>
</table>
CONGRESS INFORMATION

Period: May 25 (Sunday) - May 30 (Friday), 1997

Venue: Kyoto International Conference Hall
Takaragaike, Sakyo-ku
Kyoto 606, Japan (during the Congress)

Tel: 81 (Japan) 75-705-1230  Fax: 81 (Japan) 75-705-1231

Language: The working language of the Congress is English.
Simultaneous Interpretation between English and Japanese will be available during the following programs:
- Opening & Special Lecture
- Symposium 2 (Color Design 21)
- Open Symposium (The Rebirth of Japanese Paintings)
- Closing

How to use the Receiver for Simultaneous Interpretation:

1. Simultaneous interpretation is provided in the following modes:
   - English .................................................. channel 1
   - Japanese .................................................. channel 2
   - Speaker’s voice ........................................ channel 3

2. Turn the channel selector to the mode you wish to listen to.
3. Adjust the volume by sliding the volume switch.

Exhibition: An exhibition featuring the newest developments and literature in the fields of color and color technology will take place from May 29 - 30. An opening tapecut is scheduled at 10:30, May 29 in the Momiji Room (Room E). For detailed information please see the Exhibition Guidebook.

Open Hours:
May 29 (Thu.) 10:30 - 17:30
   30 (Fri.)  9:00 - 15:00

AIC Color 97 Kyoto Poster Exhibition

Hardcopy samples (posters) which have been downloaded and printed from the home page are displayed in the corridor between Room A and Room B1, making it possible to compare the different colors achieved. The Secretariat is delighted to receive all posters for inclusion in the display.
<table>
<thead>
<tr>
<th>Date</th>
<th>Room</th>
<th>9:00</th>
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<tr>
<td>28(WED)</td>
<td>A</td>
<td>General Assembly Meeting</td>
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**Notes:**
- IP: Invited Lecture
- S: Symposium
- O: Oral Session
- P: Poster Session
- * Simultaneous Interpretation between English and Japanese provided.
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<th>Date</th>
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</thead>
</table>
|      | A    | P03: Joel Pokorny  
Ch. K. Kitahara | P06: Color Deficiency  
1. Ch. J. Pokorny  
and K. Kitahara | P09: Color Vision  
4. Ch. M. O. Fairchild  
and Y. Nakano | 
|      | B1   | P04: Osvaldo da Pos  
Ch. K. Sakata | P08: Color Psychology  
1. Ch. O. da Pos  
and K. Sakata | P12: Colorimetry  
1. Ch. K. Wilt  
and H. Sobagaki | P15: Colorimetry  
2. Ch. F. Denner  
and M. Sugiyama | 
|      | B2   | | P11: Environmental  
Color Design 4  
Ch. J. Hutchings  
and S. Honguchi | P14: Color Imaging  
1. Ch. M. Stokes  
and M. Miyahara | P17: Color Imaging  
2. Ch. J. J. McCann  
and N. Katoh | 
| 29(THU) | G    | Poster Set-up | | Break | Poster Display | Lunch | Break | Poster Display | 
|      | H    | Poster Set-up | Poster Display | | | | | | | 
|      | J    | Poster Set-up | | P05: Color Imaging  
3. | P06: Color Design  
4. | | | | | 
|      | K    | Poster Set-up | | P08: Color Imaging  
4. | P09: Textiles,  
Cosmetics, Fashion  
Color 3 | | | | | 
|      | Momi-ji | | | | | | | | | 

10:30 | Exhibition |

17:30 |

★ All posters will be displayed from May 29 to 30. Authors are requested to remain at their posters during the "P" session times indicated.
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<th>Date</th>
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<tbody>
<tr>
<td></td>
<td>B2</td>
<td></td>
<td>O29: Color Imaging 5, Ch. R. S. Berns and N. Ohta</td>
<td>O30: Color Imaging 6, Ch. M. R. Luo and Y. Miyake</td>
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<td>G</td>
<td>Poster Display</td>
<td>P11: Color Space 3</td>
<td>Break</td>
<td>Lunch</td>
<td>Poster Removal</td>
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<td>H</td>
<td>Poster Display</td>
<td>P13: Color Vision 7</td>
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<td>Poster Removal</td>
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* All posters will be displayed from May 29 to 30. Authors are requested to remain at their posters during the "P" session times indicated.
HOW TO DECIPHER SESSION NUMBERS

A - 001 - 01
- Paper No. 1 within the session
- Session number
- O: Oral Session
- P: Poster Session
- Room A

**Boldface names** indicate presenting authors.

★ Some changes to the schedule have been made since the printing of the Preliminary Program. Please be sure to check the schedule details carefully.
### SCIENTIFIC PROGRAM

#### May 26 (Monday)  
**Room A**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Chair</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 — 9:15</td>
<td>Opening Ceremony</td>
<td>Yaguchi, Hirohisa</td>
<td>Chairperson, Organizing Committee of AIC Color '97 Kyoto</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yoshinobu Nayatani</td>
<td>President, the Color Science Association of Japan</td>
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<tr>
<td></td>
<td></td>
<td>Munehisa Akita</td>
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<td>Lucia R. Ronchi</td>
<td></td>
</tr>
<tr>
<td>9:20 — 10:25</td>
<td>Special Lecture</td>
<td>Ikeda, Mitsuo</td>
<td>THE COLOR AND CHARACTER OF JAPAN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ikuo Hirayama</td>
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<tr>
<td>10:45 — 12:00</td>
<td>Oral Session O01 “Computational Vision 1”</td>
<td>Derefeldt, Gunilla; Tominaga, Shoji</td>
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<tr>
<td></td>
<td></td>
<td>A-001-01 Lenz, R; Morin, P; Haarto-Kanari, M</td>
<td>SPECTRAL BASED ILLUMINATION ESTIMATION AND COLOR IMAGE NORMALIZATION</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-001-02 Manabe, Y; Inokuchi, S</td>
<td>RECOGNITION OF MATERIAL TYPES AND ANALYSIS OF INTERREFLECTION USING SPECTRAL IMAGE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-001-03 Nobbe, JH; Skelton, H</td>
<td>A NEURAL NETWORK THAT RESPONDS AS A HUMAN OBSERVER TO THE CIE GREEN COLOUR CENTRE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-001-04 Wolff, LB; Secofsky, DA</td>
<td>THEORY AND ANALYSIS OF COLOR DISCRIMINATION FOR THE COMPUTATION OF COLOR EDGES USING CAMERA SENSORS IN MACHINE VISION</td>
</tr>
<tr>
<td></td>
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<td>A-001-05 Asaba, T; Kanozawa, K; Ibe, K; Nimura, E; Fujimoto, A; Tominaga, S</td>
<td>VISUALIZATION FOR APPEARANCE OF METALLIC AND PEARL COATINGS BY COMPUTER GRAPHICS</td>
</tr>
<tr>
<td>13:30 — 15:00</td>
<td>Oral Session O02 “Computational Vision 2”</td>
<td>Usui, Shiro</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>A-002-01 Funt, B; Cardel, V; Burnard, K</td>
<td>NEURAL NETWORK COLOR CONSTANCY AND SPECULARLY REFLECTING SURFACES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-002-02 Finlayson, GD</td>
<td>RETINEX VIEWED AS A GAMUT-MAPPING SOLUTION TO COLOUR CONSTANCY</td>
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<tr>
<td></td>
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<td>A-002-03 Obba, K; Sato, Y; Bouchi, K</td>
<td>VISUAL LEARNING AND OBJECT RECOGNITION WITH ILLUMINATION INVARIANCE</td>
</tr>
<tr>
<td></td>
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<td>A-002-04 Pomierski, T; Gons, BM</td>
<td>BIOLOGICAL NEURAL ARCHITECTURE FOR HUMAN COLOR PERCEPTION AND ADAPTATION REALIZING COLOR CONSTANCY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-002-05 Petraikian, JP; Gaudart, L; Cothausa, J</td>
<td>COLOUR OPPONENT WAVELETS: A CHROMATIC RECEPTIVE FIELDS MODEL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A-002-06 Nakaoyama, K; Sato, M; Sawada, T; Yamamoto, D</td>
<td>BUILDING COLOR SELECTION SYSTEM USING NEURAL NETWORK SYSTEMS</td>
</tr>
<tr>
<td>15:20 — 17:20</td>
<td>Symposium S1 “Color Cognition and Machine Vision”</td>
<td>Uchikawa, Kenji</td>
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<td>Symposiumists: Shafer, S; Wandell, B; Tominaga, S; Derefeldt, G</td>
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</tr>
</tbody>
</table>
May 26 (Monday)  Room B1

10:45—12:00  Oral Session O03 “Color Space 1”

<table>
<thead>
<tr>
<th>Chair: Alessi, Paula J.; Fuchida, Takayoshi</th>
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<tbody>
<tr>
<td>B1-003-01 Indow, T</td>
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<tr>
<td>B1-003-02 Bergström, B</td>
</tr>
<tr>
<td>B1-003-03 Nakamura, S</td>
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<tr>
<td>B1-003-04 Kawasaki, H; Kobana, A</td>
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<td>B1-003-05 Sakata, K</td>
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</tbody>
</table>

13:30—15:00  Oral Session O04 “Color Space 2”

<table>
<thead>
<tr>
<th>Chair: Rich, Danny C</th>
</tr>
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<tbody>
<tr>
<td>B1-004-01 Calvano, JL; de Muntiello, MF; Honold, A</td>
</tr>
<tr>
<td>B1-004-02 Nateri, K</td>
</tr>
<tr>
<td>B1-004-03 Sobagaki, H; Takahama, K</td>
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<td>B1-004-04 Sobolinski, DA; Wolff, LB</td>
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<td>B1-004-05 Glicksman, H</td>
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<td>B1-004-06 Komatsubara, H</td>
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May 26 (Monday)  Room B2

10:45—12:00  Oral Session O05 “Color Design 1”

<table>
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<th>Chair: Oberascher, Leonard; Kodera, Sho</th>
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<tbody>
<tr>
<td>B2-005-01 Flores, TL; Muroki, K</td>
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<tr>
<td>B2-005-02 Kim, J</td>
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<td>B2-005-03 Chakinko, L; Lazona, A</td>
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<td>B2-005-04 Martin, P</td>
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<td>B2-005-05 Burton, CM</td>
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13:30—15:00  Oral Session O06 “Color Design 2”

<table>
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<tr>
<th>Chair: Hihara, Motoko</th>
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<tbody>
<tr>
<td>B2-006-01 Kim, G; Osakik, M; Kobayashi, M</td>
</tr>
<tr>
<td>B2-006-02 Lee, K</td>
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<td>B2-006-03 Okazaki, N</td>
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<td>B2-006-04 Zöldi, A</td>
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<td>B2-006-05 Hutchings, J</td>
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### May 27 (Tuesday)  
**Room B1**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Chair</th>
<th>Title</th>
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<tbody>
<tr>
<td>9:00 — 9:40</td>
<td>Invited Lecture IP2</td>
<td>Yamagishi, Masao</td>
<td>TRADITIONAL AND LOCAL COLORS IN THE CONTEMPORARY ENVIRONMENTAL DESIGN</td>
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<tr>
<td>9:40 — 10:25</td>
<td>Oral Session O10 “Environmental Color Design 1”</td>
<td>Park, Don-So; Yamagishi, Masao</td>
<td>SELECTION OF SUITABLE COLORS FOR OFFICE BUILDINGS BASED ON THEIR LOCATIONS</td>
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<td></td>
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<td>IMPACT OF THREE COLOR SCHEMES ON LONG-TERM PRODUCTIVITY AND PERFORMANCE TASKS RELATIVE TO INDIVIDUAL ENVIRONMENTAL SENSITIVITY</td>
</tr>
<tr>
<td>10:45 — 12:00</td>
<td>Oral Session O11 “Environmental Color Design 2”</td>
<td>Lee, Jin-Sook; Nakamura, Yoshi</td>
<td>URBAN COLOR DESIGN BASED ON CULTURAL CLIMATE; CASE STUDY OF KOTO WARD, TOKYO</td>
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<td></td>
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<td>AN IMAGINABLE COLOR OF THE CORRESPONDING “COLOR POLLUTION”; THE CASE STUDY IN SAPPORO AND ITS SUBURBS</td>
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<td>THE ITEMS CONCERNING COLOR PLANNING OF BUILDING EXTERIOR SURFACES AND THEIR RESTRICTIONS</td>
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<td>COLOUR CONTEXT, SITE AND CULTURE, IN URBAN PLANNING AND ARCHITECTURE</td>
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<td>FIGURAL COLOR IN THE SEATTLE CITYSCAPE</td>
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<tr>
<td>13:30 — 15:00</td>
<td>Oral Session O12 “Environmental Color Design 3”</td>
<td>Rizzo, Silvia; Iwamatsu, Katsura</td>
<td>GEOGRAPHY OF COLOR</td>
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<td>STUDY CONCERNING THE COMPUTER SIMULATION OF COLORING OF EXTERIOR SURFACES OF BUILDINGS</td>
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<td>AN ESTABLISHMENT OF THE PRACTICAL GUIDE FOR COLOR PLANNING OF THE HIGH RISE APARTMENT HOUSING EXTERIORS IN KOREA</td>
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<td>INHERENT AND PERCEIVED COLOUR IN EXTERIOR ARCHITECTURE</td>
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## May 29 (Thursday)  Room A

### Invited Lecture IP3
- **Chair:** Kitahara, Kenji
  - Pokorny, J
- **Time:** 9:00 — 9:40
- **Title:** VISUAL FUNCTION IN HETEROZYGOTE CARRIERS OF COLOR VISION DEFECTS

### Oral Session O16 “Color Deficiency I”
- **Chair:** Pokorny, Joel; Kitahara, Kenji
- **Time:** 9:40 — 10:25
- **A-016-01** Paramawi, GV, Cavouius, CR: COLOR NAMING IN EZYGOTIC TWIN PROTHANOPES AT DIFFERENT LUMINANCE LEVELS
- **A-016-02** Nakadomari, S, Kuriyama, K; Horikoshi, Y; Kitahara, K; Yajima, H: HUE CLASSIFICATION TEST USING THE COLOR CAPS OF THE NEW COLOR TEST
- **A-016-03** Yoshida, CA; Sakuraba, N; Yoshida, AM: STUDY OF AGE-RELATED YELLOW VISION IN INTERIOR FINISHING COLORS

### Oral Session O17 “Color Vision 4”
- **Chair:** Fairchild, Mark D; Shioiri, Satoshi
- **Time:** 10:45 — 12:00
- **A-017-01** Wijk, H; Berg, S; Stolk, I; Steen, B: ASPECTS OF COLOUR PERCEPTION IN AN ELDERLY SWEDISH POPULATION
- **A-017-02** Shinomori, K; Werner, JS: INDIVIDUAL VARIATION IN WAVELENGTH DISCRIMINATION: TASK AND MODEL ANALYSIS
- **A-017-03** Nakano, Y; Soehara, K; Armi, T; Yano, T: QUANTITATIVE ANALYSIS OF COLOR APPEARANCE WITH SURROUND STIMULUS
- **A-017-04** Okajima, K; Robertson, AR; Fielder, GH: COLOR VISION MODEL FOR OPPONENT AND CATEGORICAL COLOR PERCEPTION
- **A-017-05** Fukurotani, K: ANALYSIS OF COLOR-OPPONENT PROCESSES IN THE RETINA OF THE PIRANHA

### Oral Session O18 “Color Vision 5”
- **Chair:** Kokoschka, Siegfried; Nakano, Yasuhisa
- **Time:** 13:30 — 15:00
- **A-018-01** Uchikawa, K; Kariki, E; Tono, Y: INFLUENCE OF COLOR MEMORY ON COLOR CONSTANCY
- **A-018-02** Ronchi, LR: ABOUT COLOR NAMING
- **A-018-03** Lin, H; Luo, MR; Tarrant, A: DIFFERENCES IN COLOR NAMING BETWEEN CHINESE AND BRITISH
- **A-018-04** Boms, RS; Qiao, Y; Remill, LA: VISUAL DETERMINATION OF HUE SUPRATHRESHOLD Tolerances
- **A-018-05** Yamane, N; Shioiri, S; Yaguchi, H: NEON COLOR SPREADING IN A FIGURE WITHOUT SUBJECTIVE CONTURS
- **A-018-06** Nakagawa, T: COLOR ASSIMILATION BETWEEN STRIPS DISPLAYED ON CRT WITH DARK BACKGROUND

### Symposium S3 “Color Management Systems”
- **Coordinator:** Hung, Po-Chien
- **Symposists:** Pointer, MR; Stokes, M; Kotera, H; Boms, RS
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<td>9:00 — 9:40</td>
<td>Invited Lecture IP4</td>
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<td>Chair: da Pos, Osvaldo; Sakata, Katsuaki</td>
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<td>B1-O19-01</td>
<td>Albert-Vanel, M</td>
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<td>A STUDY ON THE INFLUENCES OF COLOR INTERVAL AND AREA FACTOR ON COLOR HARMONY</td>
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<td>Burns, D; Johnson, N</td>
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<td>Kobayashi, M; Suzuki, T</td>
<td>QUANTITATIVE ANALYSIS OF COLOR FEATURES IN PAINTINGS —CLASSIFICATION BASED ON DISTANCE OF COLOR DISTRIBUTION IN COLOR SPACE —</td>
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### Oral Session O22 “Environmental Color Design 4”

**Chair:** Hutchings, John; Horiguchi, Setsuko

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<td>B2-022-01</td>
<td>COOPERATION OF FIGURE AND COLOR CODE STUDIED BY REACTION TIME TO COMMONLY USED SIGNS CHARACTERIZED IN BOTH FIGURE AND COLOR CODE</td>
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<td>THE TRANSLUCENT COLORS IN HOUSING</td>
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<td>THE COLOUR AND THE ROOM—EFFECTS OF SIMULTANEOUS CONTRAST, REFLECTIONS AND ILLUMINATION ON COLOUR APPEARANCE IN A ROOM</td>
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### Oral Session O23 “Color Imaging 1”

**Chair:** Stokes, Michael; Miyahara, Makoto

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<td>DEVELOPMENT OF ‘PRINTING SIMULATOR’</td>
<td>Usui, N; Imamura, A</td>
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<td>B2-023-04</td>
<td>A COLOR CONVERSION METHOD USING A NEURAL NETWORK FOR A CROSS-MEDIA COLOR APPEARANCE MATCHING</td>
<td>Arai, Y; Nakauchi, S; Usui, S</td>
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<td>IMPROVED MATRIX METHOD FOR TRISTIMULUS COLOREDIMETRY OF DISPLAYS</td>
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### Oral Session O24 “Color Imaging 2”

**Chair:** McCann, John J.; Katoh, Naoya

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<td>THE PREFERRED REPRODUCTION OF SKIN COLOR AND CHROMATIC ADAPTATION</td>
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<td>MODIFIED FAIRCHILD'S COLOR-APPEARANCE MODEL FOR FACIAL PATTERN IMAGES UNDER VARIOUS ILLUMINANTS</td>
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<td>COLOUR GAMUT TRANSFORMATION USING VISUALLY ASSESSED COLOUR DIFFERENCE FORMULA</td>
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<td>NON-ANALYTICAL GAMUT MAPPING ALGORITHM WITH GENERALIZED TENDI</td>
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<td>CROSS-MEDIA PSYCHOPHYSICAL EVALUATION OF GAMUT MAPPING ALGORITHMS</td>
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May 29 (Thursday)  Room G

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<tr>
<td>9:40 - 10:25</td>
<td>Poster Session P01 “Computational Vision 3”</td>
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May 29 (Thursday)  Room H

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<td>THE USE OF COLORS IN PICTURES DRAWN BY ART THERAPY TECHNIQUES</td>
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## Poster Session P05 “Color Imaging 3”

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## Poster Session P06 “Color Design 4”

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<td>Cavalcanti, D.</td>
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## Poster Session P07 “Environmental Color Design 5”

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<td>10:45—12:00</td>
<td>Posters Session P09 “Textiles, Cosmetics, Fashion Color 3”</td>
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<tr>
<td>13:30—15:00</td>
<td>Poster Session P10 “Environmental Color Design 6”</td>
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### May 30 (Friday)  
**Room A**  

#### 9:00 — 9:40  
**Invited Lecture O5**  
**Chair:** Ohno, Yoshihiro  
Verill, J  
**TOWARDS IMPROVED ACCURACY OF SURFACE COLOUR MEASUREMENT**

#### 9:40 — 10:25  
**Oral Session O25 “Colorimetry 3”**  
**Chair:** Verill, John; Ohno, Yoshihiro  

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-025-01</td>
<td>STANDARDIZED TERMINOLOGY AND PROCEDURES FOR SPECIFYING AND VERIFYING THE PERFORMANCE OF SPECTROCOLORIMETERS</td>
<td>Rich, DC; Barle, D</td>
</tr>
<tr>
<td>A-025-02</td>
<td>TESTING FASTNESS FORMULAE FOR ASSESSING COLOUR CHANGE USING NEW EXPERIMENTAL DATA</td>
<td>Sato, T; Takada, N; Tokino, S; Ueda, M; Nakamura, T; Luo, R</td>
</tr>
<tr>
<td>A-025-03</td>
<td>COLOURED TEETH</td>
<td>Luana, RD</td>
</tr>
</tbody>
</table>

#### 10:45 — 12:00  
**Oral Session O26 “Color Design 5”**  
**Chair:** Travis, Peter; Ogata, Koji  

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-026-01</td>
<td>AUTOMOTIVE EXTERIOR COLOR DESIGN IN THE 21ST CENTURY — A MARRIAGE OF ART-ORIENTED AND PRODUCT-ORIENTED DESIGN—</td>
<td>Satake, I; Nagashima, Y; Osumi, M; Torimura, S</td>
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<tr>
<td>A-026-02</td>
<td>MATERIALS USED FOR RESTORATION OF BUILDING OF MINISTRY JUSTICE (STUDY ON BRICK MATERIAL AND COLOR)</td>
<td>Sugimoto, K; Amano, A; Ikene, M</td>
</tr>
<tr>
<td>A-026-03</td>
<td>COLOUR DESIGN THROUGH CROSS PERCEPTION</td>
<td>Tosca, TF</td>
</tr>
<tr>
<td>A-026-04</td>
<td>COLORED VIVIDNESS AND COMPLEX COLORS</td>
<td>Moretti, I</td>
</tr>
<tr>
<td>A-026-05</td>
<td>COLOR AND CHOREOGRAPHY</td>
<td>Laberde, V</td>
</tr>
</tbody>
</table>

#### 13:30 — 15:00  
**Coordinators:** Chase, WT; Komachiya, A  
**Symposists:** Inaba, M; Keyano, M; Preuvers, FD; Uehara, M; Wakasugi, J
May 30 (Friday) — Room B1

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Chair</th>
<th>Presenter(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 — 9:40</td>
<td>AIC Tutorial Lecture</td>
<td></td>
<td>Ronchi, Lucia R; Silvik, L</td>
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<td></td>
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<td>NCS—REFLECTING THE COLOR SENSE AS A PERCEPTUAL SYSTEM</td>
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<tr>
<td>9:40 — 10:25</td>
<td>Oral Session O27 “Color Psychology 3”</td>
<td></td>
<td>Tosca, Theano F; Murayama, Kumiko</td>
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<tr>
<td>B1-027-01</td>
<td></td>
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<td>OHMI, G; Lee, SH</td>
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<td>CROSS-CULTURAL STUDY OF AFFECTIVE MEANING OF COLOR</td>
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<td>B1-027-02</td>
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<td>Saito, M</td>
<td>IS THE SUN RED OR YELLOW? — A COMPARATIVE STUDY IN JAPAN, CHINA AND INDONESIA</td>
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<tr>
<td>B1-027-03</td>
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<td>Iijima, S; Makii, K</td>
<td>CROSS-CULTURAL COLOR DIFFERENCES IN STREETSCAPE BETWEEN GREAT BRITAIN AND JAPAN</td>
</tr>
<tr>
<td>10:45 — 12:00</td>
<td>Oral Session O28 “Color Psychology 4”</td>
<td></td>
<td>Kwallek, Nancy; Shimagami, Kazunori</td>
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<tr>
<td>B1-028-01</td>
<td></td>
<td>Hihara, M</td>
<td>TWO TYPICAL COLOR PREFERENCE PATTERN AND JAPANESE SENSITIVITY</td>
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<tr>
<td>B1-028-02</td>
<td></td>
<td>Kubayashi, S; Iwamatsu, K</td>
<td>DEVELOPMENT OF SIX METHODS OF COLOR PSYCHOLOGICAL STUDY</td>
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<tr>
<td>B1-028-03</td>
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<td>Shimamura, M; Osato, M</td>
<td>HUMAN COLOR COUNSELING (COLOR PSYCHOLOGICAL TEST)</td>
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<tr>
<td>B1-028-04</td>
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<td>Sagawa, K; Shimizu, Y</td>
<td>VISUAL COMFORT OF A COLORED IMAGE STUDIED BY SPATIAL DISTRIBUTION OF CHROMA</td>
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<tr>
<td>B1-028-05</td>
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<td>Horita, Y; Kando, A; Murai, T; Nakajima, Y</td>
<td>EXTRACTION AND ESTIMATION OF THE SENSITIVITY INFORMATION OF COLOR</td>
</tr>
<tr>
<td>13:30 — 15:00</td>
<td>Visual Illusions and Effects (Study Group Meeting)</td>
<td>da Pos, Osvaldo</td>
<td></td>
</tr>
</tbody>
</table>
**May 30 (Friday)  Room B2**

<table>
<thead>
<tr>
<th>Time</th>
<th>Oral Session O29 “Color Imaging 5”</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:40 — 10:25</td>
<td>Chair: Berens, Roy S; Ohba, Noboru&lt;br&gt;B2-O29-01 Richter, K&lt;br&gt;TESTING COLOR DEVICES WITH ANALOG AND DIGITAL, TEST CHARTS BASED ON DEVICE-INDEPENDENT COLORS</td>
</tr>
<tr>
<td></td>
<td>B2-O29-02 Osumi, M; Numata, S; Asaba, T; Kawano, K&lt;br&gt;COLOR MATCHING SYSTEM FOR THE METALLIC PEARL THAT APPLIES FUZZY THEORY</td>
</tr>
<tr>
<td></td>
<td>B2-O29-03 de Ridder, H&lt;br&gt;NATURALNESS AND IMAGE QUALITY: HUE, SATURATION AND LIGHTNESS VARIATION IN COLOR IMAGES OF NATURAL SCENES</td>
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<thead>
<tr>
<th>Time</th>
<th>Oral Session O30 “Color Imaging 6”</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:45 — 12:00</td>
<td>Chair: Luo, Ming R; Miyake, Yoichi&lt;br&gt;B2-O30-01 Miyahara, M; Otsuka, S; Tanilo, S; Algazi, R&lt;br&gt;REPRODUCTION OF HIGH ORDER SENSATION ON A DISPLAY AND CROSS MODULATION AMONG R, G AND B</td>
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<td>B2-O30-02 Beretta, G; Bhaskaran, V; Korostantinides, K; Natarajan, B&lt;br&gt;ENCODING COLOR IMAGES FOR THE WORLD WIDE WEB</td>
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<tr>
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<td>B2-O30-03 Xin, JH; Huang, D; Luo, MR; Loe, SS; Lee, D&lt;br&gt;NEW COLOUR MANAGEMENT STRATEGIES FOR INDUSTRIAL COLOUR CONTROL</td>
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<td></td>
<td>B2-O30-04 Nakauchi, S; Imamura, M; Usui S&lt;br&gt;COLOR GAMUT MAPPING BASED ON MINIMIZATION OF PERCEPTUAL IMAGE DIFFERENCE</td>
</tr>
<tr>
<td></td>
<td>B2-O30-05 Brettel, H; Chiron, A; Hardleberg, JV; Schmidt, F&lt;br&gt;VERSATILE SPECTROPHOTOMETER FOR CROSS-MEDIA COLOR MANAGEMENT</td>
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<td>Time</td>
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<td>Caivano, JL; Dotto, P</td>
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<td>Motonomi, A; Katayama, I, Katayama, T; Gao, C; Shi, S; Nakama, K</td>
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<td>10:45-12:00</td>
<td>Poster Session</td>
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<td>G-P12-01</td>
<td>Ota, S; Yamamoto, H; Ejima, Y</td>
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<td>Amano, K; Uchikawa, K; Kuriki, I</td>
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<td>G-P12-06</td>
<td>Matsuzawa, M; Suzuki, Y; Aoyama, M</td>
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<td>G-P12-07</td>
<td>Kobayashi, M; Okamoto, I; Takahashi, M; Sato, M</td>
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<td>G-P12-08</td>
<td>Tsujimura, S; Shoito, S; Ishii, Y</td>
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<td>G-P12-09</td>
<td>Fukurotani, K</td>
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<td>G-P12-10</td>
<td>Shimono, K; Hashimoto, J; Inoue, S; Shoito, S; Yaguchi, M</td>
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<td>Yamamoto, H; Ejima, Y; Urayama, S</td>
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<td>G-P12-12</td>
<td>Takahashi, S; Ito, M; Hara, T; Nakamura, S; Nonami, H; Goto, T</td>
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<td>G-P12-13</td>
<td>Otake, S; Cicerone, CM</td>
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<tr>
<th>Time</th>
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<th>Poster Session P14 “Color Deficiency 2”</th>
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<td>10:45</td>
<td>H-P14-01</td>
<td>Ro, N.; Yoshida, T.; Imai, Y</td>
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<td>Imai, Y.; Kitamura, T.; Saito, S</td>
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<td>H-P14-03</td>
<td>Sakaki, T.; Onoai, M</td>
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May 30 (Friday)  Room J

10:45 — 12:00  Poster Session P15 "Colorimetry 4"

- J-P15-01  Harti, M.; Kögka, J.
  Polščak, R.; Lška, M.
  CHROMATIC INTERFEROGRAMS EVALUATION BY COMPUTER DIFFERENTIAL
  COLORIMETRY

- J-P15-02  Hiyama, H.; Ikeda, K.
  COLOUR RENDERING PROPERTIES OF HIGH INTENSITY DISCHARGE LAMPS

- J-P15-03  Moved

- J-P15-04  Sato, I.
  REQUIREMENTS GOVERNING LIGHT SOURCES USED FOR COLOR EVALUATION

- J-P15-05  Wang, W.;
  Haata-Kari, M.;
  Teyama, S.
  OPTIMAL FILTERS DESIGN FOR MEASURING COLORS USING UNSUPERVISED
  NEURAL NETWORK

- J-P15-06  Hashimoto, K.
  Yam, T.; Natarani, Y.
  METHOD FOR SPECIFYING COLOR RENDERING PROPERTIES OF LIGHT
  SOURCES BASED ON A COLOR APPEARANCE MODEL

- J-P15-07  Shimizu, M.
  Takeda, T.
  ACCEPTABILITY OF THE ROAD TRAFFIC SAFETY COLORS UNDER VARIOUS
  LAMPS

- J-P15-08  Ishii, M.; Yamasaki, T.;
  Takayama, I.
  AN EVALUATION AND VISUALIZATION OF SPECULAR GLOSSINESS OF
  ARCHITECTURAL TITANIUM SHEETS

May 30 (Friday)  Room K

10:45 — 12:00  Poster Session P16 "Colorimetry 5"

- K-P16-01  Cancelled

  Saia, C.;
  Komatsubara, H.;
  Suzuki, T.
  RELATIONSHIP BETWEEN SUBJECTIVE EVALUATION OF MAKE-UP SKIN COLORS
  UNDER LIGHT SOURCES WITH VARIOUS COLOR RENDERING PROPERTIES
  AND THE COLOR RENDERING INDICES CALCULATED BY CIE 1998 MODIFIED
  METHOD OF COLOR RENDERING INDEX

- K-P16-03  Cancelled

- K-P16-04  Nakano, Y.;
  Sato, T.; Iga, T.
  SPECTRAL REFLECTANCE DATA BASE SYSTEM

- K-P16-05  Ohnuma, K.;
  Misihira, T.; Sale, T.;
  Miwa, T.; Uomi, T.
  DEVELOPMENT OF HIGH SPEED GONIOSPECTROPHOTOMETER AND THE
  APPLICATION FOR EVALUATION OF FOUNDATION

- K-P16-06  Kim, DH; Noh, JH
  NEW WEIGHTING FUNCTIONS FOR THE WEIGHTED CIELAB COLOUR
  DIFFERENCE FORMULAE

- K-P16-07  Chrzan, A.; Menu, M.;
  Virtaneva, J.O.;
  Pradhardmar, N.; Vionot, P.
  ANALYTICAL SYSTEM FOR THE DETERMINATION OF THE SPECTRAL
  REFLECTANCE WITHOUT ANY LOAD FUNCTION ADAPTED TO THE
  COLOUR MEASUREMENT OF WORKS OF ART

- K-P16-08  Lappalainen, S.; Silven, P.;
  Parkkinen, J.;
  Jaszkiewicz, T.
  ON THE THERMOCROMISM OF SOME MATERIALS
INSTRUCTIONS

ORAL PRESENTATIONS

〈For Chairpersons〉

• Chairpersons are requested to be seated in the front row of seats in designated session rooms at least 15 minutes before the start of the session.
• In order to ensure the smooth operation of the scientific program, it is imperative that chairpersons do not let sessions run late.

PRESENTATION TIME

• Oral presentations will take place in three different rooms. Please confirm session rooms and presentation times in this Final Program.
• The time allocated for each paper is as follows:
  
  Invited Lecture & AIC Tutorial Lecture:
  40 minutes (including 5 minutes discussion)
  Green lamp: 3 minutes remaining (after 32 mins.)
  Red lamp: Time is up (after 35 mins.)

  Symposium: The coordinators will control the length of the presentations
  Contributed Paper: 15 minutes (including 3 minutes discussion)
  Green lamp: 2 minutes remaining (after 10 mins.)
  Red lamp: Time is up (after 12 mins.)

• Please note that in order to ensure the smooth running of the Congress, it is essential that speakers adhere to these time restrictions.

VISUAL EQUIPMENT

• An overhead projector (OHP) and a single 35mm slide projector will be provided. No assistant will be present for use of the OHP. Speakers should control their slides by themselves using the remote control, otherwise, please instruct the projectionist accordingly. Slide projection facilities can only take standard slides mounted on 50mm by 50mm frames that are less than 5mm thick. As paper frames tend to become jammed in the slide carousel, we recommend plastic frames. When using the same slide more than once in the same presentation please make sure that an appropriate number of copies are prepared. We recommend that copies of important slides are also made beforehand. The secretariat cannot take responsibility for any damage to slides.
  
  All Slides should be prepared as follows:

• Only speakers in Symposia and those who have received advance approval from the Secretariat will be able to use video projection facilities. (VHS, S-VHS/NTSC, PAL, SECAM)
• Dual slide projection will only be provided for speakers who made advanced applications to the Secretariat.
• At the speaker's podium the following will be provided, a lapel microphone (speakers are kindly asked to affix it to their clothing before starting their presentations), laser pointer, small light, and a remote controller for slides.

SPEAKERS' RECEPTION DESK
• All speakers, whether using slides or not, are requested to check in at the Speakers' Reception Desk in front of their presentation rooms, at least 30 minutes before the start of their presentations. To confirm whether any equipment will be used in their presentations, speakers are kindly asked to complete the checksheet available at the Speakers' Reception Desk when they check-in. A slide projector will be available at each desk for speakers to test-run their slides.

NEXT SPEAKER'S SEATS
• A few seats in the first row of each room will be reserved for the next speakers.
• Speakers are to be seated in these seats at least 10 minutes BEFORE the scheduled start of their presentations.
  — Your cooperation for the smooth operation of the Congress is most appreciated.

SIMULTANEOUS INTERPRETATION
• Simultaneous interpretation between English and Japanese will be provided only for the programs indicated below. Presentations for Symposium 2 will be given only in English, although discussions will take place in both Japanese and English.
  1) Opening / Special Lecture May 26, Mon.  9:00-10:25 Room A
  2) Symposium 2 May 27, Tue.  15:20-17:20 Room A
  3) Open Symposium / Closing May 30, Fri.  13:30-15:20 Room A

To ensure accurate interpretation, speakers are requested to submit a copy of their oral text (if any) or any other related materials (such as the text of slides) to either the Speakers' Reception Desk or the Secretariat.

POSTER PRESENTATIONS

PREPARATION OF POSTERS
• Authors will have a space of 120cm (width) \times 140cm (height) in which to make their presentations. Poster numbers will be prepared by the Secretariat in addition to the above measurements.
• Each poster presentation must have a title with the name(s) of author(s), affiliation(s), city and country listed (to be prepared by the author). This title should fit neatly in a space 90cm (width) \times 30cm (height). See diagram below.
• Material should be displayed in logical sequence (introduction, procedure, discussion and conclusion) and each sheet should be numbered.
• As posters will have to be read from a distance of 1 meter or more, lettering should be large and legible.
• Photocopies, illustrations or charts should be prepared in advance, as materials for these purposes will NOT be available on site.
• The Secretariat will provide pushpins for attaching posters to the posterboard. Please do not use scotch tape or glue.
• The deadline for applications for the use of computer equipment was April 15. On-site applications will not be accepted.
POSTER BOARD DIMENSIONS

To be prepared by the Secretariat

*Authors are given a space of 120cm (width) × 140cm (height) in which to make their presentations.

Title, authors’ names, affiliations, cities and countries (to be prepared by authors).

In order to facilitate viewing of the poster from a distance, the Secretariat provides a blank space of 70cm at the bottom of the display board.

SET-UP / REMOVAL TIMES

• Authors are responsible for setting up and removing their posters during the following times:

<table>
<thead>
<tr>
<th>SET-UP</th>
<th>DISPLAY</th>
<th>REMOVAL</th>
<th>DISCUSSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 28 (Wed.) 15:00-17:00 and May 29 (Thu.) 9:00-9:40</td>
<td>May 29 (Thu.) 9:40 to May 30 (Fri.) 13:30</td>
<td>May 30 (Fri.) 13:30-15:00</td>
<td>Session rooms and times are indicated in this Final Program.</td>
</tr>
</tbody>
</table>

• Poster sessions will take place in four different rooms.
• Please note that the Secretariat will NOT be responsible for any damages incurred to posters not removed during the allocated times.
• Posters NOT removed during the allocated times will be taken down by the Secretariat and kept until the end of the Congress for collection.
• Please note that posters NOT collected from the Secretariat by the end of the Congress may be disposed of.

DISCUSSION

• Authors MUST be at their posters for the duration of the allocated discussion time (check the schedule in this Final Program for times and places).
• Discussions are to be held in front of authors’ posters.
• Please note that there will be NO session chairpersons for poster discussions.

PROCEEDINGS

Proceedings will be published and sent to all registered participants after the completion of the Congress. Presenting Authors who did not send their manuscripts by the deadline should present them at the Speakers’ Reception Desk outside their presentation rooms.

Manuscripts of speakers who failed to appear on-site or which were not submitted by the date of presentation, will not be included in the Proceedings.
May 26, 27, 29, 30
Lunch
Sakura Room
(Basement)

May 29, 30
Exhibition
Momiji Room (Basement)

May 29-30
Poster Presentations

May 25
Welcome Party
Swan Room
(Basement)

May 27
AP Program
(Kimono Workshop)
May 29
Kabuki Make-Up Demonstration

° Please note that the Hall Office has been changed to the 4th floor.
GENERAL INFORMATION

GENERAL INFORMATION DESK
The General Information Desk and Registration Desk will maintain the same hours throughout the Congress (see page 29).

NAME BADGES
Participants are requested to wear their name badges during all Congress functions. Only registered persons will be given access to the Congress rooms.

COMMUNICATION AMONG PARTICIPANTS
Please note that there will be no paging service. Instead, a board where messages may be posted will be set up. We encourage participants to check this board regularly for any messages.

SHUTTLE BUS
A shuttle bus service will be provided between Kitayama subway station and the Kyoto International Conference Hall (KICH) at the beginning and end of each day. On May 25 (Sun.), the shuttle bus service will be provided only at the end of the Welcome Party. Further information on times will be provided on site.

LUNCH
Participants are encouraged to make use of the lunch tickets which will be provided in the Congress bags (free of charge). Luncheons will be served from 11:00 - 14:00 in the Sakura Room (1st floor) on May 26, 27, 29, 30.

REFRESHMENT SERVICE
Coffee service will be available at scheduled break times throughout the Congress. Coffee and other refreshments will be arranged in the lobby. Participants are asked to kindly help themselves.

MEDICAL CARE
In the event of an emergency, dial 110 for the police and 119 for the fire department or an ambulance. These calls are free of charge. In case of injury or illness, please contact the Secretariat (Rm. I, 2nd floor) for assistance.

ELECTRICITY
Although 100v is the standard power supply throughout Japan, regional differences exist in the cycles (in Kyoto it is 60Hz). Most hotels, however, have outlets for 110v and 220v and converters are usually available upon request.

TIPPING
Tipping is not customary in Japan. Instead, a 10 to 15% service charge is added to the bill at hotels and some restaurants.

TAX
A Consumption tax of 5% will be added to your bill for almost all purchases, services, etc.

PHOTOGRAPHS
Photographs taken during the Congress period will be available for purchase in the 2nd floor lobby.
REGISTRATION

ON-SITE REGISTRATION

An On-site Registration Desk will be open as follows:

<table>
<thead>
<tr>
<th>Desk Hours</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>May 25 (Sun.)</td>
<td>13:30 - 17:30</td>
</tr>
<tr>
<td>26 (Mon.)</td>
<td>8:15 - 17:00</td>
</tr>
<tr>
<td>27 (Tue.)</td>
<td>8:30 - 17:00</td>
</tr>
<tr>
<td>28 (Wed.)</td>
<td>8:30 - 16:00</td>
</tr>
<tr>
<td>29 (Thu.)</td>
<td>8:30 - 14:30</td>
</tr>
<tr>
<td>30 (Fri.)</td>
<td>8:30 - 16:00</td>
</tr>
</tbody>
</table>

The Secretariat will only accept payment during the Congress in Japanese Yen.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>ON-SITE REGISTRATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Participant</td>
<td>¥ 70,000</td>
</tr>
<tr>
<td>Student*</td>
<td>¥ 25,000</td>
</tr>
<tr>
<td>Accompanying Person</td>
<td>¥ 25,000</td>
</tr>
<tr>
<td>Banquet</td>
<td>¥ 12,000</td>
</tr>
</tbody>
</table>

Note:
- All payments MUST be made in Japanese Yen.
- All participants making a scientific presentation must be pre-registered.
- Accompanying persons are: spouses, family members and non-professional friends who wish to participate in all Congress activities except the Scientific Program.
- Persons registering as students must present official student identification on-site. Without this verification of status, the General Participant fee will apply.

REGISTRATION FEE INCLUDES

For participants:
- Attendance at Welcome Party and Opening and Closing Ceremonies.
- Admission to all scientific sessions.
- Receipt of Congress bag including Book of Program and Abstracts on-site, and Proceedings after the end of the Congress.
- Lunch, Refreshment Service, Shuttle Bus Service.

For Accompanying persons:
- Attendance at Welcome Party and the Opening and Closing Ceremonies.
  (Note: Admission to the Scientific Program is NOT permitted.)
- Participation in the Accompanying Persons Program.
- Lunch, Refreshment Service, Shuttle Bus Service.

CANCELLATION AND REFUND POLICY

In case of cancellation, please notify the Secretariat in writing. An administrative charge of ¥ 7,000 will apply to cancellations received BEFORE April 15, 1997. NO REFUNDS will be made for cancellations received after this date.
HOTEL ACCOMMODATION

Japan Travel Bureau, Inc. (JTB), Kyoto Office, has reserved a sufficient number of rooms for participants’ accommodation during the Congress at special discount rates at the places of stay listed below. Persons requiring accommodation should visit the Travel Information Desk on-site. The Travel Information Desk will maintain the same hours as the Registration Desk (see page 29).

Daily room charges are as follows:

<table>
<thead>
<tr>
<th>Hotel</th>
<th>Twin</th>
<th>Single</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Takaragaike Prince Hotel</td>
<td>¥ 20,000</td>
<td>¥ 17,000</td>
<td>5 min. walk to Congress site. 30 min. taxi ride from Kyoto stn.</td>
</tr>
<tr>
<td>Kyoto Hotel</td>
<td>¥ 20,000</td>
<td>¥ 15,000</td>
<td>15 min. walk to Oike Subway stn. 10 min. taxi ride from Kyoto stn.</td>
</tr>
<tr>
<td>ANA Hotel Kyoto</td>
<td>¥ 20,000</td>
<td>¥ 15,000</td>
<td>10 min. walk to Oike Subway stn. 10 min. taxi ride from Kyoto stn.</td>
</tr>
<tr>
<td>Kyoto International Hotel (Kyoto Kokusai)</td>
<td>¥ 18,000</td>
<td>¥ 10,000</td>
<td>10 min. walk to Oike Subway stn. 10 min. taxi ride from Kyoto stn.</td>
</tr>
<tr>
<td>Holiday Inn Kyoto</td>
<td>¥ 17,000</td>
<td>¥ 10,000</td>
<td>Free bus to Congress site. 20 min. taxi ride from Kyoto stn.</td>
</tr>
<tr>
<td>Karasuma Kyoto Hotel</td>
<td>¥ 17,000</td>
<td>¥ 10,000</td>
<td>3 min. walk to Shijo Subway stn. 10 min. taxi ride from Kyoto stn.</td>
</tr>
<tr>
<td>Hotel Gimmond</td>
<td>¥ 14,000</td>
<td>¥ 8,500</td>
<td>5 min. walk to Oike Subway stn. 10 min. taxi ride from Kyoto stn.</td>
</tr>
<tr>
<td>Kyoto Garden Hotel</td>
<td>¥ 13,000</td>
<td>¥ 8,000</td>
<td>5 min. walk to Oike Subway stn. 10 min. taxi ride from Kyoto stn.</td>
</tr>
<tr>
<td>Maruko Inn Kyoto</td>
<td>¥ 13,000</td>
<td>¥ 7,500</td>
<td>10 min. walk to Shijo Subway stn. 10 min. taxi ride from Kyoto stn.</td>
</tr>
</tbody>
</table>

- The above room rates include tax and service charges (no meals included).
- All rooms with bath
SOcial Program

Welcome Party
Date: May 25 (Sun.), 1997
Time: 16:00 - 18:00
Place: Swan Room, Kyoto International Conference Hall
Fee: Free of charge (Included in the Registration Fee)
Light snacks and refreshments will be served.

Banquet
Date: May 29 (Thu.), 1997
Time: 18:30 - 20:30
Place: Gyo-un Banquet Hall, Kyoto Hotel
Fee: ¥12,000
Style: Buffet style (seating provided)
Dress: Informal
Advanced reservations necessary (Space permitting, on-site application will also be accepted at the Inquiry Desk.)
The presentation of the AIC Judd Award will take place preceding the Banquet. A traditional Japanese performance of Kagami-biraki, Koto Music, Japanese Dancing, Kyo-mai may also be enjoyed during the course of the evening. A shuttle bus from the Kyoto International Conference Hall to Kyoto Hotel for the Banquet will be provided.

Accompanying Persons Program
Introductions to the activities of the Tea Ceremony and Flower Arrangement as well as a Kimono workshop will take place. Participants will have the opportunity to experience a taste of traditional Japanese culture.
Date: May 27 (Tue.), 1997
Fee: Included in the Accompanying Persons’ Registration Fee
Advanced reservations necessary for Tea Ceremony & Flower Arrangement

1. Kimono Workshop
Time: 11:00 - 12:00
Venue: Room C1, Kyoto International Conference Hall
Kimono is traditional Japanese dress, now often used for formal occasions such as weddings. In this program, demonstrations on how to wear various types of Kimono will be made. There will also be a short show of Kimono, which will be open to all participants, not only accompanying persons. Registered participants are welcome to attend this workshop.

2. Tea Ceremony & Flower Arrangement
Time: 13:30 - 17:00
Venue: The head master’s house of a Japanese Tea Ceremony and Flower Arrangement school.
Tea Ceremony, Cha no-yu, was introduced to Japan via China and perfected by master Sen-no-Rikyu, who was heavily influenced by 16th Century Zen Buddhism.
The art of arranging flowers, known as Ikebana or Kado, is a unique aesthetic achievement of Japanese Culture. This art form has close ties to the Tea Ceremony as flower arrangements are often used to decorate the tea room. There will also be an opportunity for participants to try flower arrangement for themselves.
Transportation from the Congress site to the head master’s house will be provided by the Secretariat.
EXCURSION

Wednesday will be set aside for an excursion after the General Assembly. No lectures will be scheduled during this time. The itinerary has been carefully planned to cater to individuals interested in the fields of Color and Color Science.

**Date:** May 28 (Wed.), 1997
**Time:** 9:15 - 10:00 - 18:00

**Itinerary:**

**Fee:** ¥12,000 (Lunch included)

*Advance reservations necessary*

**KAWASHIMA TEXTILE MUSEUM (Kawashima Orimono)**
This museum, completed in 1984, was built to commemorate Kawashima's 140th anniversary. The "Kawashima Collection" housed in the museum numbers around 80,000 pieces ranging from ancient Egyptian fabrics to contemporary textiles and include historical examples of dying, weaving and embroidery.

**KINKAKU-JI (TEMPLE) (Golden Pavilion)**
The present pavilion, built in 1955 after its destruction by fire in 1950, is an exact replica of the original which was erected in the 14th century. The 3-storied Gold Pavilion of which the walls of the 2nd and 3rd floors are covered with gold foil has a bronze phoenix at its peak and is complemented by its beautiful garden and forested hills.

**KYOTO CULTURAL EXHIBITION ROOM (Viewing of Decorative Flower (Hoko))**
Kyoto Cultural Exhibition Room has a permanent exhibition of cultural assets of the Gion Festival. Valuable articles are on exhibition under extraordinary cooperation by the Gion Festival Yamahoko Federation.

**HEIAN JINGU (SHRINE)**
Established in 1895 in commemoration of the 1,100th anniversary of the founding of Kyoto as the capital of Japan. It is an exact replica on a reduced scale of the original Imperial Palace. The bright red Torii gate, 23 meters high, is the largest in Japan. The garden at the back is known for its beautiful flowers in every season.

**KABUKI MAKE-UP DEMONSTRATION**

**Date:** May 29 (Thu.), 1997
**Venue:** Room C1, Kyoto International Conference Hall

*Kabuki* is one of the Japanese traditional stage arts. It is said to have originated in the Seventeenth Century. *Kabuki* has its own special movement and acting conventions, with beautiful costumes and special make-up.

There will be a short film of a *Kabuki* performance, followed by a short lecture in the morning and a demonstration on how the make-up is applied to the performers faces in the afternoon.

This program will be open to all participants, not only accompanying persons. Registered participants are welcome to attend the program.

**Part One (10:30 - 12:00)**
- **Greeting:** Chikashi Mogi, Vice President, Shochiku Co., Ltd.
- **Discussion:** "Color of Kabuki"
  - Koji Orita, Vice Manager, Testing and Training Dept., National Theatre of Japan
  - Film: "Beauty of Kabuki" (costumes)

**Part Two (13:00 - 14:30)**
- **Commentary:** "Representative Kabuki Costumes" (including actual costumes), Shizuo Ito, Executive Director, Shochiku Costume Co., Ltd.
- **Interview and Demonstration:** "Transfiguration to Onnagata"
  - (make-up and dressing demonstration of Faji Mutsu
  - Shibajaku Nakamura, Onnagata performer Koji Orita, commentary
TECHNICAL TOURS

AIC Color 97 Kyoto, in cooperation with the individual companies listed below, is pleased to be able to offer the following 3 technical tours open to all registered participants of the Congress. There will be no charge to join these tours, however participation is limited to those people who have completed registration for the AIC Color 97 Kyoto. Applications will be dealt with on a first-come first-served basis. Applications for remaining space in Technical Tours can be made at the General Information Desk.

TT-1 Minolta, Toyokawa Administrative Center
Date: May 27 (Tue.), 1997
Time: 8:30-19:00 (Full Day Tour)
Itinerary: 08:30 Kyoto International Conference Hall——09:00 Kyoto Hotel——Lunch——
11:00-12:00 *MINOLTA——12:00 Kyoto (Kyoto Hotel)
*A tour of the Planetarium, Factory Tour, Introduction to New Products and a Question & Answer Session is scheduled.
Information for applicants: 35 people will be able to take part in this tour.

Color Meters: Accurately Defining Colors with Numbers
The world is filled with various colors, some distinctive and some subtle, and Minolta has created a variety of instruments for accurately measuring them. Our spectrophotometers are capable of high-speed data processing and can be used with diverse software, which make them suitable for a wide range of applications.
Minolta also supplies many types of color meters, that analyze the various components determining a color and express them as numeric values.

TT-2 Dainippon Screen MFG. Co., Ltd.
Date: May 29 (Thu.), 1997
Time: 9:00-15:00
Schedule: 09:00 Kyoto International Conference Hall——*Inspection Tour——
Lunch——*Inspection Tour——13:00 Kyoto International Conference Hall
*Shashin Kagaku Co. Ltd. Kusatsu Factory
**Dainippon Screen Mfg. Co., Ltd. Yasa Factory
Information for applicants: 20 people will be able to take part in this tour.

DAINIPPON SCREEN MFG. CO., LTD., is one of the world’s leading comprehensive manufacturers of desktop publishing (DTP) and prepress equipment and systems for the graphic arts industry. Using its proprietary technologies, the company has developed a wide range of equipment used in semiconductor, liquid crystal display (LCD), hybrid substrate, and printed circuit board (PCB) manufacturing. Dainippon Screen also manufactures shadow masks and aperture grilles for cathode-ray tubes (CRTs) and other applications.
Dainippon Screen was separated from the Ishida Kyokuzan Printing Works (former SHASHIN KAGAKU CO., LTD.).
TT-3  ATR (Advanced Telecommunications Research Institute International)

Date:      May 27 (Tue.), 1997 (TT-3-A)
           May 29 (Thu.), 1997 (TT-3-B)
Time:      12:30-17:30
Itinerary:

12:30 Kyoto International Conference Hall ...... 14:15 Takanohara Station
                                           ......... 14:30 16:15 *ATR Tour ...... 16:30 Takanohara Station ......
                                           ATR BUS
                                           17:00 Kyoto International Conference Hall

*Tours of the Human Information Processing Research Lab, Communication Systems Research Lab, and Interpreting Telecommunications Research Lab are scheduled.

Information for applicants:  40 people will be able to take part in these tours.

Promotion of Integrated R&D Activities

This institute was established in 1986 with support from various sections of industry, academia and government and was intended to serve as a major center of basic and creative telecommunications R&D. Another of its functions is to establish research relationships both domestically and abroad.

In the spring of 1989, our new research laboratory was officially opened in Kansai Science City.
OPTIONAL TOURS

The following Optional Tours are operated by Japan Travel Bureau (JTB). For information please contact the Travel Information Desk, on-site. English speaking guides will be present throughout all of the following tours.

OP-1 MT. HIEI & LAKE BIWA — Cancelled

As the minimum number of participants for this tour was not reached, it has been cancelled. Those people who have already paid can receive a refund from the Travel Information Desk on-site.

OP-2 KYOTO MORNING TOUR

Major Hotels – Nijo Castle – Golden Pavilion – Kyoto Imperial Palace – Higashi Honganji Temple – Kyoto Handicraft Center

OP-3 KYOTO AFTERNOON TOUR

Major Hotels – Heian Shrine – Sanjusangendo Hall – Kiyomizu Temple

OP-4 KYOTO 1 DAY TOUR


OP-5 SPECIAL NIGHT TOUR

Major Hotels – Tea Ceremony at Japanese Inn Yoshiima – Supper – Gion Corner

OP-6 KIMONO & YUZEN DYEING

Major Hotels – Yuzen dyeing at Kodai Yuzen-en – Nishijin Textile Center

OP-7 KYOTO & NARA 1 DAY TOUR


RELATED MEETINGS

1. AIC General Assembly

   Date & Time: May 28 (Wed.), 1997, 9:00-10:00
   Venue: Room A, Kyoto International Conference Hall

2. Executive Committee Meetings

   (1) Date & Time: May 25 (Sun.), 1997, 10:00-16:00
       Venue: Room 105, Kyoto International Conference Hall

   (2) Date & Time: May 30 (Fri.), 1997, 12:00-13:30
       Venue: Kurama Room, Takaragaike Prince Hotel

3. Member Countries Representative Party

   Date & Time: May 27 (Tue.), 1997, 12:00-13:30
   Venue: Hiei Room, Takaragaike Prince Hotel

4. Get-together (AIC Party)

   Date: May 28 (Wed.), 1997
   Time: 18:00-21:00 (after Excursion)
   Place: Asahi Beer Restaurant - Super Dry (2nd floor)

5. Pre-event AIC Commemorative Color Seminar

   Personal Color and Public Color

   Date & Time: May 24 (Sat.), 1997, 10:00-17:30
   Venue: Kyoto Teresa Hall

   Inquiries should be addressed to: AIC Color 97 Kyoto/Secretariat
6. **CIE Division 1 Meeting**

**Date & Time:** May 23 (Fri.) / 24(Sat.), 1997, 9:15-17:00

**Venue:**
Kyoto International Community House
2-1 Torii-cho, Awataguchi, Sakyo-ku, Kyoto 606, Japan
Tel: +81-75-752-3010  Fax: +81-75-752-3510

**Correspondence:**
Mr. Francois Denner (Division 1 Secretary)
Optical Radiometry Project
National Metrology Laboratory
PO Box 395, Pretoria 0001, South Africa
Tel: +27-12-841-4349  Fax: +27-12-841-4458
e-mail: bfdenner@csir.co.za

or

Dr. Ken Sagawa (Division 1 Director)
National Institute of Bioscience and Human Technology
1-1 Higashi, Tsukuba, Ibaraki 305, Japan
Tel: +81-298-546750  Fax: +81-298-546752
e-mail: sagawa@nibh.go.jp

7. **ICC (International Color Consortium)**

**Date & Time:** May 28 (Wed.), 1997, 9:00-17:00 (tentative)

**Venue:**
Room C2, Kyoto International Conference Hall

**Correspondence:**
Mr. William K. Smythe, NPES
The Association for Suppliers of Printing and Publishing Technologies
1899 Preston White Drive
Reston, Virginia 22091-4367, U.S.A.
Tel: +1-703-264-7200  Fax: +1-703-620-0994
e-mail: ksmythe@npes.org
TRAVEL INFORMATION

OFFICIAL TRAVEL AGENCY
Japan Travel Bureau Inc. (JTB), has been appointed the Official Travel Agency for the Congress to handle all travel arrangements within Japan. Any Accommodation and travel inquiries may be made at the Travel Information Desk on-site.

FOREIGN EXCHANGE AND TRAVELER’S CHECKS
It is recommended that participants purchase traveler’s checks in Japanese Yen or U.S. Dollars before leaving their own countries. The Secretariat, however, will only accept Japanese Yen in cash. Exchange of major foreign currencies is available at most banks, airports, large hotels and on the 4th floor of the Kyoto International Conference Hall.

KYOTO, YOUR HOST CITY
Japan’s ancient capital, Kyoto, is surrounded on three sides by a magnificent mountain backdrop. Established as the seat of the Imperial Court in the 8th Century, the city prospered as the center of government, commerce, and the arts, and to this day remains the cultural capital of Japan with its magnificent Buddhist heritage, including amongst its almost 2000 shrines and temples no less than seventeen World Cultural Heritage Sites as designated by UNESCO. Yet it is also a modern metropolis, with an infrastructure adapted to serve the needs of the approximately 40 million foreign and domestic tourists annually.

ACCESS TO THE CONGRESS SITE
A municipal subway runs north to south under Karasuma Dori (street). The northern terminal of the subway is Kitayama station. (See back cover)
At the end of official programs each day at Kyoto International Conference Hall as well as in the morning, a shuttle bus service between Kitayama subway station and Kyoto International Conference Hall will be provided. The regular city bus route number “North 4 (44)” can also be used from Kitaoji subway station.
LIST OF CONTRIBUTORS

Ministry of Education, Science, Sports and Culture
Suga Weathering Technology Foundation

JAPAN PAINT MANUFACTURERS ASSOCIATION
Tokyo Bankers' Association
The Federation of Electric Power Companies
All Japan Fashion Teachers
Japan Automobile Manufacturers' Association
Japan Painting Contractors Association
Japan Department Stores Association

Asahi Chemical Industry Co., Ltd.
Chubu Electric Power Co., Inc.
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Hitachi Cable, Ltd.
Hoya Corporation
INAX CORPORATION
Japan Color Enterprise Co., Ltd.

JAPAN FASHION COLOR ASSOCIATION
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Color Association of China (China)
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Norsk Farveforum (Norway)
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Singapore Institute of Standards and Industrial Research (Singapore)
Slovene Research Centre for Colour (Slovenia)
South African Colour Science Association (Republic of South Africa)
Comité Español del Color (Spain)
Stiftelsen Svenskt Färgecentrum (Sweden)
Pro Colore (Switzerland)
The Colour Group (Great Britain) (U. K.)
Inter-Society Color Council (U. S. A.)
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President: Munehira Akita

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Shojo Tomiagawa
Hirohisa Yaguchi (Chairperson of Scientific Program Committee)
Masao Yamagishi (in charge of Pre-event)
ABSTRACTS

INVITED LECTURES
AIC TUTORIAL LECTURE
SYMPOSIA
OPEN SYMPOSIUM
CONTRIBUTED PAPERS
ABSTRACTS

INVITED LECTURES AND TUTORIAL LECTURES

SYMPOSIA

OPEN SYMPOSIUM

CONTRIBUTED PAPERS
INVITED LECTURES

AIC TUTORIAL LECTURE
Invited Lecture IP1

THE PERCEPTION OF COLOR FROM MOTION
Carol M. Cicerone  Dept. of Cognitive Sciences, University of California, Irvine, Irvine, CA, 92697, USA

"Color from motion" (Cicerone et al., 1995) describes the perception of a spread of subjective color over achromatic regions seen as moving. One way the effect can be produced is with a stimulus display consisting of multiple frames of colored dots, randomly placed upon a white field, with dots in the test region differing in both chromaticity and luminance from those in the surround. In this case, the subjective color spread, of low saturation and bounded by a subjective contour, is seen to move over the random dot display. Miyahara and Cicerone (1996) showed that in the absence of luminance differences between the dots in the test and those in the surround regions, chromaticity differences alone are sufficient to produce color spread from motion. In this case, color spread is perceived despite the absence of a subjective contour. Thus, contour formation is not a prerequisite for color from motion. In the tested range of luminances and chromaticities, the hue and saturation of the subjective color spread are determined largely by the luminance and the chromaticity of the dots in the test region not by those of the dots in the surround. Thus, color from motion may arise in sites distinct from those for color contrast. Other experiments suggest a central locus for this effect. If every odd-numbered frame of the full stimulus sequence is presented to one eye while every even-numbered frame is presented separately and out of phase to the other eye, what is seen is color spread equalling that seen with the full sequence presented either monocularly or binocularly. Thus, the locus of color from motion is likely to lie central to the point of binocular combination. When the stimulus display consists of colored dots on a low luminance field, the perception of motion is linked to a different organization of the visual scene: An object is seen to move behind a partially excluding screen and in front of a uniform background. The object is seen as uniformly colored and matching the highly saturated test dots in color. The background is seen as uniformly colored and matching the highly saturated surround dots in color. Hence, color from motion can be used by the visual system to produce amodal completion, suggesting it may play a role in enhancing the visibility of camouflaged objects.


Invited Lecture IP2

TRADITIONAL AND LOCAL COLORS IN THE CONTEMPORARY ENVIRONMENTAL DESIGN
Don-soh Park
Department of Architecture, Ajou University

It is not difficult to recognize the fact that both traditional colors, which any cultural society has, and local colors, which depend on the climate and the natural environment, provide motifs and ideas for environmental color design.

However, these colors do not seem to have dominating influences on the contemporary environmental design. The use of the colors in the contemporary environmental design, such as architecture, landscape architecture, and street furniture etc., are not based on unique cultural tradition or locality, but based on common sensitivity of contemporary people.

This trend is due to the advanced telecommunications and transportation which result in the current phenomena that boundaries between regions and between nations are disappeared and the transfer of information is much faster and easier than ever before. It is also an evidence of the fact that human being has common sense of feeling in some ranges over different racial, local, and national backgrounds.

For more diverse and plentiful cultural environment of human beings it is necessary to find harmony between common generality of human beings and traditional and local identities. To do so every designer should make a consistent effort to find colors determined by different tradition, history, climate in the world, and try to apply them to the contemporary environmental design.

The lecture presents and describes slides of these examples found mainly in Korea and some other countries.
Invited Lecture IP3

VISUAL FUNCTION IN HETEROZYGOTE CARRIERS OF COLOR VISION DEFECTS

Joel Pokorny, Vivianne C. Smith and Eriko Miyahara*
Visual Sciences Center, The University of Chicago
*Current address: Department of Psychology, University of Nevada, Reno NV

The mother or female child of a male with an X-chromosome-linked color vision deficiency is a heterozygous carrier for the defective gene. We have studied two sisters who are heterozygous carriers for congenital X-linked protanopia. The heterozygous state was established by molecular analysis of their visual pigment genes. Both sisters were normal trichromats as defined by the Rayleigh match on the anomaloscope. The normal color match establishes that the spectral sensitivities of their long-wavelength sensitive (LWS) and middle-wavelength sensitive (MWS) cone visual photopigments are within normal variability. Their chromatic discriminative ability as measured by the FM 100-hue test was by Parnsworth's classification, superior. Heterochromatic flicker photometric (HFP) spectral sensitivities were like those of protanopes. The estimated LWS/MWS cone ratios from the HFP data were 0.09/1 and 0.03/1, compared to ratios in the range of 0.6/1 to 10/1 for typical normal trichromats. Studies of the cone mosaic included measurement of chromatic grating acuity on chromatically selective backgrounds. The data were consistent with a sparsity of LWS cones. Both protan carriers showed normal spectral sensitivities for all three cone types under cone isolating chromatic adaptation and normal three-peaked curves for increment thresholds on a white pedestal. Hue estimation, run on one carrier was normal. The unique yellow locus, measured in the other carrier, was in the range of normal trichromats. The data indicate that normal color vision can occur even when the LWS/MWS cone ratio is markedly abnormal.

Invited Lecture IP4

COLOUR ILLUSIONS.

Osvaldo da Pia
Department of General Psychology, University of Padua, Italy

The paper reflects on a series of problems concerning general theories of perception, various concepts of illusions and different colour / non-colour distinctions. The relevance of phenomenological accounts of visual illusions appears when different definitions of perceptual illusions are discussed. By overcoming the philosophical problem of the so-called "physical reality", it is maintained that perceptual illusions are discrepancies between perceptual experiences differing as a function of the context. This assertion seems to be in agreement with most scientific theories, with the common sense and with the role that illusion effects play in many artistic expressions. The paper will plunge into a selection of illusions in which colour plays a major role, i.e. where variations in hue, saturation and chroma, whiteness and blackness, luminance and illuminance, lightness and brightness, light and shadow are essential conditions for the emergence and the strength of the illusion itself. Some results achieved by the AIC Visual Illusions And Effects (VIAE) Study Group, chaired by the author, will be then mentioned and discussed.
Invited Lecture IP5

TOWARDS IMPROVED ACCURACY OF SURFACE COLOUR MEASUREMENT

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The system for specifying colour in numerical form was recommended by the CIE in 1931. However, many companies still find it necessary to circulate coloured samples to specify their requirements. This is because the problem of measuring to within the ability of the human eye for discriminating colours has not been completely solved. To do this requires the production of measuring instruments of different makes and models to agree to within 0.5 CIELAB units peak to peak, or better, for all colours. An international intercomparison of surface colour measurements between four laboratories each with responsibility for national standards of measurement gave agreement to within 0.5 CIELAB units for only approximately half of the measurements. Differences up to 2 CIELAB units occurred. A second intercomparison between industrial companies gave roughly the same level of agreement between commercial instruments of the highest quality. (Other instruments gave less good agreement.) The required improvement of a factor of 4 can only be achieved by the reduction of systematic errors in colour measurement. A summary of these errors is given. They can be divided into two categories, the first due to the measuring instrument, the second due to the properties of the samples themselves. The first category includes errors in the absolute scale of diffuse reflectance, photometric linearity, dark level, wavelength, gloss trap and integrating sphere non uniformity. The second category includes non uniformity, thermochromism, and translucency. An outline of a method for improving the agreement between colour measuring instruments by determining the errors in a systematic way and applying the corrections through software is given.

AIC Tutorial Lecture

NCS - REFLECTING THE COLOR SENSE AS A PERCEPTUAL SYSTEM

Lars Sivik
Department of Psychology, University of Göteborg and
Department of Architecture, Royal Inst. of Technology, Stockholm

Everybody knows what color is - but how do we define color? One problem in discussing color, both for scientists and other color professionals, is that there are many definitions. One reason for this is that there are many meanings of the word "color" - a confusing but probably inevitable problem. In the most proper meaning, however, color exists only as the psychological phenomenon "color sensation". Consequently, the only definition we can come up with is the extensive - color is what we see as color.

This was the conceptual basis for the German physiologist Ewald Hering when he, more than hundred years ago, drew up his theory of opponent colors. This theory implies that we humans have six "Urfarben", or elementary colors as built-in references for color perception. They are termed elementary because they cannot be further visually divided.

With his phenomenological approach he anticipated a scientific view which has only recently become accepted, namely that our senses - including color vision - do not just consist of separate receptor channels but of several interactive and active information seeking perceptual systems.

In the lecture I shall touch upon the theoretical and pragmatic application of the now recognized theory of opponent colors and its follow-up in the NCS system and the NCS method of visual color assessment. Further, I will discuss some practical color research problems for which the NCS could be advantageous as a reference system, e.g., color rendering, color changes due to distance, color categorization, and in particular, studies of color combinations.
SYMPOSIA

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Symposium S1
"Color Cognition and Machine Vision"

Physical Aspects of Appearance

Steve Shafer
Microsoft Corporation
Vision Technology Research Group
USA

What makes things look the way they do?

We use vision to analyze and measure our environment many times every second. By just a glance at an object, we can tell its color, its texture, its size, perhaps what it is made out of. In some cases we can even tell what surrounds the object, for example if it is a mirror or a shiny dinner plate. Our visual system provides a wealth of information about the physical properties of the world at every moment.

Yet, we don't know how it is done. How do you know whether something is plastic or metal, just by looking at it? Most physics theories can predict the appearance from a description of the object, but those theories cannot be reversed to describe the object from looking at its appearance. Successful vision requires very careful analysis of what makes something appear shiny, rough, translucent, and so on. For successful machine vision systems, this analysis must be very quantitative and precise. We know how to analyze each individual aspect of the physics of appearance, but no one knows how to put it all together to analyze complex images.

In this talk, we'll take a look at some pictures that illustrate many issues in appearance, some of which are rather surprising. Based on our study of these issues, we are working on a new approach for machine vision in which we hypothesize the physical scene description at the same time that we're segmenting the image. I'll show the principles of our approach, and discuss the issues and our current results.

The Visibility of Colored Patterns: Measurements and Models

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The visibility and color appearance of an image patch can vary strongly with the image pattern. We have measured aspects of the covariation of pattern and color in a set of asymmetric color matching experiments and detection experiments. Data from our measurements are close to predictions made by using simple models in which pattern and color computations are handled in separate stages. Based on these experiments and ideas, we have developed an extension of the CIELAB color metric (S-CIELAB). The S-CIELAB metric includes a spatial pre-processing step so that it can be applied to textured patterns; but, the calculation reduces to CIELAB when applied to uniform patterns. The extension is built using efficient, pattern-color separable architecture. We continue to apply the model to several engineering tasks and to experimentally test the predictions of S-CIELAB on simple patterned images consisting of digital halftones and JPEG compressed images.
Computational Approach

Shoji Tominaga
Japan

I will discuss the systems and algorithms for machine vision application. A number of methods were proposed to demonstrate computationally how color constancy may be accomplished. The goal of computational color constancy is to recover the physical properties of illuminants and surfaces from photosensor responses. First, I describe why the computational color constancy is difficult, and review the previous methods. Next I introduce a multi-channel vision system for estimating both the surface-spectral reflectance function and the illuminant spectral-power distribution from the image data. The vision system consists of several sensors over the visible wavelengths by combining a monochrome CCD camera and color filters. The calculations for estimating the wavelength functions are based on approximation using low dimensional linear model.

Moreover I will discuss algorithms for analyzing complex images. When multiple objects like plastics are placed close together, we observe not only object colors, but also highlights and inter-reflections from the surfaces. A method is shown for estimating the colors of object surfaces from the camera data.

Cognitive Aspects of Color

Gunilla Derefeldt
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Division of Human Sciences, Linköping, Sweden

This report surveys cognitive aspects of color in terms of behavioral, neuropsychological, and neurophysiological data. Color is usually defined as psychophysical color or as perceived color. Behavioral data on categorical color perception, absolute judgement of colors, color coding, visual search, and visual awareness refer to the more cognitive aspects of color. These are of major importance in visual synthesis and spatial organization, as already shown by the Gestalt psychologists. Neuropsychological and neurophysiological findings provide evidence for an interrelation between cognitive color and spatial organization. Color also enhances planning strategies, as has been shown by studies on color and eye movements. Memory colors and the color-language connections in the brain also belong among the cognitive aspects of color.
Symposium S2

"Color Design 21 — The Role of Color in the 21 Century"

Now that we are facing the 21st century, new paradigms are required in the world. Misgivings about material civilization, for example, have led to a re-evaluation of moral and spiritual culture. In a similar vein, we need to sum up the historical role color design has played during the 20th century.

What is the significance of the development of color design? What should be its future direction?

The speakers will give us their valuable views or suggestions on their fields of study.

1. Keynote Lecture - Traditional Innovation - by Leonhard Oberascher

2. Panel Discussion - Environmental color:
   "Image creation - the role of the designer" by John Hutchings
   "The Use of Films to Simulate Age-Related Declines in Yellow Vision" by Clara Ako Yoshida
   "Art and Design" by Peter Travis
   "Environmental Color Psychology" by Nancy Kwallek
   "Marketing and Color design" by Shigenobu Kobayashi

(Registrators: Paul Green-Armitage and Miho Saito)
Symposium S3
"Color Management Systems"

A Color Management System is a basic software tool that provides the means to move the color of an image between different devices in a controlled way. As digital imaging and desktop publishing systems have become more and more popular, images can be originated and reproduced using many different types of device. For example, input can be via an electronic camera or a scanner while output can use a video display unit, an inkjet printer or a thermal transfer printer. Since the way each type of device handles color is dependent on their separate color analysis characteristics, e.g. RGB or CMYK, the image data cannot be exchanged directly between two devices in order to reproduce colors having the same appearance.

The basic theory of Color Management Systems is to convert the device dependent values into device independent values, so as to handle the image data in a controlled way. First, the image values can be converted into CIE values, for example XYZ tristimulus values, to make them device-independent. The tristimulus values may then be translated into psychological values, such as Hue, Chroma and Lightness, using a color appearance model. Once a relationship between the image values and the psychological values is established, the image data from different types of device can be independently handled including giving consideration to the viewing environment in terms of parameters such as the white point, the luminance and surround.

In terms of device independent color, the CIE 1931 Standard Observer and CIE Standard Illuminants are commonly used to achieve device independent color. However, the CIE has not yet been able to establish a unique color appearance model to convert these device independent color coordinates into the device-environment independent color parameters. The imaging industry has, however, long realised the necessity of having a unified color handling methodology, i.e. a Color Management System. The International Color Consortium (ICC) was formed a few years ago by eight industry vendors and has been working on a standard color definition data format, or Profile format, for converting device dependent color to/from device independent color. More than 50 vendors have now joined the consortium. While the Profile format is being successfully implemented on many digital imaging devices, some markets need a simple, well-defined, monitor color space, which is commonly used on the Internet, or World Wide Web. Since the Color Management Systems need to take care of huge amounts of image data, color transformation speed is an important issue. For a high speed image processing system, some users need hardware processing, or fast silicon processors.

In this symposium, four experts have been invited from both academic and industrial fields to make presentations. Michael Pointer will review CIE recommendations and recent activities. Several Technical Committees are actively working on vision and color appearance. Michael Stokes will summarize the current status of the digital color imaging industry and the standardization process of the ICC Profile format. He will explain the necessity of having a standard RGB color space, or sRGB, from an industrial point of view. Hiroaki Kotera will describe silicon processor technologies based on look-up-table and interpolation in comparison with software processing. Finally, Roy Berns will discuss the importance of color appearance models in Color Management Systems. Current Color Management Systems lack a unique color appearance model although it is eagerly awaited by the imaging industry. He will point out the difficulties in unifying color appearance model performance in practice, and the limitation of Color Management Systems.

(Coordinator: Po-Chien Hung)
Open Symposium
"Tth Rebirth of Japanese Paintings — Color and Conservation"

Our symposium will examine the conservation of Japanese paintings, discussing the characteristics of Japanese paintings in regard to material and technique, and specifically relating to color.

Today, conservation of cultural properties has become a serious world-wide problem. Japanese paintings have many difficulties in conservation, resulting from special preparation techniques. Seven experts will attend as coordinators (W. Thomas Chase and Asao Komachiya) and symposiumists (Masamitsu Inaba, Masako Koyano, Frank D. Preusser, Mahito Uehara and Junji Wakasugi). They will discuss individual problems, starting with the BIG BANG of Japanese-painting-conservation in the USA and Japan, followed by three topics from the position of conservation science with the remaining topics on color beauty in conservation. Topics will include new information on the problem of damage and appropriate repair, the characteristics of Japanese painting colors in comparison with Western colors, the availability of Japanese paper (WASHI), the architectural beauty of Ancient Kyoto and the organized beauty of ancient scrolls.

The symposium will ask for various support from color scientists, and some suggestions will be put forward regarding possible solutions.
CONTRIBUTED PAPERS
A-001-01
SPECTRAL BASED ILLUMINATION ESTIMATION AND COLOR IMAGE NORMALIZATION
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Color constancy is the property of human vision system to compute the influence of changing illumination conditions. This problem is central to computer vision and has many practical applications including automatic color correction and visual data representation in image databases. We present an algorithm which normalizes images taken under different illuminations to the same reference image. The illumination does not have to be the same across the scene since the algorithm requires only a small number of (differently colored) pixels. In spite of very simplistic assumptions about color image formation the technique produces reliable results.

It is assumed that the statistical properties of the colors in the reference image are approximately described by a database (like the Munsell system) for which spectral data is available. The logarithm of these spectra can be represented by a small number of coefficients in an eigenvector expansion. The effect of the illuminant on the expansion coefficients of the log reflectance function is a location independent (constant) shift. Thus the recovery of the illuminant is reduced to estimating the shift of the most probable value of the distribution of the expansion coefficients computed from the image and the corresponding value computed from the database. The distribution of the expansion coefficients of the logarithmic spectra is very diverse. To estimate the most probable value for each coefficient, a robust mode estimator has to be employed.

The calculated light distribution is only an estimate of the true spectral distribution of the illuminant. Direct inverse filtering for normalization may lead to undesirable results since these processes are often ill-defined. Therefore we apply a regularization techniques in applications (such as automatic color correction) were the visual appearance of the reference image is important.

A-001-02
RECOGNITION OF MATERIAL TYPES AND ANALYSIS OF INTERREFLECTION USING SPECTRAL IMAGE
Yasuo Motabe and Seji Inokuchi
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A new method of recognition of material types is described. To materialize this idea, this paper proposes a simple color reflection model based on dichromatic reflection model which classifies colored opaque objects into three categories: "metallic", "matte nonmetallic", and "glossy nonmetallic". Also an image processing of a spectral image for indoor object recognition is described. An experimental image acquisition system with 2D scanning of a spectrometer is able to generate 2D spectral images, not a multi-band image. As applications of the spectral images, spectral image is used to the validity of this method is shown by experiments.

We can identify material types of an object based on information of the object surface. As surface information, there are a condition of finished process and a change of color or brightness. The smoothness of the object surface can be also perceived by the sense of sight perceiving some information of scene, highlight and/or reflected image on the surface same as by the sense of touch. So we aim the recognition of material types from images.

Shafir et al. are at the vanguard of researchers studying the glares (highlight) of RGB color images in computer vision[1]. He proposed a simple model representing the reflection process of surfaces of dielectric objects such as plastic paint including highlights. This is called the "dichromatic reflection model." They developed their study on elimination of the glares component and the segmentation by applying their model to a scene including glossy objects.

On the hand, in existing color image processing system, a RGB color camera is used. However, a real image is a projection of a complex optical phenomena with spectral distribution. But, there are only few systems acquiring spectral distribution as an image. So we proposed a spectral image acquisition system, and have applied spectral images to object recognition[2,3].

Moreover, when there are some objects with same color and different material, it is difficult for RGB color image to classify them to each material. Observing spectral distributions, however, we note they have characteristic differences if they are different material.

This paper proposes a method of recognition of material types and analysis of interreflection using spectral image based on a reflection model.

A NEURAL NETWORK THAT responds AS A HUMAN OBSERVER TO THE C.I.E. GREEN COLOUR CENTRE

Dr James H. Nobbs 1, Miss Helen Skelton 1

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72 colour difference pairs were prepared around the CIE recommended green colour centre in nine different vector directions. Panels were prepared in water based emission paints using three pigments. Observers were tested with the panels under standard viewing conditions. They were asked to judge whether the colour difference of the green pair was greater or smaller than that of a grey anchor pair of around 1 unit \( \Delta E \) \( L^*a^*b^* \) colour difference. Thirty colour normal observers were tested and their quantal responses were used to train a fixed forward-back-propagation neural network to try and learn the same response as an average human observer. The neural network was trained with an input of colour difference data from four colour difference equations, and an output of the human observer response. The colour difference equations studied were CIE \( L^*a^*b^* \), CMC (1,1), CIE94 (1,1) and the Bradford formula. Upon successful training the network was tested with an additional set of twenty green colour difference pairs, which had also been observer tested. This data was used to verify that the network had learned to solve the problem.

THEORY AND ANALYSIS OF COLOR DISCRIMINATION FOR THE COMPUTATION OF COLOR EDGES USING CAMERA SENSORS IN MACHINE VISION

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A salient noise characteristic of color camera sensors used in machine vision is that the covariance of photometric measurement values at a pixel in a color image is strongly dependent upon which portion of the camera's color photometric space this local distribution of values occurs. Over a half century ago MacAdam observed a similar characteristic for human color discrimination covariance ellipses in CIE photometric color space [1], [2]. While empirical measurement of various color discrimination ellipses throughout the CIE space has been important for Uniform-Scale Chromaticity Diagrams in industry [3], in machine vision the importance of covariance ellipses and their variability throughout the camera sensor photometric measurement space for 'normalizing' sensed color variation between image pixels has gone unnoticed. We propose that accounting for photometric sensor noise covariance which can vary from pixel to pixel, is particularly useful if not critical to the accurate computation of color edges in images taken with a color sensor. As edges arise in a color image due to variations in photometric values between neighboring pixels, the 'strength' of color edges must take into account this numerical photometric variation in relation to the covariance ellipse of the sensor at a pixel. The orientation direction of the color edge gradient is also significantly affected. This paper develops a Riemannian geometric framework for color edge computation which tractably incorporates the modeling of camera sensor noise. The geometric framework is generally applicable to intensity images, and color images with arbitrary number of channels per pixel (e.g., RGB = 3 channels). Using a basic application of modern differential geometry, a 2x2 matrix generalized color edge operator is developed which allows instantiation of existing color edge computation methodologies while accounting for sensor noise characteristics. This 2x2 matrix is shown to generalize previous formulations where color edge strength and orientation are respectively computed from the largest eigenvalue and corresponding eigenvector. Of particular significance is the experimental demonstration of dramatically improved accuracy of color edge strength and orientation computation using this generalized framework on imaged color patterns of known ground-truth. Experimental calibration procedures are presented for practical implementation.

A-O01-05

VISUALIZATION FOR APPEARANCE OF METALLIC AND PEARL COATINGS
BY COMPUTER GRAPHICS
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The present paper describes a simulation method for surface reflectance of metallic and pearl coatings, based on the measured spectral reflectances of the materials, and presents a computer-graphics technique for making realistic images of the coated objects.

It is found that the difference in appearance between metallic and pearl coatings is caused by the difference of the surface spectral reflectances in the boundary regions between the diffuse reflection component only and the diffuse reflection plus specular reflection component.

The measured spectral reflectances in these regions are examined in details. We show some realistic images representing the difference in appearance between metallic and pearl coatings.

A-O02-01

NEURAL NETWORK COLOR CONSTANCY AND SPECULARLY REFLECTING SURFACES
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Modeling specular reflection in the training set for a neural network designed for color constancy substantially improves the network's estimate of the chromaticity of the ambient scene illumination. Our initial results with neural network color constancy were based entirely on a model of matte reflectance. This worked fine on synthesized test scenes, but resulted in larger errors than expected when tested on real images. Various factors could have accounted for the difference between the results for synthetic and real images, noise being the most obvious. However, modeling noise in the data accounted for only a small portion of the error. We were thus led to look further in an attempt to explain why the theoretical and experimental results were so different.

The neural network approach to color constancy involves a perceptron network [18] with 2560 binary input nodes, 3 output nodes, and 2 hidden layers with 400 and 30 nodes each. The network's input is a discretized and binarized chromaticity histogram of the image mapped to a one-dimensional input space. The network's output represents the chromaticity of the incident illumination. The network is trained using the back propagation algorithm by presenting the network's input nodes with the chromaticity histograms of synthesized scenes and its output nodes with the chromaticity of the synthesized illumination. Inititally scenes were synthesized by combining randomly selected reflectance and illumination spectra from a set of 280 real reflectances and 89 real illuminants.

While results with real images surpassed most existing color constancy algorithms, the errors for real images significantly exceeded those for synthesized images. Examination of images for which the neural network's error was unexpectedly large revealed many shiny surfaces in the scenes, leading to the hypothesis that specular reflection was causing the problem. To overcome this problem specularities were added to the training set using the dichromatic model of reflection [21]. The dichromatic model states there are two reflection components: body and interface reflection. Interface reflection is approximately the spectrum of the incident illumination. Based on the dichromatic model, the training set was expanded to include synthetic scenes with random amounts of specularly. Since specularly reflected light is approximately the same spectrum as the incident light, this means adding a random amount of the scene illumination to the matte component. The resulting spectrum is then multiplied by the camera sensor sensitivity functions and integrated to produce synthesized camera RGB responses. After training on the new data set containing synthetic specularities, the error in illumination estimation dropped by 21%. We conclude that the specular component cannot be neglected for color constancy in real images.

A-002-02

RETINEX VIEWED AS A GAMUT-MAPPING SOLUTION TO COLOUR CONSTANCY
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Edwin Land's Retinex[4] is a computational theory which attempts to explain the phenomenon of colour constancy. Computation proceeds in two-stages: first the white-point of the retinal image is estimated and in the second stage, this estimate is used to remove the colour bias due to illumination. To estimate white, Retinex searches for the maximal cone responses in each of the L, M, and S channels. This search is motivated by the observation that, if a white were present it would induce the maximal L, M and S responses. The illumination colour bias is removed by scaling the retinal image with factors equal to the reciprocal of white. Mathematically, if \( \{ L_r, M_r, S_r \} \) and \( \{ L_w, M_w, S_w \} \) are the cone responses of an arbitrary reflectance \( r \) and the white estimate \( w \) then \( r \) scaled by the reciprocal of \( w \) is equal to \( \left( \frac{L_r}{L_w}, \frac{M_r}{M_w}, \frac{S_r}{S_w} \right) \). Of course the maximal L,M and S responses is a rather arbitrary definition of white and so colour constancy performance is often quite poor. For this reason, Land's Retinex algorithm has been rejected as a viable theory of colour constancy.

In this paper we resurrect the white-estimation method of Retinex by presenting its operation and goals in a different context. We begin by recasting the problem of colour constancy such that instead of trying to find a unique solution we, following on from the work of Forsyth[2], attempt only to characterise the set of all plausible answers. To see how this might be done, let us suppose that the gamuts of colours for a standard reference illuminant is known; as an example, this could be the set of LMS cone responses induced under D65. It follows then that image cone responses (created under any unknown lighting conditions) must correspond to reference responses under an appropriate mapping. By applying certain (quite reasonable) restrictions to the size and shape of the reference gamut we show that the set of solutions to the colour constancy problem are all triplets of scaling factors \( (x, y, z) \) such that \( 0 < x \leq \frac{1}{D_x}, 0 < y \leq \frac{1}{D_y} \) and \( 0 < z \leq \frac{1}{D_z} \). That is, by finding the maximal response in each of the L,M and S channels we can effectively solve for the entire set of mappings which takes image colours into the reference gamut. Importantly, the size of the solution set becomes very small when a white or near white is present in the scene. Indeed the size of the solution set provides a measure of the uncertainty in white-point estimation. Thus, viewed from a gamut mapping perspective, Retinex appears to be quite a well-founded theory of colour constancy.


A-002-03

Visual Learning and Object Recognition with Illumination Invariance
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This paper describes a method for recognizing partially occluded objects under different levels of illumination brightness by using the eigen-space analysis. In our previous work, we have developed the "eigen-window" method to recognize the partially occluded objects, and have demonstrated that the method works successfully for multiple objects with specularity under constant illumination.

In this paper, we modify the eigen-window method for recognizing objects under different illumination conditions by using additional color information. In the proposed method, a measured color in the RGB color space is transformed into the HSV color space. Then, the hue of the measured color, which is invariant to change in illumination brightness and direction, is used for recognizing multiple objects under different levels of illumination conditions.

The proposed method was applied to real images of multiple objects under different illumination conditions, and the objects were recognized and localized successfully.
A-002-04

BIOLOGICAL NEURAL ARCHITECTURE FOR HUMAN COLOR PERCEPTION AND ADAPTATION REALIZING COLOR CONSTANCY


A multi-stage color model [De Valois, 1989] was modified and extended to to form a color appearance model of parvo-cellular foveal color vision realizing a chromatic adaptation inside a physiologically motivated fundamental color space.

As illustrated in Fig. 1 the transformation into this space is performed by the connections of parvo cells in the retina (cones, horizontal cells, midget bipolar and midget ganglion cells) and of parvo LGN cells in the human brain. The resulting space (Fig. 1 top) is stretched between the orthogonal BG, BY and WB activation axes according to the ideas of Hering (1965) and covers all the color sensations of a human being. The chromatic adaptation is realized by analysis and modification of location-, size- and form parameters of the color activation distribution in this opponent color space. This results in a prediction of color appearance of object colors for various states of adaptation.

During the observation of a multitude of scenes the model is demanded to move towards a steady state independent of color context. A color activation cluster of the orientation shown in Fig. 1 top right demonstrates exactly an interpretation of color constancy that has only been postulated so far, but now can be explained by geometric means. This distribution represents an average level of color sensation, which is equivalent to constant color sensations.

A-002-05

COLOUR OPPONENT WAVELETS: A CHROMATIC RECEPTIVE FIELDS MODEL

Jean-Pierre Ponziani, Louis Gassart, and Jean-Claude Baum.

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An attempt to describe the human colour vision process is made using the wavelet transform theory. To understand the visual process, the wavelet transform is used to construct a multiscale analysis which generalizes the classical results.

The aim of the present work is to construct a basic wavelet in order to give a model of the chromatic receptive responses. In a first part, we describe the main features of the wavelet functions. They can be deduced from a single function which must follow various mathematical conditions and must take into account physiological properties in order to describe the visual process. Then we give a model of the retina cells responses. Wavelets, with an opponent centre-surround structure are defined. These wavelets correspond to the three cones types: L, M, and S. The chromatic receptive field curves are deduced from these wavelets. In particular, the type I cell, the type II cell, the double opponent cell, and the ¾ double opponent cell are deduced using a linear combination of a single wavelet.

The obtained results show that the wavelet analysis is more efficient than the Fourier analysis or the Gabor analysis to explain the experimental responses of chromatic receptive fields.
A-O02-06

BUILDING COLOR SELECTION SYSTEM USING NEURAL NETWORK SYSTEMS
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2 Application Engineering Group Kono Keikaku Engineering Inc.

Exterior color is an important factor in determining the impression of a building. It also has a great influence upon the appearance of the street. As it is difficult to select a compatible exterior color when a building is built or repainted, expertise is required in converting the desirable impression into the appropriate color. On the other hand, when the exterior color has already been selected, the impression should be evaluated before the building is constructed.

Exterior colors of a building are generally associated with impressions by using adjectives. Although many studies have been conducted on the relationship between colors themselves and adjectives, few studies have been made on the exterior colors of buildings and adjectives.

Until now, an effective method for determining the relationship between these innumerable colors and adjectives has not been devised. Today, computerized techniques allow us to develop a fuzzy function and a neural network system. This study probes the mutual relationship between exterior colors and adjectives using this neural network system.

Experiments using the semantic differential rating method (30 scales) were conducted to determine the relationship between exterior colors and adjectives. Ninety-eight stimuli (computer graphic perspectives) were used. Each perspective comprised a different exterior color.

Two types of neural network systems were constructed based on experimental results; namely, a system to select exterior colors of a building by adjectives, and a system to evaluate the impression of exterior colors by adjectives.

Accordingly, it became possible to grasp the relationship between exterior colors of a building and its adjective impression more easily.

B1-O03-01

COLOR DIFFERENCES AND PRINCIPAL HUE VECTORS IN THE MUNSELL SPACE
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Munsell color chips are embeddable in a 3-D Euclidean space as such a configuration of points \( \{ P_i \} \) that inner-point distances \( d_{jk} \) between \( P_j \) and \( P_k \) were proportional to corresponding scaled color differences \( d_{ijk} \). \( j, k = 1-10; n = 104 - 178 \). For each pair of chips \( (j, k) \), the subject selected two Munsell grays \( (V_{A_j}, V_{B_k}) \) the lightness difference of which matched in size with the color difference, and \( d_{ijk} \) were defined by \( |V_{A_j} - V_{B_k}| \). Pairs \( (j, k) \) were limited so that \( d_{jk} < 3.5 \) l. For each color chip \( j \), the subject also assessed the degree of grayness, \( \Delta N (j) \), and the amounts of principal hues, \( \xi_j \), where \( \alpha = R, Y, G, B \) or \( R, Y, G, B, P \). In my past studies, \( \{ P_i \} \) was defined so as to minimize the discrepancies between \( d_{ijk} \) and \( d_{ijk} \). The root-mean-squares (RMS) of discrepancies was \( 0.20 - 0.24 \) l. The global structure of \( \{ P_i \} \) was in agreement with the Munsell spacing, though there were some systematic deviations. Munsell units for \( V \) and \( C \) were found to be 2 to 1 in size. Radial vectors \( f_k \) from the achromatic axis were defined so that the contravariant components of \( f_k \) on \( f_k \) represent \( \xi_k \). Except \( B \), the directions of \( f_k \) were in agreement with \( S H_0 \). Irrespective of whether \( P \) was included or not, \( f_9 \) was clearly shifted toward \( SPB \).

In the present study, a different approach is taken, which may be more practical for color science. Inter-point distances \( d_{ijk} \) are defined according to the current Munsell spacing and compared with data \( d_{ijk} \). Then, RMS of discrepancies is \( 0.42 \) l for chips between \( V_4 \) and \( V_6 \). The same comparisons are made in each \( V \) level to see change of the relation between \( d_{ijk} \) and \( d_{ijk} \) according to \( V \). Principal hue vectors \( f_k \) are defined with regard to the Munsell H-C concentric circles \( \{ P_i \} \). Again, \( f_k \) is in the direction of \( SPB \) at all levels of \( \{ P_i \} \). Directions of \( f_k \) and Chroma steps on \( f_k \) are given as a function of \( V \). This approach provides useful information to obtain quantitative predictions on color differences as well as on proportions of principal hues and achromatic components from the current spacing of Munsell system.

B1-O03-02

NCS AS A TOOL FOR COLOUR COMMUNICATION IN COLOUR DESIGN
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The increasing use of colours in different contexts within the field of colour design has led to the need to be able to communicate colours in an unambiguous way. It is not sufficient just to identify a colour in terms of pigments and their mixtures or in terms of wavelengths and physical stimuli. Many colour systems and colour artists have been developed, but these have been based on different conditions and different theories, and has added to the difficulty of communicating within this field. The primary meaning of colour must however be the perceptual experience of colour, since colour is what we see, a subjective visual sensation.

A perceptive colour system such as NCS begins with colour appearance according to the perceptual attributes of hue, chromaticness, whiteness and blackness. NCS is a tool which makes it possible to communicate, analyse, plan, choose, produce and control colours in an unambiguous way within different areas of colour design. It has been used to map and analyse colour scales for traditional pigments, nature’s colour palette, different colour order systems, foodstuffs etc.

In the colouring of our homes and buildings, both externally and in the interior, it is important to find structure and context in the experience and knowledge which is obtained through professional work in colour design. For architects and designers it is easy to analyse, decide and combine colours with the help of NCS. It is easy to illustrate ideas and present propositions with the help of the colour samples.

In industrial companies manufacturing products where colour is important and where the manufacturing tolerances are narrow, a visual colour order system with colour samples makes it possible to achieve a rational coordination between different materials, different formulations, colour measurement and colour control. In addition to need to achieve the correct colour, it is also important to have a method of analysing the colour range of a particular product, which can be difficult if the range is extensive. NCS makes it easy to find the regions where there are too many or too few colours.

For “corporate identity colours”, the NCS samples can be used as a standard for colour control. When a company has chosen a special colour to identify their company, it is natural that it wants to have the same colour on different features such as letters, textiles, signs, packages, buildings, cars etc. With a colour sample you can communicate between these different materials.

When persons in the field of graphic design are preparing some printed matter or a brochure, they often work with a colour system based on pigment formulations. The colour of the printed product then depends entirely on the colour and absorbivity of the paper and on the ink film thickness, since the printing ink is transparent. This means that the final visual result can differ from the colour chosen by the designer in his colour proposal. NCS colour samples make the task of achieving the desired colour easier.

B1-O03-03

DIVIDED PARTS IN THE NCS COLOR–TRIANGLE
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Since the NCS system has a feature of the same shape of the color triangle regardless of hues, divided parts in the triangle are useful for selecting and classifying colors. The parts are arranged from two points of views. One is how near the points of colors in the triangle are to each of the corners, i.e. the elementary color white, the elementary color black and the full chromatic color. The other is the nearness of the points of colors to each side of the triangle. The latter corresponds to the cleanness of colors.

The divided parts are made with regard to the characteristics of distribution of two kinds of colors. The first are those of about 2000 color-cards made by about 60 firms for color planning. The results are applicable to painted materials and colors of most products. The second are colors of about 3500 color-cards made by two printing–ink firms. The results are suited to works of visual representations.
B1-O03-04

STUDY OF PRACTICAL COLOR CO-ORDINATE SYSTEM
Hideoaki Kawasaki and Akira Kodama
Women's Junior College of Fine Art and Japan Color Research Institute
A purpose of the development, abstract of studies and the essential part of the Practical Color Co-ordinate System (PCCS) are explained. The possibility of new application of PCS is also discussed. The history of PCS development is given as under: 1. Takashi Hosono et al. in the Japan Color Research Institute were denoted by contact to "Geometric Formulation of Classical Color Harmony" (1944) by Noon and D.E. Spencer. They carried out the large scale research study on 190 subjects who included famous artists, designers and art students about 1326 kinds of samples with two color arrangements which were made systematically using "Standard of Color" of the then Japanese standard color system in 1955. Some new important harmony rules were derived quantitatively from the analytical result of the extensive collection of data, such as the harmony and inharmony of color were not provided under the scale of difference of Hue but the large effects of lightness and saturation, the range of difference of harmony and inharmony of hue was changed with the kind of hue as the starting point and the type of harmony varied with a type of occupation, for example, painter and designer etc. 2. The investigations expanded over the studies in 1 to the next "A Study of Color System for Color Harmony Plan" successively. "Essential Part of PCS and Domain of Systematic Color Name", "A Study of Saturation", "Domain of Hue. Research of Color Domain of Red, Yellow, Green and Blue", "A Study of Segmentation of Hue", "Segmentation of Lightness and Saturation" and "Establishment of Tone Series". On the basis of these studies, the essential part of PCS was shown for the first time by "Basic Color System" in 1964. The basic theory of PCS was published as 180 Color Chart (Harmonic Color Chart, 1965). This system has found with acceptance with the fields of art and design education. We explain the content of the above studies and the essential part of PCS, at the same time, we discuss the possibility of applying it to the color education in the art and design education and to the color harmony plan in the fields of art and design.

B1-O03-05

ELEMENTARY COLOURS IN CHROMATIC COLOURS
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Absolute quantity of elementary colours in chromatic colours were measured by magnitude estimation method in order to investigate if human visual mechanism can know absolute quantity of elementary colours or relative quantity of them. Five subjects observed chromatic colour papers under illumination of D65 simulator. The tasks required were to judge the magnitude of elementary colours which he or she can perceive in the stimulis, and to report the ratio of elementary colours compare with pure psychological colours which are in one's mind. Nevertheless they could not see any other colours but colours involved in the stimulis. The data showed that the sum of estimated quantity of elementary colours were less than 100% and that they did underestimate each elementary colours. In the case of stimulus color which all the quantity of each elementary colours which were involved in stimulis were not so different, each elementary colours were estimated correctly, i.e. in the case that observers perceived three elementary colours in the stimulus simultaneously, the sum of all the elementary colours were almost 100. But if the case of stimulus of which amount of an elementary colour of the elementary colours involved in the stimulus was very large, observers could not perceived the change of other elementary colours, i.e. the estimated quantity of an elementary colour was increasing as the colour involved in the stimulus, however other elementary colours involved in the stimulus were not decrease. These result suggests that our visual perception of elementary colours cannot be explained as Euclid space, and that blackness is processed independently same as other elementary colours.
B1-O04-01

VISUAL ASSESSMENT OF COLOR: COMPARATIVE ANALYSIS OF THE MUNSELL SYSTEM AND THE NATURAL COLOR SYSTEM
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One of the possible uses of a color order system is to assess the color one sees by referring to the variables of the system, without employing an atlas with physical samples to make the judgements. The Natural Color System, as a matter of fact, was used in this sense before an atlas of it existed. It would seem that this system is more suited than any other to perform such a task. The aim of this research was to verify this hypothesis, by comparing the NCS with the Munsell system, of which it is often said that cannot be used without its atlas. Thus, the purpose was to determine which of these two systems is more suited to identify and name colors by simple visual assessment, without the aid of an atlas to make direct comparisons.

In this survey, 60 color samples randomly distributed in the chromatic space and 160 university students not previously acquainted with any color order system were employed. The subjects were divided into two groups, each one receiving an explanation of only one system. The task for each group was to name the color of the samples by simple visual assessment, according to the notation of the system in question, writing down hue/blackness/chromaticness for the NCS and hue/value/chroma for the Munsell system. After that, the resulting notations were compared with the exact designation of the samples obtained by a matching technique against the NCS and the Munsell samples. In this way, the deviations between the direct visual assessment and the matching with the atlas were obtained for each color.

The results indicate that the deviations are in general of the same statistical order for both systems. This fact suggests that both, the NCS and the Munsell system are equally apt to be used in direct visual assessment without necessity of the atlas. In the paper, the psychophysical reasons that led to these results will be discussed.

B1-O04-02

INTRODUCTION OF PRACTICAL COLOR CO-ORDINATE SYSTEM (PCCS) USED IN COLOR RESEARCH
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The Practical Color Co-ordinate System (PCCS) was produced by Japan Color Research Institute in an early in 1964. Since then, PCCS has long been enjoying the popularity among various areas such as Japanese industries and school education because of its outstanding merits. One of the merits of using PCCS is the ease to systematically categorize and describe any types of color by combining hue and tone (munsell of color). This merit derives another practical merit; the exclusive achievement of high intelligibility for everyone including designers and clients. The purposes of this presentation are two-fold. The first purpose is to explain the basic method of color research using PCCS. The second purpose is to briefly introduce three typical cases of researches using PCCS. The first case is a color preference study of Japanese that has been continuing since 1978. The second case is the example of color distribution study on products and landscapes by systematically linking PCC, with other color order systems such as the Munsell system. The third case is the application of PCCS to analysis of interior color combinations. PCCS has proved to be practically very useful due to its intelligibility, because PCCS enables to express any color combinations intuitively using hue relations and tone relations.
B1-O04-03

DERIVATION OF SPECTRAL REFLECTANCE DISTRIBUTION OF HIGHLY SATURATED COLOR IN MUNSELL COLOR ORDER SYSTEM

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In the previous study, the authors applied the principal component analysis to the measured spectral reflectance distributions (SRD) of the JIS Z 8721 color chips, and proposed a reconstitution method for deriving the SRD corresponding to any specified Munsell renotation. However, the SRD generated by the method did not satisfy the surface color condition (0 ≤ ρ(λ) ≤ 1) for highly saturated colors, where ρ(λ) refers to the SRD.

The authors try to derive the SRD satisfying the surface color condition in the region of highly saturated colors. The SRD of highly saturated colors are given by combining the SRD by the reconstitution method with the SRD of optimal colors and with those of the achronic colors. This method was applied to all the highly saturated colors specified in the JIS Z 8721 to provide the standard colorimetric values under the CIE illuminant D65.


B1-O04-04

ACCURATE VISUALIZATION OF THE CIE COLOR SURFACE IN 3-SPACE

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The significance of geometrically visualizing the structure of the CIE color chart was realized over a half century ago by MacAdam [1] and Stiles [2][3]. Such a geometric construction affords a fundamental understanding of the human perception of local color variation in an image. Because local color differences are not uniform across the standardized CIE color chart for a given incremental replacement in the chromaticity coordinates, the geometric structure must be visualized as a 2-D Riemannian surface existing in an ambient space of three dimensions or higher. Although well-known methods were implemented separately by MacAdam and Stiles in the 1940s for approximating the CIE color surface, a correct methodology for directly constructing a surface of the CIE color chart from discrete local metric data together with a methodology for verifying the correctness of the resulting solution has never been achieved - in essence this has been an open problem for quite some time. The paper model construction of the CIE color surface by MacAdam [1] is based upon the methodology of Silberstein [4] which depends upon the best fitting of adjacent sides of neighboring parallelograms, a procedure that is not well defined and will not produce a correct result. Furthermore, being in the form of a paper model makes it difficult to verify its accuracy using a computer. Stiles discovered an analytic form for a metric which integrates directly into a solution for a curved 2-D surface in a 3-space with metric possessing this desired analytic form. The approximation to MacAdam's empirical data however is not nearly as good as implied, particularly with respect to the rate-of-change of the metric. A methodology is presented in this paper which endows an initial surface mesh of data points with dynamical forces that iteratively act on the surface making it converge to a verifiably correct embedding of the 2-D CIE color surface in 3-space. The approach taken in this paper dispels the long misunderstanding in the color science literature that there is just one realization of the CIE color surface in 3-space - in fact there are theoretically an infinity of such embeddings of which two are presented in this paper. This methodology for constructing surface visualizations has general practical applicability to experimental data that could be represented by intrinsic metric geometry such as any empirical results involving line elements in color science.

White is Green  
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Looking through the prism as Goethe did, we see white between cyan and yellow in the spectrum, exactly where green is in Newton's spectrum. Color pickers for RGB computer systems show white as 100% red, green and blue, when in fact, the proportions of white are closer to 30%R 59%G and 11%B. The distribution of spectral energy indicates that white is centered in the spectrum in the same place as the hue of green. A white balance is set by adjusting the red and blue levels until white appears neither warm nor cool, i.e. centered on green. White does not appear green because of the mechanism of color constancy. Our perceptual systems are optimized for seeing the green frequencies while at the same time optimized for separating a single frequency of green from light that is mostly green but contains a mix of frequencies. We are conscious of minute hue distinctions and unconscious of large value differences.

Giving white a place in the spectrum allows hues and values to be plotted on the same plane of color space. The author has created a chart of the hue/value relationships of color by mapping the hues of the RGB spectrum onto the values of the grayscale. This chart allows the selection of equal value color combinations similar to the harmonies of a traditional artist's color wheel, but in the far greater gamut of hues and values of RGB color, making color selection and matching more intuitive for the general computer user. The chart may be seen on the World Wide Web at http://www.csulb.edu/~percept.

Performance Testing of Color-Difference Formula.

Part I – A Color-Difference Dataset in Low Chroma Colors.

Hitoshi Komatsuura
Color Technology Division, Japan Color Research Institute

A color-difference dataset was developed for testing the performance of color-difference formula. The dataset comprises 40 color-difference pairs at seven color centers. Seven colors were chosen in low chroma as popular color at ceramic tile industries. Two visual estimations were done for 267 pairs. Observations were made with approximate 0º45 geometry under D65 fluorescent lamp. The response was the population frequency of correct or accept decisions and Probit analysis was used to calculate perceptibility and acceptability of color-difference
B2-005-01

SEMIOTICS OF COLOR IN PHILIPPINE VERNACULAR DWELLINGS

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Vernacular architecture is considered a form of non-verbal communication where every stylistic pattern, structural component, spatial element, number of openings and applied colors are accorded certain cultural meanings. This paper explains how 'color speaks' in the dwellings of farming villages in the Philippines as derived from the people's mental concept of association with certain colors. Further, the result of the study showed how color is interrelated with the people's "concept of habitation." Though folkloric colors are mostly seen in traditional clothes, applied colors in architectural components and home furnishings in their usual indigenous distempered look are indiscriminately taken for granted. Every particular color found in the dwelling, such as those in their entrances, altars, living spaces, and basic possessions elicit certain signifiers that give the dwellers codified concepts of powers, feelings and emotions, superstitions and religious beliefs. The traditional color palette of certain communities used in dwellings enhance the form and function of the built forms and constitute as a visual language of the inhabitants which do not only express their observed values and social structures but also show the pattern of influences from other cultures and overlapping definitions of symbolic realities in different societies.

This research is a part of the Ph.D. thesis the author is presently writing on the cultural study of dwellings in the highlands and lowlands of the Philippines.


B2-005-02

A COMPARATIVE STUDY ON THE COLOR DECORATION OF EASTERN AND WESTERN RELIGIOUS ARCHITECTURE IN THE MIDDLE AGES

- A Comparison of Korean Buddhist "Danchung" with Gothic Stained glass
- Junghun Kim 1 Department of Architectural Engineering, Ewha Womans University

This study is concerned with the color decoration of Buddhist temple and Catholic church. The main subject of the study is to investigate the commonness and difference of color decoration between Buddhist "Danchung" and Catholic "Stained glass" in the middle ages. I examined the architectural and historical backgrounds, and analysed the elements, techniques and principles of color combination. The result of this study is as follows: 1) "Danchung" was developed to embody spiritual beauty from practical function. While Stained Glass was developed to embody symbolic sacred space by theological interpretation of light. 2) Two dimensional "Danchung" exists in both outside and inside of the centripetal Buddhist temple. But four dimensional Stained Glass exists for only inner space of the centripetal church. 3) In spite of the different background and medium, they have some similarities in the elements, techniques and principles of color decoration. Those are symbolic color use, architectural expression, basic patterns, black and white line use, color arrangement.
According to our conception all byelorussian colour culture has experienced its development through light and colour, through its mythology and magic, philosophy and religious symbols, its associations with colour system of natural world. Colour features of historical monuments and people architecture, painting and decorative arts is a base for national colour preferences, because they integrate polychromatic and ornamental traditions, which have been created by centuries. The main tendency of colour interpretation of architectural monuments from 6 different historically-ethnographical regions in using of the middlewave part of colour's spectrum (red, yellow, green, ochre and sky-blue). These colours give the possibility of forming a contrasting background for sculptural-ornamental and architectural form. Architectural polychromy of Belorus takes the tints of nature: the contrast of two or three colours with guilting so that architectural elements look more bright on the rather intensive background in order to create the surrounding of richness and mosaic of colours. Having learned the principal features of colouristic palette of architectural objects of Belorus we can state: 1) The colour of Belorusian architecture was formed for many centuries on the base of country building materials with using of the elements of folk applied art in corresponding with light climat and landscape characteristics of a region. 2) Among the factors that determine the formation of Byelorussian colour culture the most influential is the culture of different country which border on our country (Russia in the East, Ukraine in the South, Poland in the West, Latvia and Lithuania in the North.) Nowadays, for determination of connection with artistic traditions and with colour culture of regions as a whole the architects try to restore in colour of modern cities the principal palette of historical polychromy, using of data about the main laws of historical formed and modern colour preferences. For creation of optimum colour climat and achievement of artistic expressiveness and stimulation of aesthetical perception they use of colouristics on the level of all ranges of detailed elaboration (silhouette, mass of building, tinctures of facades, plasticity of surface and texture of material.) For these aims colour and plastic forms may be combined by analogy and by contrast (tectonic and actonic "supergraphic" colour design). At the Department of Architecture we have prepared a special programme of discipline "Colouristics in Architecture", which help to study the means and methods needed for paintings, applied art and architecture in the terms of colour harmony as a reflection of the general colour culture of Belorus.

ORANGE AS A CONTEMPORARY EXPRESSION OF SPIRIT

Paul Martin
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Life is bright. Life is orange, runs the advertising jargon for one of Britain's most successful new companies, ORANGE mobile phones. It is not outside of contemporary contexts that the name of this company was chosen. There has been a huge upsurge in the popularity of this colour in recent times. This seems to go against much research which places orange at the bottom of the list when people are asked to state colour choice in order of preference (1). Blue is the most preferred colour of about two thirds of western people, and it is significant that this is the complimentary of orange. In a documentary about the work of lighting director Vittorio Sastriro he explains how he uses orange and blue symbolically in the film Sheltering Sky to light and define the two main characters - orange as day/sun/earth/masculine and blue as night/moon/sky/feminine (2). However the symbolism of orange runs deeper than this. Orange is the colour of earth when used as natural dye (it is chosen by Buddhist and Krishna monks for their robes to represent a basic commune with nature and the richness of life) and its increased popularity signifies an increasing respect for the environment of the Earth and a desire of people to return to a more organic and healthier lifestyle. Therefore orange can be said to represent the body. However orange is also the colour of the sun and therefore of light. It is colorful and spiritual and can therefore be said to represent the mind. It signifies a return of people towards a more spiritual/meditative interpretation of medicine and spatial design at a time of intense commercialism/consumerism. But most of all, as the colour of light, it is the colour of hope and fun. The sun lights up the day, but electric light, which is in more orange in hue, lights up the night - it is the colour of entertainment. The last time that orange was popular in Western culture was in the 1960s when it was part of the start of youth culture and psychedelia as a rebellion against conformity - a new direction. Then the dyes were a celebration of new synthetic materials and processes. Could this recent popularity of orange signify another change of direction and an expression of new spirit at a time when current systems are beginning to fail and burn out?

B2-O05-05

A GLOBAL COLOR RESEARCH AGENDA FOR 2000 AND BEYOND

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Color professionals from diverse areas are demanding that color research needs be documented. These international research priorities will be the focus for the research agenda for the twenty-first century. An international survey will be mailed to a sample of AIC members from 23 Member Nations' and 6 Observer Nations' mailing lists. The two page survey and cover letter have been pretested, revised and refined. The results will document - for the first time - the research needs by profession, country and area of study. This documentation will establish the color research priorities within six categories and will assist in stating the international color research needs for possible funding into 2000 and beyond.

B2-O06-01

PRINCIPLES OF KOREAN COLORS

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Culture is the result of human creation to nature and climate. Color, as an expression of culture, tells us social, cultural and historical context of a country. Different natural environment creates different colors of soil, plants, skies and different culture of colors as well. At the same time, there also exists universal color theory beyond nature and culture.

Yin and Yang from ancient China has affected the principle of Korean color composition. This principle has red, blue, yellow, white, and black as basic colors and green, sky blue, light yellow, purple and rouge as sub-basic colors that are produced combining two of the basic colors. Above two colors are divided into two groups of Yin and Yang.

The colors of traditional clothes have expressed the difference of social status. Common people from lower social standing have used white or colors of materials easy to obtain, while people of governing class from high social standing had used original colors of high chroma. Red, green and purple were used by them according to the rank of status. On the other hand, there were usages of colors beyond the differences of status. They are the colors in ceremonies and events following the principles of universal color design.

In the traditional paintings, we could find basic usage of colors following the principles of Yin and Yang. The difference of class or status has been also expressed by colors of clothes in the paintings. As a whole, they have used light colors in large area and dark colors in small area in the paintings. Above the principles could be found in the design of traditional buildings. The houses of common people were made of straw, pole or stones and they had there material colors respectively accordingly. The houses of Yanban were made of manufactured materials such as roof of tiles and plaster walls with ashes. The buildings of royal class had different coloring called 'Tanchung' to distinguish the class difference. The Tanchung coloring is quite unique to Korea. But there found universal principle of coloring. They are the contrasts of warm-cool, light-dark, Junge-small area, and social dividing by white and black lines.

The purpose of this study is to show the principles of Korean colors created by the integration of Yin and Yang and universal way of coloring through the analysis of colors in traditional clothes, paintings and buildings.
The Sacdong is the most popular traditional color combination in Korea. We can see the original pattern of Sacdong in the ancient currently wall paintings of Nakkyo. Sacdong is used for costumes and wrapping papers. Therefore, Sacdong is the most familiar color combination for Koreans. The aim of the present study is to investigate the color combination of Sacdong and its pattern in Chosun era (1392-1910). Through remained materials of Sacdong in Chosun era, we can see Sacdong used in children's and women's costumes and cloth wrappers (Hworshibi) called Bozagi. The colors used in Sacdong were the principle colors of Chosun era except black. That is red, yellow, blue, white, pink, green, purple and so on. Although the original pattern of Sacdong was the striped pattern on costumes, a large number of varied patterns were used for cloth wrappers. This is because the design technique of Sacdong depended on the maker. Accordingly, we can not find the same color arrangements and patterns in Sacdong. However, in general, striped patterns were used in costumes, while square patterns, triangle patterns, and free patterns were used in cloth wrappers.

For 4000 years, the Chinese dragon, colorful and awe inspiring in appearance and dynamic in movement is the symbol of enthusiasm, strength, courage, wisdom, prosperity and good luck. In Far-east Asian countries under the Chinese civilization, the dragon is also the same symbol. In the case of Japan, it is said, the dragon culture was introduced about 2000 years ago together with paddy agriculture and then after not to be disappeared. Even in the present days, the dragon has maintained its popularity among those people for soaring spirit. The dragon, it goes up to the heavens at the Spring Equinox and down to the valley at the Autumn Equinox, changing it's size from time to time and summoning wind and rain. It is free and unrestrained, and is in different forms sharing the following common features—the horn of deer, the head and neck of snake, the belly of calf, the scales of fish, the claws of eagle, the ears of ox, the feet of tiger and the colorfully decorated body. The red dragon, green dragon, yellow dragon, golden dragon and silver dragon, what of dragon has inspired people's mind with special sensation? There is one of ancient theories called as "Yiuyang Wuang (in Chinese) " or " Inyo Gogyo(jin Japanese) " appeared about 2000 years ago. According to this, " Negativeness " and " Positiveness " originate the Five Elements (Tree, Fire, Earth, Metal, Water), and the interactive reaction of these elements governs everything on the earth. The Element is assigned to various kinds of things and phenomena as follows.

<table>
<thead>
<tr>
<th>Five Elements</th>
<th>Tree</th>
<th>Fire</th>
<th>Earth</th>
<th>Metal</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five Colors</td>
<td>Green</td>
<td>Red</td>
<td>Yellow</td>
<td>White</td>
<td>Black</td>
</tr>
<tr>
<td>Five Directions</td>
<td>East</td>
<td>South</td>
<td>Center</td>
<td>West</td>
<td>North</td>
</tr>
<tr>
<td>Four Seasons</td>
<td>Spring</td>
<td>Summer</td>
<td>Autumn</td>
<td>Winter</td>
<td></td>
</tr>
<tr>
<td>Four Gods</td>
<td>Green Dragon</td>
<td>Red Phoenix</td>
<td>White Tiger</td>
<td>Black Turtule</td>
<td></td>
</tr>
</tbody>
</table>

Perception of form and color as an ignorance through eyes causes some sentiment in mind. The dragon color might be given based on the assignment of the Inyo Gogyo theory. From this view point, the dragon color would be discussed.
B2-006-04

COLOUR SYMBOLISM, COLOUR PREFERENCE IN HUNGARIAN FOLKLORE AND FOLK ARCHITECTURE

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Colour symbolism is a very special and ancient field of communication. Each culture has its own way of using colours. While the language of the forms seems to be international, the-colour-language has a special national character (e.g. the national flags). Through the examination of the different colouring systems we can get closer to the mentality of the different groups which use it. The basis of the symbolism is the nature. Those groups -as the primitive cultures, children, or village people- who have close connection with the living nature and are not poisoned by the civilization have reserved the original symbolism. The Hungarian folk art is especially rich in objects which has symbolic meaning and belong to a common language. The Hungarians due to geographical and historical reasons mixed their culture with several other peoples' ones while keeping a special national character which differs from the Western-European style of decoration and is closer to the eastern one.

The lecture discusses this special character from architectural and artistic point of view. Illustrated with colour slides.

B2-006-05

JAPAN AND BRITAIN - A COMPARATIVE COLOUR FOLKLORE

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Relationships between the appearance images of a person and the materials, physics and design of the scenes depend greatly on the upbringing and heritage of the viewer [1]. Folklore plays a large part in our upbringing and the relevance of colour in folklore is a subject of ongoing study. Questionnaires were used to obtain comparative data on lucky colours, colours used in rites of passage, calendar associations, and specifically coloured traditional foods [2].

Driving forces for the use of colour in folklore can be considered under the headings Historical, Economic, and Social. Colours are used in a patriotic historical sense. Maypole ribbons in Britain are the red, white and blue of the flag. The red sun on a white ground was adopted as a national flag in Japan in 1870 at a time of industrialism and imperialism. This coincided with the time when red rice was introduced as a dish for happy occasions.

 Mourning colour is an example of an economic driving force. In most countries this colour is achromatic. In Japan and Britain it is normally black. In China white. Such observations are used to highlight cultural differences. However, normal working clothes are achromatic, and respect for the dead dictates that worn for funerals they should be clean and tidy. This is appropriate for individuals who cannot afford to buy rarely used clothing. It so happens that the cultures have optimised colour in different directions.

Although questionnaires from both countries show high responses for the bride's white dress, the reasons given for the colour are different. In the west white symbolises bodily purity, in Japan mental purity.


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This paper takes its title from the mnemonic taught to English-speaking schoolchildren to help them to learn the Newtonian sequence of colours in the rainbow - Richard (Red) of (Orange) York (Yellow) Gained (Green) Battles (Blue) In (Indigo) Vain (Violet). The rainbow - the universally recognised manifestation of the pure spectral hues - has featured as a motif in the work of artists of different cultures for a variety of symbolic purposes. For example, John Constable painted a rainbow as a symbol of the transience of beauty in 'Stonehenge', while Millais' 'The Blind Girl' employs a double rainbow to symbolise the pleasures of the natural visible world. In the art of the Navaho Indians, the rainbow is a Goddess; conversely, in Greek mythology, the Goddess Iris personifies the rainbow. In China, a rainbow was an emblem for marriage. The rainbow also has a history as a literary motif and symbol. It appears in the works of writers and poets - notably D H Lawrence and Wordsworth - and can also be found in proverbs and children's rhymes and songs.

In the 20th century, the spectral arc has become an ubiquitous image in popular visual culture. While this can be attributed to some extent to the advent of modern printing technologies which facilitate the cheap and effective reproduction of full strength hues, the rainbow has clearly been identified as a motif and symbol which expresses some of the essence of our times. This paper explores the use of the rainbow in the everyday world in contexts as diverse as trademarks, pub signs, advertisements, tattoos, printed ephemera, kitsch objects, murals, structures, etc. It identifies the symbolism and associations which these rainbows communicate, and compares these with the range of meanings which visual and literary artists have created with the same motif. The results bring together a revealing mixture of the predictable and the arbitrary with the surprising, the imaginative, and the amusing. The author has been photographing and documenting rainbows as a motif in popular visual culture in the UK and the USA for many years and has exhibited this work at several venues. This paper will be supported with extensive visual material drawn from this body of photographic work together with new material recorded specifically for this presentation.
A-O07-01

EFFECT OF COLOR AND ECCENTRICITY ON SPLITTING VISUAL ATTENTION IN MOTION INDUCTION

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Using the motion induction (MI) procedure, we previously found that the split attention is involuntarily allocated according to the luminance of the pre-cues (ARVO96). When two cues (dots) were presented simultaneously with the same achromatic luminance followed by a line, the line was observed to be drawn from both side and meet at the center. We termed it meeting point and interpreted the fact for the possible evidence of split visual attention. The purpose of the present experiment is to observe possible influence of color and eccentricity on motion induction.

Methods. Presenting two colored cues (0.4 deg, separated 7.2 deg during, fixing a dot at the center 3.5 deg below on a CRT center), then presenting a colored line (6.8 deg horizontally wide with connecting both side to cue). Both cues were presented for 83 ms, then a line was presented with ISI of 83 ms. In each session, fixation point was shifted along horizontal meridian up to 3.6 deg to both right/left side to test eccentricity effect. Observer’s task was to indicate the perceived meeting point by computer mouse. We also observed this procedure in a single cue condition. We employed red (x = 0.61, y = 0.35, L = 13.15 cd/m²), green (x = 0.31, 0.66), and blue (x = 0.13, 0.05). Background was a gray (0.28, 0.30) of equal luminance.

Results. Preliminary results showed a little influence of color and eccentricity on MI. That is, when two equiluminant colored cues were presented simultaneously followed by a colored line, MI was observed and adjusted meeting point was not shifted from the center as was in the achromatic conditions even in a condition employed blue stimulus.

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A-O07-02

EFFICIENCY IN VISUAL SEARCH FOR A COLOR TARGET IN A COMPLEX COLOR ENVIRONMENT

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In our living environment colors are used in various signs for attracting our attention and providing specific information. However to find a color sign effectively it is necessary to keep surrounding colors in appropriate condition. The purpose of this study was to explore a quantitative method to estimate searching efficiency of a color target in complex color environment. We carried out the experiment in which a subject searched a marked target of a cured color in a two-dimensional color array that was created from an image of an actual scene. The target and background color array were displayed on CRT monitor and searching times were measured. As expected, searching time was strongly influenced by the relationship between color of the target and colors of the background. We found that searching time increased with the number of areas whose color was similar to that of the target. Also searching time was increased with increasing complexity of color arrangement in the background. It is concluded that efficiency of visual search for a color target can be estimated using those two factors, namely the number of target-like color areas and complexity of color background.
A study on the Influences of Color to Area Perception on a CRT Display

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In our experience, a light color patch may be perceived bigger than a dark color patch with same shape and area. However, so far no research has studied the exact amount of influence of the three attributes of color contributing to the area perception. Thus, a series of experiments has been conducted in this study to systematically investigated this effect on the CRT display. In the first experiment, each time two shades with same shape but different colors and sizes will appear on the screen of a computer monitor, the one with fixed black color and fixed area is treated as the target, while the other with color systematically varied along the three attributes of color (hue, brightness and saturation) in the testing sample. Subjects of college students with normal vision were asked to adjust the area of the testing sample until it looks the same in size as the target. In this way, we found that some of the three attributes of color shows significant effect on area perception. To check whether this is caused by the fixed appearing locations of the two shades on the screen, another experiment with the controlled appearing locations to balance out this possible effect of location was conducted. The result is almost the same as the previous one. We then doubt that the invariability may be due to the continually adjusting method used in this experiment. Thus, another experiment with the method of constant stimuli has been conducted. Again, no significant effect of color on area perception has been found. We conclude this study with some discussions on this unexpected finding.

keywords: area perception, three attributes of color, constant stimuli, CRT display.

A-O08-01

SIMPLE METHOD FOR ESTIMATING THE HELMHOLTZ-KOHLRAUSCH EFFECT
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Two color stimuli with the same luminance, one achromatic and the other chromatic, do not give the same brightness. The chromatic color is generally brighter than the achromatic, though the effect is different for different hues. This is called the Helmholtz-Kohlrausch (H-K) effect, which has been a fundamental and important subject in photometry and colorimetry during more than thirty years in CIE. "Equivalent luminance " or "equivalent lightness" is used to a test chromatic color stimulus for the representation of the effect. In addition, the senior author reported lately the existence of the two kinds representations in the H-K effect, one the VAC (Variable Achromatic Color) method and the other the VCC (Variable Chromatic Color). In the present study, four kinds of prediction equations to the effect are given, which can determine the equivalent lightness for object colors and the equivalent luminance for luminous colors to each of the VAC and the VCC methods. The equations use the CIElUV formula, and they are as easy in computation as the Ware-Cowan equation. Using the prediction equations the following experimental results were predicted very nicely. 1) B/L ratios of the Sanders-Wyszecki experiment. 2) Derivations of N_{max}^{*}(\lambda) and N_{0}^{*}(\lambda) from N_{max}(\lambda) and N_{0}(\lambda) respectively. 3) Estimations of V_{max}(\lambda, Td) from 100Td to 100,000Td measured by Yamada et al. on the basis of N_{max}(\lambda) and adapting luminance La. 4) Estimation of mesopic spectral luminosity functions V_{max}(\lambda, Td) by a heterochromatic brightness matching from 100Td to 0.01Td measured by Sagawa et al. on the basis of V_{max}(\lambda) and V(\lambda). 5) Experimental results on 20 chromatic color stimuli using the VCC method done by Sagawa et al. 6) Estimation of equivalent lightness on NCS colors with specified values of (s, C, L). The authors expect that the CIE Technical Committees related to the H-K effect to consider the adoption of the present methods proposed.
COLOR CONSTANCY AFTER CHANGE IN VISUAL SENSITIVITY

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[Purpose] Color constancy was often studied with asymmetric color matching method. Since observer sets test and matching stimuli in alternation, the stimuli which render objects under different illuminants might cause to produce unstable state of chromatic adaptation of the visual system, if the size of the stimuli are relatively small. Our purpose of study is to investigate the mechanisms of color constancy under rigid state of chromatic adaptation, by using a room as the adapting and matching field.

[Methods] The observer sat in a room of gray (N50) walls and viewed another small room through a window (11deg x 8deg) on the side wall. A variable-chromaticity illuminant was placed on the ceiling of each room. Eight surround color chips and a test color chip (2deg x 2deg) were mounted on a N 5/ gray background, and presented as a test stimulus in the small room. For the matching stimulus, a CRT monitor was placed 20cm behind an aperture (2deg x 2deg) on front wall. The same color chips with the of the test stimulus were placed to surround the aperture, i.e., matching stimulus. The illuminant of each room was varied from D65 to orange, blue, green or purple. After 5min of adaptation to the room illuminant, observer made matches between center color chips of the test and matching stimuli, as if they appear to be an identical piece of paper. The state of adaptation was monitored by unique-white setting. [Results] Our results showed that the state of adaptation was determined by the chromaticity of illuminant in the main room. When the illuminants for the main and small rooms were different, matched colors showed some systematic shifts from perfect color constancy. The shifts were not canceled with chromatic adaptation alone. We tried to predict this systematic shift with our original model, which reflects our idea that the cone responses after the change in sensitivity are used for spatial interaction of the chromatic signals. The result showed good prediction to our data. [Conclusions] Our results suggest that a stage for the change in sensitivity could locate prior to the rest of the color constancy mechanisms in the visual system.

COLOR MONDRIAN EXPERIMENTS WITHOUT ADAPTATION

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The McCann, McKee and Taylor (MMT) experiments provided quantitative measurements of the change in color appearance caused by change in the LMS components of the illumination. These experiments provide a baseline for quantitative changes in appearance for color constancy conditions. The MMT experiments used the same display in all five cases, so that the average radiance of the entire field of view changed with the illuminant composition.

The experiments described in this paper uses the same papers and illuminants as in MMT. However, this time a new surround is added to exactly compensate for the shift in the average radiances caused by the change in illuminant. In other words, the new surround compensates for the new illuminant so that the color adaptation levels of observer are constant.

Two formats of surround were used in the experiments. First, the compensating surround was placed around the outside of the 17-area Mondrian. Second the compensating surround was placed around each individual area in the Mondrian. In both cases the color matches were found to be very similar to those measured in the original MMT experiment. The experiments show that both global and local adaptation conditions had minimal effect on the colors observers chose.

NATURALNESS JUDGMENTS OF OBJECT COLOURS
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The subjective quality of colour images of natural scenes depends strongly on how much the colour of the objects in a scene are perceived to be natural. The reason is that the degree of naturalness shows how well a colour reproduction agrees to the observer's expectations. It might also indicate how tolerant observers are to colour transformations. The objective of the present study is to define naturalness and to determine the process underlying naturalness judgments. To this end, two kinds of colour manipulations were applied to two digitised natural images (scene 1: a boy sitting in a field of grass; scene 2: fruit), namely, a 'local' manipulation in which the hue and saturation of every pixel representing three specific objects (scene 1: skin, shirt; scene 2: banana) are varied, and a 'global' manipulation in which the hue and saturation of the pixels of the whole image are varied. These manipulations were carried out in CIELUV colour space. The three objects were chosen because they are assumed to have different ranges of colours in nature and, thus, vary in degree of 'criticality'. In a first experiment the colours of the skin and the shirt were manipulated in a factorial design. The subjects' task was to judge the naturalness of the whole scene on a 11-point category scale. Results demonstrate that naturalness judgments of the whole scene are primarily limited by the manipulation of the most critical object, i.e. the skin, and hardly determined by the manipulation of the less critical object, i.e. the shirt. In a second experiment the naturalness of the 'locally' manipulated colours of all three objects was asked explicitly. The relationship between these naturalness judgements and the averaged chromaticity coordinates of the object-representing pixels in the CIELUV colour space can be described by a bivariate normal distribution with four parameters: two means and two variances of the Gaussianians on the hue- and saturation dimensions. The variances for the natural objects, i.e. the banana and the skin, are much smaller than for the man-made object, i.e. the shirt. The data of a third experiment showed that these variances are slightly bigger for 'globally' manipulated images in comparison with 'locally' manipulated ones. In a fourth experiment subjects' task was to rate the similarity in colour of the banana and skin samples used in the second experiment to the typical banana and skin colours stored in their mind. The relation between 'naturalness' and 'similarto-memory' judgments are found to be linear. In general, we define naturalness as the degree of correspondence to memorized reality, and conclude that the naturalness of a whole scene is determined mainly by the memory representation of the most critical object.

LIGHTNESS JUDGMENT IN RELATION TO THE SIZE OF THE RECOGNIZED VISUAL SPACE OF ILLUMINATION CONTROLLED BY LIGHTNESS AND COLOR SATURATION OF OBJECTS

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People can immediately understand how a room is illuminated when s/he enters the room. The state is called that s/he got the recognized visual space of illumination (RVSI) for the room. The size of the RVSI can be controlled by changing the initial visual information, or the appearance of objects that the s/he first observes in the room. We prepared two miniature rooms of a same size, A and B placed side by side and illuminated by the same ceiling light sources. The walls and the furniture of the rooms were made of grey surfaces with various lightness but those of A had lightness greater by the amount of 1.5 compared to those of the room B in respective object. We can expect that the size of the RVSI of the room A is greater than that of B, and that a test grey patch in A will be judged darker than that in B even if those two patches have a same lightness. The subjects judged lightness of test patches placed in the room A and B when the illuminance of both rooms were set equal. The results showed as expected that the test patch in the room A was perceived darker than that of room B when both patches had the same lightness. This implies that the RVSI of the room A is perceived brighter or its size greater compared to that of the room B, and that the lightness of the test patch was perceived smaller than that of the patch in B as the judgment was based on the size of the RVSLs. A similar experiment was also conducted by controlling the size of RVSI by changing the color saturation of objects placed in respective rooms and smaller lightness was perceived in the room A of which objects were made of higher color saturation.
A-009-01

COMPARISON OF THE STRUCTURES AND PERFORMANCES OF COLOUR APPEARANCE MODELS
Robert W.G. Hunt and M. Ronnier Luo, University of Derby, England

Colour appearance models usually consist of three stages: a chromatic adaptation transform, a dynamic response function, and a colour space for representing the correlates of the percepts. The earliest, and still a very useful, chromatic adaptation transform was that devised by Von Kries, based on a set of cone sensitivities, and most recent models use modified Von Kries transforms; however, it is shown that better predictions are provided by the Bradford transforms, which depends on a set of sharpened spectral sensitivities having some small negative lobes, and which incorporates a power function in its blue channel. The dynamic response functions used are cube-root in the CIELAB, RLAB, and LLAB models, logarithmic in the Nayatani model, and hyperbolic in the Hunt model; these different functions diverge most for very bright and very dim colours. The colour spaces used in these models are similar in that they all provide approximate correlates of redness-greenness and yellowness-blueness, ratios of which are used to derive angular correlates of hue, and square-roots of the sum of the squares of which are used to derive correlates of chroma, while non-linear functions of an achromatic signal are used to derive correlates of lightness; but only some of the models also provide correlates of brightness and colourfulness. The differences in the chromatic adaptation transforms, in the dynamic response functions, and in the colour spaces, all contribute to the differences between the predictions made by the models. These predictions are compared with various sets of data of experimentally determined colour appearance. The possibility of combining the best features of all the models in a single version is discussed. The CIE is aiming to provide a model available in both a comprehensive form for general use, and in a simplified form for application in limited conditions; the aim is to achieve this by the end of 1997.

A-009-02

TESTING COLOUR MODELS' PERFORMANCE USING UNRELATED COLOUR APPEARANCE DATA
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Most of the earlier colour appearance data sets were produced using related colours viewed under photopic conditions. This data set was accumulated using unrelated colours assessed under both photopic and mesopic conditions. The experiment is divided into five phases according to the different viewing conditions studied, i.e. surface and self-luminous colours, related and unrelated modes, and different luminance levels (100 and 4 cd/m² for the photopic and mesopic conditions respectively). The 120 JIS colour cards were used for the surface colour experiment. 90 colours were presented on a CRT with colour coordinates close to those surface colours (5 CIELAB 4E). The other colours were out of the colour gamut of the CRT. A Photo Research 1980B spectroradiometer was used for measuring colours.

Each colour was assessed with 12 observations by a panel of 6 normal colour vision observers. The magnitude estimation method was used. Each colour was described in terms of brightness, colourfulness and hue. In total, about 20,000 estimations were made. These results were used to compare various parametric effects and to test five colour appearance models: Hunt, Nayatani, RLAB, LLAB and Guth. The results were also used to modify the Hunt and LLAB models. The detailed results will be given in the conference.
A-O09-03

INVESTIGATION OF COLOR APPEARANCE USING THE PSYCHOPHYSICAL METHOD OF ADJUSTMENT AND COMPLEX PICTORIAL STIMULI

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The study of color appearance and the formulation and testing of color appearance models require various forms of data. One of the most widely used data types is corresponding-colors data gathered by making color matches across changes in viewing conditions. This method, combined with a variety of viewing techniques (e.g. successive viewing, memory matching, haploscopic matching), has been successfully used to collect data for simple stimuli such as uniform patches on uniform backgrounds. Since color appearance is complex and known to depend partially upon cognitive factors, it is also of interest to study color appearance in more complex stimuli such as pictorial images and real scenes. A psychophysical technique was developed for generating pictorial images in different media and viewing conditions that match in color appearance. Observers used a commercial image-editing software package to match CRT reproductions to print originals. In a control experiment, observers produced accurate matches when images were viewed in matched conditions (symmetric matching). Subsequent corresponding-colors data were collected for changes in medium (print to CRT) and changes in chromatic adaptation and medium. The conditions studied included matching for CRT-6500K to CRT-6500K (control), print-6500K to CRT-6500K, print-9000K to CRT-6500K, and print-3000K to CRT-6500K. Experiments were completed using a successive short-term memory matching experiment that was developed in previous research. Two pictorial scenes were used and five observers participated in the matching experiment. The corresponding-colors data were used to evaluate a variety of color appearance and chromatic adaptation models and to derive simple transformations for changes in chromatic adaptation. A selection of the resulting images were used in a second painted-comparison experiment in which a large number of observers (32) compared the matched images with the predictions of various models. A third scene was added to test the robustness of a fitted model. The images generated through observer adjustment were found to be equivalent or superior to predictions of color appearance models for the larger observer population. This presentation reviews the new experimental technique, the results obtained, and the performance of the various appearance models. It also includes a review of ongoing experiments to collect additional corresponding-colors data for a larger number of observers and images viewed under internationally standardized viewing conditions.

A-O09-04

EFFECT OF PERCEPTUAL CONTEXT ON COLOUR APPEARANCE

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We report an extension into the chromatic colour domain of a lightness illusion devised by Adelson (1993). We take two identical patches of light which look slightly pinkish on a homogeneous neutral background and produce two different contexts for them by using pictorial cues to render the image of a corrugated plaid. In one context the patches appear slightly different colours because of simultaneous contrast. A far more drastic change in colour, however, is produced in the other context by changing the depth relations within the display. This is so even though neither the spectral compositions of the patches nor the internal configuration of the corrugated surface are changed.

The relevant feature of the second context is that the changed depth relations make one patch appear to be brightly illuminated while the other is shadowed. We measured the resulting colour shift by matching to a comparison patch in a neutral surround. Such a hue shift cannot be accounted for by known theories of colour contrast since all they are insensitive to changes in 3D structure. To explain the illusion, therefore, one needs to consider the sort of higher level contextual interactions that have been discussed by Gilchrist in the lightness domain. The colour-shadow invariance hypothesis (Logvinenko & Menshikova, 1994; Logvinenko, 1996) is generalised from the achromatic to chromatic colours to account for the new colour illusion.

A-009-05
COLOR APPEARANCE MODEL EVALUATION FOR HARDCOPY/SOFTCOPY IMAGE COMPARISONS
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This paper will summarize the activities of CIE Technical Committee (TC) 1-27, Specification of Color Appearance for Reflective Media and Self-Luminous Display Comparisons. A detailed set of guidelines for coordinated research on evaluation of color appearance models for hardcopy (illuminated reflection print/softcopy (self-luminous display) image-matching comparisons was published1. Researchers from around the world have responded to the published guidelines with experimental results. A summary of all researchers’ experimental results, including color appearance model performance for BFD, CIELAB, CIEUV, von Knoe, Hunt, Nayatani, and BLAB under a variety of viewing conditions across media will be presented.


A-009-06
EFFECTS OF CHROMATICITY ON THE UPPER LIMIT OF LUMINANCE FOR SURFACE COLOR MODE PERCEPTION
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It is known that the appearance of stimulus gradually changes from surface-color to aperture-color as the luminance increases. In this study, we investigated effects of chromaticity of stimuli for the surface color mode perception. In the present experiments, the upper limit of the luminance which yielded surface color mode perception was measured using a computer controlled CRT monitor. The stimulus consisted of 3 x 3 array of color chips on a large gray background of three levels of Munsell neutral gray. The test stimulus was presented at the center of the array with a CRT monitor. 8 Munsell color chips surrounded the test stimulus. The observer adjusted the luminance of the test stimulus so that the stimulus appeared as of high reflectance as possible. The results show that the upper limits of the luminance differ depending on the chromaticities of the test stimuli. The limits for white and yellow stimuli are higher than those for blue and red stimuli. We assume the equivalent luminance reflectance defined as the ratio of luminance between the test stimulus and the 100% reflectance surface. Our analysis shows that all limits of colors were set below 100% equivalent luminance reflectance. We found that brightness of the stimulus with the upper limit of luminance were almost equal among all test chromaticities. We repeated all experiments using the CRT simulated stimuli, and obtained the similar results. Our results suggest that the mode of color perception is determined by the brightness of the stimulus.
SELECTION OF SUITABLE COLORS FOR OFFICE BUILDINGS BASED ON THEIR LOCATIONS
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2 Japan Color Research Institute

Japan's countless office buildings are located not only in urban business districts but also in various other surroundings due to the nation's limited land area. The color of an office building should be determined by considering surroundings, due to the normally large size of these structures.

The purpose of this study is to determine the relationship between colors of an office building and its location. Two psychological experiments were carried out. The first was to obtain desirable impressions of office buildings located in various types of surroundings. A semantic differential method (fifteen rating scales) was used. Forty observers were asked for their impressions. Factor analysis was conducted to show two psychological factors of the desirable impressions, that is, "attractiveness" and "familiarity", and the desirable impressions of the office building in each surroundings.

The second was to determine what colors would be suitable to the office building on its location. Five original photographs of office buildings located in different types of surroundings were used. Fifty stimuli were created using a color simulation method which substituted the original color of the office building in each photograph with ten new colors. The forty observers were asked to evaluated the degree of suitability between the colors of the office building and the surroundings.

Canonical correlation analysis was conducted to classify the colors used in experiment into four groups; one group represented preferred, another group disliked, another group neutral (unconditionally) and the other preferred or disliked according to the surroundings.

It was concluded that there is a natural tendency of preference regarding the colors of an office building based on its location.

Impact of Three Color Schemes on Long-term Productivity and Performance Tasks Relative to Individual Environmental Sensitivity
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The purpose was to examine the impact of three work environments—predominantly red, blue-green, and white color schemes offices—on worker productivity and performance over a 4-day work week relative to individual differences in environmental sensitivity. The impact of the colors was examined on extensive proofreading and typing office tasks administered and performed intermittently throughout the workday and week. Matched on relevant variables, 90 subjects were randomly assigned to one of three offices. Similar to earlier findings on short-term clerical tasks, on the first and second work days, workers in the predominantly red color office with high screening ability were more productive than workers with low screening ability. On the other hand, workers with low screening ability were more productive than high screeners in the blue-green color office. In terms of performance, primarily on the third and fourth days, subjects made more errors on the proofreading and typing tasks in the blue-green color office, and to a lesser degree in the red color office, than in the white office. This was true regardless of stimulus screening ability. These findings are discussed by the investigator in comparison with previous findings. Earlier studies on short-term clerical tasks suggested that a white color interior might be associated with lower worker performance than identical tasks performed in a red or green color office.
URBAN COLOR DESIGN BASED ON CULTURAL CLIMATE
-CASE STUDY OF KOTO WARD, TOKYO

Mari Ozaki, Gyungin Kim, and Masami Kobayashi

OZ Color Studio Tokyo Inc., Department of Global Environment Engineering, Kyoto University,
Department of Global Environment Engineering, Kyoto University,

Cultural climate is total expression of climate, weather, geology, geography and landscape of a land. The cultural climate is not a simple natural environment. It is a way of self-understanding carved in the mental structure of the human being. The culture climate creates literature, arts, religions and custom of the land. Accordingly, the colors created by cultural climate teach us the design of colors proving harmony. These days, the urban colors of Japanese cities in most are filled with confusion because of the negligence of climate colors.

The purpose of this paper is to develop a color design method to provide order of color harmony in chaotic urban landscape using the color palette created cultural climate.

First, outside colors of existing buildings have been surveyed to grasp the present status of color design of the city. The survey spots have been selected evenly throughout the city. On each spot, the colors of buildings strongly affecting surrounding townscape have been measured by the Munsell Value indicated by Hue, Value and chroma. The scales, materials and usage of the building have been also coded.

Pallet of colors created by cultural climate has been provided collecting the colors of sky, water, green, flowers coming from natural environment and the colors of cultural environment such as clothes, historic buildings, paintings and ceremonies in Koto ward.

Feature colors of existing buildings of each district by using the colors pallet from climate colors, color design guide of the districts is presented.
B1-O11-02
AN IMAGINABLE COLOR OF THE CORRESPONDING "COLOR POLLUTION": THE CASE STUDY IN SAPPORO AND IT'S SUBURBS
Noya Sakahara, Dept. of Architecture, Hokkaido Institute of Technology

The Purposes of this study are to find the names of color that makes people feel "Color Pollution" and to provide some basic data for the color planning of architectural design. The areas we researched are Sapporo City and 3 other cities around it in Hokkaido(Ishikari, Kitahiroshima, Otaru). Hokkaido has a different history and a climate comparing the other districts of Japan. Hokkaido has the tradition of development for some 120 years ago. Japan is generally in the temperate zone, but Hokkaido is in the subfrigid zone. And so Hokkaido has a cold and snowy climate, and is also thinly populated area. We think that those matters mentioned above has given the great influence to the choice of color and other things.

We carried out the research on June and August in 1995 and 1996. These are our method and conditions: #We chose 28 districts. #Those 28 districts contain "District Planning Area" and "Non-district Planning Area". #Those different areas are side by side. We had 5079 effective data and the recovery rate of 87.5% with the questionnaires.

In this study, we took up 3 questions in all of our research: #Do you know the meaning of "Color Pollution"? #What color do you think "Color Pollution" is? #Do you agree with making an agreement on the matter of color? We summed up the answers to those questions according to sex, age, residential years, and the existence of "District Planning", and finally we give some considerations.

B1-O11-03
THE ITEMS CONCERNING COLOR PLANNING OF BUILDING EXTERIOR SURFACES AND THEIR RESTRICTIONS
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The purpose of this study is to obtain the items required for color planning of building exterior surfaces and to assess their restriction quantitatively.

To obtain the items, firstly we examined several reports written by the color designers who had decided a concrete color planning of building exterior surfaces. Secondly we conducted an experiment in which subjects were required to decide the color of a building practically. Consequently we obtained the items required for color planning, which could be categorized into several groups such as place, function, material, concept and so on.

To assess the restriction of the items, we conducted an experiment in which subjects were asked to rate each of 98 color stimuli under a certain planning items by using a method of semantic differential, from "just fit to" to "not fit to". The number of planning items used in this experiment was 45, which were selected from the items obtained from previous experiment of color planning.

As a result, the restriction of each item could be assessed by analyzing the variance of the rates. If the variance of an item was small, we can say that the restriction of such an item was severe. These items were mostly concerned with material except those which were not dependent on a color of material. For example "a pain". Conversely if the variance of an item was large, the restriction of such an item can be said to be light, since the rates of every subject didn't coincide. These items were mostly related to concept. The other side, some items had many colors and some items had a few colors which the subjects evaluated "just fit to". These shows the amount of color which can be used under a certain item. The items having many colors were "an elementary school", "amusement facilities", and the items having a few colors were "a power station", "a high-rise house", for example. The result of this study revealed the tendency of the negative correlation between the amount of color and the restriction with some exceptions: such as "in a down town", "in a new town" concerning place, "a fire department", "an elementary school" concerning function and "smart" concerning concept.
COLOUR CONTEXT, SITE AND CULTURE, IN URBAN PLANNING AND ARCHITECTURE
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Colour appearance in environmental concepts is part of "site spirit" either in urban spaces or rural areas. Against "Visual Pollution" "colour is a subtle component in impact studies for adaptation of the intrusion of urban development and architecture in all sites. In all human groups, colour is a sign providing natural information or (and) cultural messages; colour belongs to memory of groups and reveals for each of them part of their identity and belief. "Colour may be good or bad, it depends on context," a Chinese maxim says.

Urban development and architecture are tight up to a site, a "scale" of times, and natural cycle, to keep or suggest harmony between architecture and site, colour aspects need to be in accordance with the supporting area. Fashion, various economical and technical aspects have impact on the colour appearance development. How to suggest a good balance between those two components of daily life? How to explain and identify colours explicitly with vocabulary? What impact on manufactured material? How to introduce the colour aspect in urban development or architecture teams? The studies will suggest concepts and goals used on:

- Housing Authority in Hong Kong: chromatic chart for new social housing settlements in rural or urban spaces based on. Sites analysis - Sites chromatic ranges (NCS vocabulary) - Sites manufacturer ranges - Follow up of projects in relationship with landscape teams.

The goals were to provide the architects colour basic information for: a better fitting with environment, that means, six micro-sites where chosen by architects, as being representative of typical geographical and settlement areas. The visual relationship being merging the building in site or enhancing it as a focused part in the area. - an identification and character of the internal landscapes of the estatic scale of space, dimension, material, relationship between building and groundlevel - a new visual pollution and a comfort support for daily life.

- Footbridges (private or public) in Central Hong Kong (Highways administration) were considered as a symbolic link between two parts of the same area along the "corridor". A colour family range was affected, to reinforce each area character, with additional corridor specific range. Wanchai, more colorfull, will be looking different from Central, more white light, and grey. As part of a long-term project, references where based on NCS.

- Hue, past imperial city, in Vietnam is a cultural city, where colours are involved in clothes, architecture and light. The material most often used in past was chalk water coating with variation on ochre, blue, purple, turquoise. The goals are to memorize the traditional range part of heritage and as support, in NCS translated, being suggested to foreign companies to be included in their own range, for another hue palette in harmony with tradition and new materials from abroad.

FIGURAL COLOR IN THE SEATTLE CITYSCAPE
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Urban form relies, in part, on how one perceives figural objects in the cityscape. This study looks at the colors of significant figural structures in Seattle, Washington and how these colors are affected by the varying light and atmosphere in the predominantly overcast skies of the Pacific Northwest. Seattle is composed of several hills interspersed with bodies of water and can be viewed at varying distances from a boat and vertically in layers. Methodology involved observing and documenting photographically figural colors in differing light and atmospheric conditions. Actual colors of figural and background buildings were recorded on site using the NCS Index. Similar color samples from the NCS Block were then arranged to make an abstract two dimensional color model of the cityscape which represented a particular urban field. The color samples of the figural blocks were interchanged in hue, chromaticness (c), and blackness (k) to determine the characteristics that increased or diminished their figural status and were observed in varying light conditions. Results demonstrated that of the many well-documented spatial effects of color, chroma was the most significant variable. In sunlight and clear atmosphere, when (c) was below 20 in all the buildings in the field, the light-dark contrast was the primary factor in determining figural status. Black was dominant in all fields and white was secondary in fields where the background was dark. Hue contrasts were of lesser importance. In a field where several buildings were figural hue and (c) were most important. Yellow (S0580 Y) was primary since it is low in (k) and high in (c). Y was followed by GY, R and G. R advanced due to warm-cool contrast, and both R and G became strongly luminous in sunlight in high (c), which increased advances in their spatial position within the urban field. Black was strongly figural, as was white. In overcast sky and shade, yellow, high in (c), low in (k), was figural and dominant, but lost its luminosity and receded from its position in sunlight. Blue (S1060 B), less powerful than yellow, was secondary, but retained its luminosity and advanced spatially in this light. Black and white were both figural in this light. In fog or haze, yellow retained its figural status and appeared to penetrate this atmosphere. YG and YR in high (c) also appeared to penetrate fog. White in this atmosphere was also figural against a darker urban field, but not against the sky, and did not appear to penetrate fog. Black and other hues of high (k) lost their figural status in fog or haze.
"Geography of color" © Environmental Color Design

"Where is the color, here?" wonders the dweller in front of his house, the only colors of which are wood, stone or brick. "There is no color on this house. Come and see the flowers in my garden, you'll see colors there...!" Those who live amidst color don't perceive it. It's part of them, it is themselves. The "Geography of color" © is precisely the clear statement of existing, specific and particular colors which express a leading characteristic in a determined spot: this is what has always been called "picturesque color". It is an other way of looking which enables us to perceive in a new and different way. Where does it come from? From geographical factors, such as geology, soil quality, sky, light, vegetable varieties, dwelling materials, and building color. But also socio-cultural factors in which may blossom traditions and customs, particular choices of colors, contrasts, combinations and harmonies which are available here, rejected there, appreciated yesterday or today, but may be replaced tomorrow.

Color changes, color evolves and lives. This regardful observation of color components in the landscape is a inexhaustible matter which reveals a constancy: color participates in the identity of a place, it belongs to patrimony and contributes to the cultural roots of a population. It is rich with signs and symbols.

The detailed inventory of color alphabets, the colored assortments of which the sites are composed with (town, village, narrow or wide landscape, rural or industrial...) reveal some more other ranges, textures and materials ones which express their whole value under the lights and when they are handy. It is a greater component of everyday life and reveals in his way, by a specific language, the spirit of a place and the soul of a people.

STUDY CONCERNING THE COMPUTER SIMULATION OF COLORING OF EXTERIOR SURFACES OF BUILDINGS
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The requirements for the practical usage of the computer simulation of coloring of exterior building surfaces is firstly discussed. Because the actual environment is too complicated to be calculated for generating it's image, the computer simulation should provide a superimposed image composed of the image of the building, that is the subject of the simulation, and that of the surrounding environment filmed by a camera. In order for the simulation to support color design, the relative relationship of colors within the image should be stored. To do so, the luminous environment of the building and the surrounding environment filmed must correspond, and the color reproduction performance during conversion into image form must also correspond.

Concrete color simulation methods are secondly examined. The simulation with three-dimensional data used within the computer was covered, with concrete examples given of methods of filming background images, methods of measuring the luminous environment and methods of setting the light sources. In addition, simulation using filmed images of existing buildings were dealt with, and a simple simulation method that does not measure luminance and chromaticity was proposed.
AN ESTABLISHMENT OF THE PRACTICAL GUIDE FOR COLOR PLANNING OF THE HIGH-RISE APARTMENT HOUSING EXTERIORS IN KOREA

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Korea is a small, overpopulated country and the government has been making a great effort to build high-rise apartment housing of 20-stories or so to lessen the house shortage. The sight of the high-rise apartment housing plays an important role in making a good impression of the certain urban area. So these buildings colored without any planning can only give the image of disorderness to people.

This study is aimed for securing the lowest level of color planning in high-rise apartment housing exteriors and establishing the practical guide which will rearrange these disordered color systems of apartment housing.

The process of this study is composed of three steps: 1) The color properties of apartment housing should be grasped by color survey of the existing exteriors. Then the color image and the evaluation construct model of the exterior colors in apartments can be obtained by using the Repertory-Grid Developmental Method. 2) The dominant colors and subdominant colors as standard colors are selected as the two methods - 'method of ranking color frequency' and 'method of decreasing color difference'. And then, the color palette of the standard colors should be made out. 3) The evaluation experiment of color simulation should be carried out by using Color Image Processor. A mean for an evaluation is the SD(seemetic differential)Method composed of seven steps. A technical statistics is carried out for the reliability of the data. Through the HAYASHI 1 program, the quantitatively estimated index for the evaluation of the exterior colors is established.

The results of this study are as follows: 1) On the basis of the color survey, three color factors - the dominant and subdominant color, the pattern of color scheme, the harmony of color scheme - which influence exterior color image of apartment housing are extracted. Then the analysis for the exterior colors in apartments can be obtained by using the Repertory-Grid Developmental Method. 2) The dominant colors and subdominant colors are selected as the standard colors for apartment exteriors. 3) The experiment should be carried out by evaluation scenes of the three color factors, made out of the standard colors. The results of the analysis are as follows: the images of subdominant, repesentation, are greatly affected by the value of color and the harmony of color scheme. The dominance, variable, images are mainly affected by the harmony and the patern of color scheme. And the variance, softness, images are deeply related to the hue of color. Finally, it is proposed as the quantitatively estimated index.

With the results of this study, the color palette by the color image and the practical guide for color planning are proposed to the designers for their practical use in the business fields.

INHERENT AND PERCEIVED COLOUR IN EXTERIOR ARCHITECTURE
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The main question of the project is: How does the perceived colour of a facade differ from the inherent colour? Most people who have ever chosen colours for facades have experienced this problem. You choose a colour sample, and when you see the finished facade you find that the colour looks different from what you had expected.

The inherent colour is a constant property of the facade. In simple terms, the inherent colour of a newly painted surface is equal to the colour code of the paint used. More strictly, the inherent colour is here defined as the colour that the surface would have it was seen under the standardized viewing conditions of the NCS system. In practice it can be assessed through comparison with NCS samples placed directly on the surface.

The perceived colour of a facade is the colour that an observer can see in the actual situation. It changes all the time and is affected by factors such as viewing distance, light conditions, colours of surrounding houses and vegetation etc.

The survey includes totally 84 houses with painted wooden panel, observed in their already existing surroundings. Surveys of this type have so far not been presented. Therefore an important part of the study has been to develop and evaluate methods for colour assessment that can give information about the changing varieties of the natural setup.

The perceived colours of the 84 houses have been assessed repeatedly under various viewing conditions and with different methods of assessment. The observation data are analysed with two different aims. 1) To evaluate the used methods and discuss the development of new methods of determining what colour people perceive on houses. 2) To find tendencies in the relationship between inherent and perceived colour and to see how these are affected by viewing conditions.

Some preliminary results:
1) The evaluation of methods shows, that methods where perceived colours are assessed without reference to colour samples seem to give the most accurate information. As soon as colour samples are used for comparison there are inevitable problems connected with differences of lighting, the size and presentation of samples and the changing attitude of the observer.
2) There is a tendency that houses with achronomic or only slightly chromatic inherent colours are perceived as less yellowish /more bluish than the inherent colour. This tendency has shown for light grey inherent colours and for slightly chromatic inherent colours with hues near green and red. The effects of viewing conditions have not yet been analysed.

At the 1996 AIC conference methods and preliminary results were presented for one single house. The data for all houses are now being processed, and at the 1997 AIC congress I intend to present the results of the total survey.
AN EXPERIMENTAL STUDY ON COLOR EVALUATION OF TOWNSCAPE ELEMENTS
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This study is an attempt to propose both fundamental data for color guidance of townscape ordinance in Japan and guidelines for color design of architecture. Psychological experiments were carried out for gathering data on evaluation of exterior colors of buildings; being utilized a 1/200 scale model of typical street view which were lit by xenon lamps and fluorescent lamps, the above townscape elements were judged as the mode of surface color. The questionnaire was composed of 4 scales; 1) activity, 2) contrast, 3) harmony, 4) necessity of regulation.

As the result of scale construction, the following were clarified.

1) Activity was influenced by value and chroma. Contrast was influenced to a greater degree by chroma than by any other factor of color.

2) 2 scales-harmony, necessity of regulation showed similar tendencies on the estimation, and they also were considerably influenced by chroma. The ranges on acceptable chroma of the townscape elements were shown by using these data as a basis. As the ranges are considerably influenced by hue and value, careful steps should be taken.

ANALYSIS OF COLOR GRADATION HISTOGRAMS
FOR INTEGRATING URBAN STRUCTURES INTO SURROUNDING LANDSCAPES
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Histograms of color gradation levels in landscapes surrounding traditional urban structures in Japan were studied in an attempt to clarify the factors responsible for the good aesthetic balance between these structures and their landscapes. The shape of the histogram was found to be a more important aesthetic factor than pure color harmony when designing urban structures because color distribution takes into account all the natural elements in the landscape.

1. Urban infrastructures and landscapes studied: Structures such as the Togetsu Bridge (Kyoto), Biwako Canal (Kyoto) and Takumi Bridge (Kamuroto Pref.), which are well-known examples of the aesthetic balance between an urban infrastructure and its landscape, were studied. These structures were constructed more than 100 years ago using natural materials that have since undergone environmental aging. The target elements of analysis in the landscapes surrounding these structures were mountains and forests, which in some cases were located a significant distance from the structure. In addition, color gradation histograms were also analyzed for modern elements such as asphalt streets and concrete buildings.

2. Measurement of RGB and Munsell color gradation levels: Analysis was performed on approximately 200 slides using a computer equipped with an RGB color mode (16,700,000 colors). The slides were converted into RGB digital data using a slide-scanner at 225 dpi, and RGB and Munsell histograms consisting of 256 gradation levels were calculated. A photographic processing tool was used to define the outline of each element and thereby increase accuracy of the analysis.

3. Conclusion: The RGB histograms were similar for the various traditional infrastructures and tended to describe a normal distribution with a long toe (100-150 gradation levels) and single peak. Many of the natural surroundings also exhibited a color distribution that was normally distributed. Thus, the color gradation in the landscape surrounding an urban structure appears to consist of a wide range of colors, and the degree of congruency between the color histograms of the structure and its natural surroundings can provide a quantitative assessment of this well-balanced aesthetic relationship. Environmental aging of the natural materials used to construct urban structures can play a significant role in achieving this aesthetic balance.
DIGITAL, COLOR PALETTE for Color Education in Arts and Design on Internet WWW

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In this paper we shall show a new DIGITAL COLOR PALETTE to develop the color sensitivity in art education.

Most people can see six or seven colors in a rainbow, but now PC displays can illustrate more than 16 million colors. Electric colors in computer arts and on the Internet WWW are made up of three basic colors, the primary colors of light: orange-red, green, and violet-blue. Since Netscape and other WWW browsers were released, we have been able to control the numerous colors using the HTML.

Artists have often used watercolor or oil color palette, on which the colors are mixed. Those paints are object colors and they are quite different from light-source colors.

Hence DIGITAL COLOR PALETTE in art is the current subject of extensive research, i.e., the artistic research about a reason of why an artist chooses certain colors out of the 16 million colors.

In this study, 21 students and teachers of the college of fine arts selected suitable colors for their artistic works on CRT monitors. It can be observed that some high luminance green colors and low luminance yellow-green colors have the same chromaticity coordinates. We suspect that this is the phenomenon of Bezold-Brake shifts. It follows from these results that the several fundamental colors for artists can be seen on CIE-xy color spaces.

VISUAL DENSITOMETER: NON-INSTRUMENT BASED PRECISION MEASURING TOOL

Chia-Liang Gan¹, Kim-Yan Hang², Joo-Tatt Ten², Yuen-Peng Ho¹, Seow-Har Goh³

Conventional step-tablet chart rarely display below 3% density steps, due to an unquestioning acceptance that:
(i) Human eyes have difficulty telling apart smaller than 3% density-step boxes, and
(ii) Clearly differentiated stepped density boxes are more useful.

The author proposed two revolutionary changes to the step-tablet color chart design:
1. The use of MSDOTE chart technology, characterized by the placement of visible marginal stepped density-object targets embedded in a shared color density box. This technology capitalizes the most density-sensitive discernible instrument evens human eyes. With MSDOTE patented display arrangement, it is now possible to distinguish the presence of, for example, separated 98%, 97%, 96% and 99% stepped density-objects by superimposing them in a shared 100% density box.

2. Allowing embedded objects to merge into its shared density box is another technical advancement. In the above example, if the reproduction density-curve changed, the 98% density-object becomes invisible when it merged into the shared 100% density box. In this case, different persons can objectively deduce a density gain of 2% without subjective disputes.

Visual Densitometer is now a reality with MSDOTE technology. Singled out for discussion are these two applications:
a) 1% density accuracy for precision tuning of a monitor's white and black points, without the use of a reference card nor instrument. This is achieved by adjusting the gamma curve in a display viewing environment, until targeted objects (≤1% density steps) in the highlight and shadow boxes satisfied the preferred "what-you-see-what-you-don't" embedded objects count.

b) Visually color-communicable image management for color standardization. In this case, an original color image can be appended with the respective primary color MSDOTE tablets, together with markers indicating the presence of embedded objects. After the image is reproduced or transmitted, each primary color curve deviation can be recorded by observing the number of embedded objects that have merged into the respective shared density box.

The use of MSDOTE display, either shortened for device's limited gamut range or extended based on visual threshold limits, gives unprecedented precision in measurable visual detection. It opens up new standardization possibilities, at a low cost, in the different color-reliance industries and also further optometry research work.
B2-O13-03
M. A. DEGREE IN COLOUR DESIGN AT THE UNIVERSITY OF ART AND DESIGN HELSINKI UAH, FINLAND
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Never before has the potential for a profession in colour for architecture seemed so plausible and realistic. The 2-year M. A. degree programme in colour design at the University of Art and Design Helsinki was initiated in the fall of 1996. It is the first graduate programme of its kind in Europe to provide an academic opportunity for students to specialise as colour designers in architecture and the environmental design disciplines. The objective is to give students an artistic, theoretical and practical knowledge of colour and light applicable to buildings, interiors and urban spaces. The programme is comprehensive in its reflection of an international colour perspective while being grounded in the colour traditions of Finland, Scandinavia and Europe.

The programme is intended for students with prior professional training, a B. A. or equivalent first degree in art, design or architecture, and provides a specialisation in colour that will extend their professional opportunities. Although the degree aims at a highly focused professional identity, its curriculum is broad in academic preparation. The studies include colour interaction, colour classification and identification, colour measurement, colour literature, color space design, visual communications, lighting design, ergonomics, perceptual psychology, media and materials, computer studies and humanities. Being the largest and most diversified design school in Scandinavia, with 1500 students, 400 teachers and 12 degree programmes covering the entire design spectrum, the UAH provides an ideal background and support for the study of colour, which by nature is highly interdisciplinary. Innovative initiatives, such as the International Conference on Colour Education in 1994 and the publication of distinguished texts on design, education and research are a normal aspect of the University's annual programme.

Recognising the need for maintaining and improving the visual quality of our urban centres, historic buildings and public spaces and the crucial role of colour in this task, the UAH has responded to the challenge by offering this graduate level programme. The programme provides an academic 'springboard' for the colour consulting profession, while increasing awareness for the potential of colour in architecture and design.

B2-O14-01
MANAGEMENT OF SKIN COLOR BY MICRO-TATTOOING METHOD AND APPLICATION OF THE COMPUTER
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Selections the proper pigment color when trying to camouflage a pigmented skin lesion by overtattooing has always been a challenge. Initially, we tried to use colored silkscreen mesh over the skin as a simple simulation. However it was difficult to predict the skin color reappearance accurately, due to multiple factors such as depth of insertion, sort of tones, ingredients, region of treatment, fading with time and color of the surrounding normal areas. We analysed the composition of pigments which are used common in plastic surgery now, and made improved products (SHISEIDO Lab.) to be fit to use MICRO-TATTOOING METHOD. Regular doses of new pigments were injected at interval of 1mm in proper depth of dermis, and be examined histologically and optically. The images of preoperative and the follow-up at one month are recorded using a digital color camera (DS-500, Fuji), including a color match sticker (CASWIT), Kyowa Tokei). We created a computerized system that allows us to collect original color images. It is useful to compare clinical changes that occur with fading of the tattoo over the passage of time. Simultaneously, we measure the skin color using spectro-colorimeter (CM-2002, KONICA) and compare it with the desired color. This system is capable of simulating micro-tattooing method using image-processing software (Photoshop 3.0), and predict the best combination of pigments, rate and depth. All the data in the present study were collected by image-database software (4th-Dimension).
B2-O14-02
A STUDY OF CHANGES IN THE APPEARANCE OF FACIAL COMPLEXION IN REGARD TO EXTERNAL CIRCUMSTANCES - The Influence by the color of Lipstick -
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Shiseido is currently conducting research into changes in the appearance of the facial complexion of Japanese women in everyday situations. Facial complexion is influenced by many environmental factors, among these we have focused our experiments on three factors; lighting, clothes, and lipsticks. In the following study we will report on our findings regarding how the appearance of facial complexion is influenced by lipstick color.

In this experiment observers (12 women) evaluated 17 different attributes of the facial appearance of a model (with lipstick applied) and ranked them on a scale of 1-5. Prior to the experiment we selected 37 women who we appraised as reflecting the wide range of skin color possessed by Japanese women. And we selected 22 colors of lipstick for application from the range of lipstick colors within the Munsel color system. Thus, the evaluation was repeated 22 times for every model.

The factor analysis at the results of the evaluations indicated that two factors caused variations in the evaluations of model's overall appearance. Factor 1 included items related to the perceived attractiveness of skin color. Factor 2 included items related to the contrast between the lipstick color and skin color. Complexion was appraised positively when skin color appeared light and radiant. This trend to be when the chroma value of the lipstick was high, the level of brightness was low and the hue was reddish, exaggerating color difference in comparison to facial skin color. However, there were differences in this evaluation between the different age brackets of the observer sample, with observers in their fifties strongly favoring vivid-colored lipsticks. Moreover, the observer’s evaluation of overall facial appearance was high when the lipstick color suited the model’s complexion. In this instance, the chroma of lipstick tend to be low rather than the chroma when the model’s complexion was appraised positively.

Our findings in regards to lighting and clothing color were that overall impressions of appearance were favorable when white or red hues were prevalent in skin complexion and appraisals were especially negative when associated with situations where dark or yellowish hues were prevalent.

B2-O14-03
EFFECT OF DIFFERENCES OF SPECTRAL REFLECTANCE ON APPEARANCE OF BARE SKIN AND COSMETIC FOUNDATION APPLIED SKIN
Tomomichi Kamekato, Mami Inoue, Hiroyuki Sugaya, Takashi Kawata, Nobuyoshi Ojima, Takahide Minami, and Machio Kawai
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We have investigated the appearance of bare skin and cosmetic foundation (abbreviated here as “foundation”) applied skin individually and studied the relationship between them. At first we studied about the relationship between the appearance of bare skin and its spectral reflectance. In this study, we especially aimed at skin with “doll” appearance. As a result, we found out from the spectral reflectance measurement, that the area of the depression caused by the absorption between 500nm and 620nm (abbreviated here as “SS500”) is smaller than the skin with healthy appearance. Then we determined the SS500 as an objective index of appearance of doll skin.

Next, comparing the spectral reflectance of bare skin and foundation applied skin, similar difference as mentioned above was observed in the area of the absorption between 500nm and 620nm, so SS500 can be applied as an index indicating the difference of bare skin and foundation applied skin. And the general foundation applied skin had relatively small value of SS500 than bare skin.

Generally, foundation users select foundations whose color matches one’s face color. So the colors of the bare skin and the foundation applied skin may be regarded as metameric colors. And if the illumination condition is changed, this color matching is broken. In this case, the appearance of foundation applied skin presents an unnatural appearance because of the difference of appearance from bare skin. Then we made a foundation whose SS500 is larger than general foundations and similar to bare skin when applied to the skin. The appearance of this foundation applied skin is natural even when the illumination condition is changed. In this way, the difference of spectral reflectance could be estimated by applying SS500 as an index, and a correlation between the appearance and the spectral reflectance of the skin was found out.
B2-O14-04
THE PREFERRED SKIN COLOR DEPENDS ON THE RECOGNITION OF THE SITUATIONS
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To explore the psychological image structure which determines the preferred skin color, I examine the effects of the background of the portrait to produce the preferred skin color. The backgrounds contain the change of the times(T), places(P) and occasions(O). The preferred skin color changes according to TPO. Then, I examine the psychological image structure to cause this change.

B2-O14-05
PREFERENCE FOR JAPANESE COMPLEXION COLOR UNDER ILLUMINATION
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Human complexion is an important topic in the evaluation of the color rendering properties of light sources. However, "Preferred Complexion" under illumination has not been yet found for the "Japanese Woman's Complexion". Some experiments were conducted to find the chromaticity coordinates of "Preferred Complexion of Japanese Woman" under illumination, and the relationship between the chromaticity coordinates of the complexion colors under illumination and the subjective evaluation values of "preference".

As the results, the chromaticity coordinates of "Preferred Complexion of Japanese Woman" were \((u', v') = (0.2425, 0.4895)\) under the standard illuminant D65. The region of "Preferred Complexion of Japanese Woman" on the CIE 1976 \(u'v'\) chromaticity diagram was made clear based on the subjective evaluation values of the complexion's. Also, the experimental results were compared with those on the "Preferred Complexion of Caucasian Woman" by Sanders, and the differences of "Preferred Complexions" in these races were made clear.
SONIA DELAUNAY'S COLOUR PLANNING

Haako ABE
Tokyo National University of Fine Arts and Music

Sonia Delaunay is an artist, a designer and is also called one of colorist. She participated in the development of Orphism with her husband, the painter Robert Delaunay. Their theories on Simultaneous Colour, known as "Simultanism", which held that vibrant colour is the principal means of expressing the dynamism and movement of contemporary experience. The term "simultanous contrasts", refers to Chevreul's law. Sonia Delaunay is an appraised exploiter of the use of colour in the fine and applied arts and is recognized as one of the most significant designers in twentieth-century modernism, rather than as painter, especially as a fabric designer in all her works.

I am interested in Sonia Delaunay's colours, particularly, her fabric designs in the 1920s. I have analyzed some of her favorite colours from her fabric designs, using the table of colour names in her exhibition catalogue.

Conclusion, She has used, in particular, the following 6 colours: Black, Navy blue, Red, Green, Grey, and White on her fabric designs. She gives movement on her fabrics, by the alternation and repetition of colours, to create an optical vibrating effect. It was recognized that her views on pattern placement have much in common with those of psychologists, of almost the same period, who the state Gestalt laws of organization, that is, the "grouping" or "factor of similarity" in Gestalt psychology. Much of the techniques used by optic artists, kinetic artists etc., in the twentieth-century avant-garde paintings of the '60s are said to be influenced by Sonia Delaunay.

COLOR IDENTITY IN TEXTILE DESIGN

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New materials and textile technology processes extend application possibilities of textiles. They change the criterion of design thinking by which designer transfrom the language of form into the language of textile science. Textiles reflect technology interpretation of formal visual elements. Color identity is one of them. It depends on the whole textile design logic which simultaneously determine plastic and technological parallels. These are textile materials, techniques of realization, finishing processes on one side and cultural heritage, art history, fashion and psychology of form and color on another side. Textile pattern based on drawing, painting, sculpture, relief, photography, collage or film is a textile metaphor. In the design process it becomes textile itself that reflects a repeat of structure, color and materiality.

Textiles are in one, two or more colors. Cloth reflecting in one color represents sincerely designer's inner color imagination and sensibility. A clothes-pattern is a basic woven, knitted or netted structure itself. In industry they select carefully one-colored fabrics for production by trend predictions.

Two-colored textile patterns represent a great part of many worlds traditional textile collections. They are usually in various scales that are in proportion to a human body or to an interior, depends on intention of use. Visual appearance of a fabric expresses harmony between pattern and its background. The pattern color and the background color are in an appointed color and quantitative contrast relation. The repeated structure looks symmetrical with some modifications in rhythm, shade, density or size of figured elements. These alterations caused by unforeseen handicraft become inspirations for industrial projects.

The addition of a third color extends variations of visual qualities in a pattern. Colorful plastic composition synchronizes visual qualities of material with textile techniques. These are the finest jacquard fabrics, various prints, embroideries, etc. The identity of colorful patterns varies between art and decoration based on knowledge of textile history. That is a challenge to a modern textile design that should not create only user's new image. It has to be an innovation that contributes to better conditions of human existence.
B2-O15-03

DEVELOPMENT OF COLOR RANGE FOR THE FASHION INDUSTRY IN KOREA
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The purpose of this study was to develop a practical color range for the fashion industry in Korea. 3623 color samples used by 109 brands from 93 spring/summer to 96 spring/summer were collected. Also, the application frequency and consumer responses of each collected color were analyzed in this study. To clarify the characteristics of color range used in the fashion industry, density of colors was determined by color clustering based on JbR and consumer responses. The results of this study were as follows:

1. The result analyzed based on the Munsell system revealed that the distributions of how were concentrated in R, Yb, Y, and Plh. The chroma was concentrated mostly in the low range and the value, on the contrary, showed relatively even distribution.

2. 458 representative colors were selected by color clustering based on the JbR less than 1.0. In addition, the frequency of color applications and consumer responses were also considered when selecting the colors frequently used in the fashion industry and finally, 1163 colors were obtained. The color range of the representative colors showed similar color characteristics with the 3623 colors supplied by the fashion industry. As a result, this approach was proven to be appropriate to develop a color range for a practical use.

3. In conclusion, around 1200 colors were suggested to organize the color range to reflect the characteristics of the fashion industry with an acceptable color difference for color planning and management.

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B2-O15-04

THE SOCIAL REPRESENTATION OF THE INDIVIDUALS THROUGH COLOR AND CESIA IN CLOTHING

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The aspects of appearance that vary with the spatial distribution of light, and are different from color, shape, and texture, have been encompassed with the generic term cesia. From the physical point of view, cesia depends on the transmission or reflection of light, whether it is produced regularly or diffusely, as well as on the absorption of light by the materials. On the perceptual side, cesia has to do with the visual categories of transparency, translucency, opacity, gloss, matte appearance, etc. [1].

The fabrics used in clothing, according to their physical conformation, present different degrees of permeability to light. At the same time, various levels of absorption or diffusion of the incident light are produced in them. These facts affect the exterior appearance of the clothes, creating modifications in the visual perception of them, physical limits, and semantic boundaries that determine, for instance, that a transparent, opaque, or metallic cloth is adequate or inadequate at certain times in the day or in the context of certain social groups. In clothing, the cesias give birth to cultural conventions and norms, so much so as it happens with the colors. With these variations in the visual perception of clothing, the sensations of seduction, concealment, protection, dehumanization, body selection, consolation, etc. also vary. In this paper, examples will be shown of how, by means of the play with transparencies, gloss, opacity, translucency, etc., appearances are built that serve as nexus for the social representation of the individual and in his relation with other individuals through clothing.

APPAREL COLOR AND COLOR IMAGE PREFERENCE OF KOREAN CONSUMERS

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The purpose of this study was to identify Korean consumers' preferences of apparel color and image expressed by adjectives related to season and clothing category and to find the differences in the preferences of color and image expressed by adjectives among the consumer groups classified by age and sex. The data were collected via a questionnaire from 868 male and female adults of ages 25's to 50's living in Seoul, Korea. The data were analyzed by factor analysis, one-way ANOVA, repeated measure two-way ANOVA and Chi-Square test.

The results of this study were as follows:

1. Two dimensions of color image expressed by adjectives were identified by factor analysis: image associated with value and image associated with chroma.

2. There were significant main effects of season and clothing category on preferences of image associated with value, and significant interaction effects of season and clothing category on the image associated with chroma in male consumers. There were significant interaction effects of season and clothing category on preferences of image associated with value and image associated with chroma in female consumers.

3. Significant differences among seasons and between clothing categories in preferences of color and image expressed by adjectives were found. Also, the preferences of color and image expressed by adjectives according to the season and clothing category were partially differed among the groups classified by age and sex.

Depth Effect on Human Skin Lightness Assimilation to White/Black Lace

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Assimilation phenomenon has long been known, but it was first investigated systematically by Helson (1963). His subjects compared gray bars between white bars with gray bars between black bars. Assimilation (i.e., the former gray appearing whiter than the latter gray) gradually changes into contrast (i.e., the former appearing blacker than the latter) with increasing width of the white/black bars.

Our subjects matched skin lightness behind white/black lace with Munsell's lightness scale. Three white laces (thick, medium and thin) and two black laces (medium and thin) were presented at a distance of 60 cm from the subject's eyes. A left bare forearm of a woman was presented at distances of 0.1, 1, 10, or 100 cm behind one of the laces. The room was illuminated from the ceiling at the illuminations of 100, 320 or 1000 lux. Any one of the laces was thin enough to cause assimilation, but the medium laces of both white and black caused the biggest assimilation. The amount of assimilation became biggest when the forearm was displaced 1 cm behind the lace, i.e., the forearm appeared whitest behind the white lace and blackest behind the black lace. Further, the saturation of the forearm appeared clearly different in this condition. The saturation of the skin color increased or decreased behind the white/black laces. The laces appeared blurred and somewhat half-transparent. But when the depth was as large as 100 cm, the laces did not appear blurred, and the effects of the lace appeared to be diminished.

We concluded from these results that the degree of assimilation is closely related to transparent appearance of the lace.
A-O16-01
COLOR NAMING IN DIZYGOTIC TWIN PROTANOPES AT DIFFERENT LUMINANCE LEVELS
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A color-naming method was used to examine small-field color perception in dizygotic twin protanopes. The stimulus was a 2.2° circular field, displayed for 3 sec. Twenty-five wavelengths and an achromatic light were equated in luminance at four levels - 0.2, 2, 20, and 200 cd/m². The stimuli were presented in random order and the dark-adapted observers were asked to name each, using four basic color terms and ‘white’ in single, double or triple combinations. ‘White’ was included in order to gain more information on achromatic aspects of color appearance. Color-naming functions of the dizygotic protanopes correlated highly with each other. For both, color names were significantly influenced by luminance. The ‘white’ function enabled us to determine the protanopes’ neutral zones in the spectrum (near 500 nm). It also showed that short-wavelength lights were perceived as desaturated. The relationship between color naming and wavelength in the middle spectrum was idiosyncratic, and the protanopes’ performance was very poor by comparison with that of normal trichromats. For long wavelengths their use of ‘red’ was unexpectedly systematic. In general for both protanopes the information about wavelength conveyed by color-naming responses, as evaluated by an index of the reduction in uncertainty, was much less than that in the normal trichromats. Performance was generally somewhat better at low photopic levels. While with a larger field (3°), color naming is considered a rather sensitive indicator of color deficiency (1) and gives evidence of a weak third pigment situated in sparse cones (2), under the small-field condition, as the present results show, it appears that for protanopes a luminance dimension is much more salient than the red/green dimension, and spatial summation of suggested residual cones is insufficient to transmit information about wavelength.


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A-O16-02
HUE CLASSIFICATION TEST USING THE COLOR CAPS OF THE NEW COLOR TEST
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Some patients with impairments of the color processing system which were caused by cerebral lesions have disturbances in categorical color perception. We tried to investigate the categorical color perception using the color caps of the New Color Test. The subjects were 63 volunteers with normal color vision and 32 patients with homonymous hemianopsia by Goldmann perimetry caused by cerebral lesions. Fifteen hue caps which were subtended at about 2 degrees of visual angle were presented and classified into 4 color categories: red, yellow, green or blue. 7 hue caps were classified into the same color categories in all normal volunteers, but none of the hue caps were classified into the same color categories in the patients with homonymous hemianopsia. Using this test, obvious abnormal behavior in categorical color judgments was found in 12 cases. As a result, it was suggested that this test was very appropriate for investigating disturbances of categorical color perception in patients with cerebral lesions in clinical situations.
A-O16-03

STUDY OF AGE-RELATED YELLOWVISION IN INTERIOR FINISHING COLORS

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Both the number and proportion of older persons in population of Japan is increasing 1% in 1993, with projected increase to 24% in the year 2025. One of these appropriate social support systems for older people is environmental or architectural barrier free design, especially intensive interior color design for the aged vision. One of characteristics of normal age-related vision loss is the loss in one's ability to discern color intensities clearly, and selected films to simulate age-related yellowing levels.

In this paper, we found that the indoor accidental death of the aged increase rapidly, because of failures in discerning boundaries of floors or stairs. We obtained colors' x-chromaticities and brightness ratios (Y) from 329 market interior finishing color samples, including walls, floors, stairs and boundaries, covering with each 3 films, which simulates each the middle or profound level of age-related vision, or without. After analyzing in the color distribution of the chromaticity diagram and brightness ratios, we concluded that considerable colors could be discerned if profitable combination of colors were selected in the interior spaces, such as thick YG and so on, even after being age-related yellowing vision.

After those brightness ratios of finishings were compared mutually safe and healthy colors elections from market interior finishings can be possible, because mutual brightness contrasts in boundaries are within 1.5 to 2.5, of which contrast to be effectively discerned.

Finally, we made a tentative book, "Interior Finishing Colors Concern in age-related yellowing vision" which could be considerably useful to architects or interior designers in their work.

A-O17-01

ASPECTS OF COLOUR PERCEPTION IN AN ELDERLY SWEDISH POPULATION.

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Sweden has the third oldest population in the world after Japan and Iceland. In Sweden the proportion of the elderly persons aged 65 years and older was 17, 6% in 1993, and is estimated to have reached 21 % in the year of 2025. It is especially the number of persons over 80 years of age that will increase rapidly, a period of life when diseases and dependence become characteristic. Many old people in Sweden spend their last years in various kinds of institutions which puts great demands on a functional and aesthetic design. It is essential that the caring environment is clear and easy to interpret in order to help the inhabitants in orientation, taking into account that both poor sight and cognitive disturbances are common problems in old age. Colour could be a helping device in those aspects and therefore information is required about colour perception and the changes of this in old age. A pilot study showed that colour perception seemed to be well preserved in old age despite the influence of dementia, and that patients suffering from dementia gained significant support by colour in a memory task (1).

The overall aim of the project is to get deeper understanding of colour perception of elderly people both regarding with and without dementia diseases. The aim of this study is to describe some aspects of colour perception in a representative group of elderly people from a normal population. The study is part of a longitudinal gerontological and geriatric population study, NORA (Nordic research on ageing) running in Sweden, Denmark and Finland.

The study population consists of men and women 80 years of age (n = 204). The methods include colour naming (22 colours), colour discrimination (4) (4 targets colours in eight variations) colour preferences (7 colours) colour as a memory support and colour as a code. The test instrument is based on the NCS (Natural Colour System).

The result showed that the ability of colour naming was well preserved in the study population. The names of the elementary colours was best recalled (red 1090-R, green 1070-G, blue 2070-B and yellow 0080-Y) and less well for the mixed very light or very dark colours (8010-R50B, 7020-B50G, 6020-R50B, 1050-B50G). The colour discrimination test indicated that it was easier to discriminate between shades of red (target colour 3040 R100G) and yellow (T = 3040 Y10R) than between shades of blue (T = 3040 B100G) and green (T = 3040 G00Y). The most preferred colour in this study was blue (2070 B) followed by green (1070 G), red (1090 R), yellow (0080 Y), purple (2060 R40B) and brown (7030 Y50R). Colour seemed to have a supportive role for the short time memory but not memory over time. The conclusion of the study is that colour perception in old age (80 years) seems to be well preserved. The project continues with studies of colour perception in healthy old age (95 years) as well as people with Alzheimer disease. These results could act as guidelines in designing environments for elderly people.

INDIVIDUAL VARIATION IN WAVELENGTH DISCRIMINATION: TASK AND MODEL ANALYSIS
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Wavelength discrimination functions (420 to 620—650 nm) were determined for four younger (mean = 30.9 years) and four older (mean = 72.5 years) observers. Discrimination thresholds were measured using a spatial 2-alternative forced-choice method combined with a staircase procedure. Monochromatic lights were presented in each half of a 2° circular bipartite field using a Maxwellian-view optical system. All stimuli were equated in luminance for individual observers on the basis of their heterochromatic flicker photometry functions determined with a 10 sf standard of 570 nm light. Each trial began with both hemi-fields filled with light of identical spectral composition, after 4.5 sec, one of the two half-fields gradually changed over approximately 4.5 sec to a specified wavelength and remained at that wavelength for 1.0 sec. The observer's task was to press a button to signal whether a change in color was detected in either the left or right hemi-field.

Although the brightness of the test field was not adjusted during trials, our resultant Δx vs. Δy functions obtained from young observers resembled classic functions shown in the literature. There was a small, but consistent difference in Δx between the younger and older groups of observers even though age-related changes in ocular media densities were compensated by equating the stimuli individually in terms of retinal illuminance. This difference between the two age groups was not systematically related to wavelength.

The data were analyzed in terms of a modified version of the Boynton-Kanbe color discrimination equations.1,2 with a power law. In this model, discrimination thresholds are determined by signals from 3-cones and a second mechanism that combines signals from a luminance mechanism, and chromatically-opponent channels receiving signals from all three cone types. This model provides good fits to individual data sets collected by us and other studies, and has permitted us to analyze individual variations in such parameters as the L/M cone signal ratios in M-L and L-M channels, the relative weighting between M-L and L-M channels, the amount of S-cone contribution to discrimination thresholds, and the Weber fractions and noise levels associated with the two proposed mechanisms underlying wavelength discrimination.


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QUANTITATIVE ANALYSIS OF COLOR APPEARANCE WITH SURROUND STIMULUS
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Color appearance is strongly affected by its surround condition. A color appears to be orange without surround, for example, will appear to be bright white with yellow surround even though its physical condition of the central color is the same. This is of course explained as the effects of blackness induction, simultaneous contrast and so forth. There is, however, no quantitative way to specify color appearance accounts for these effects. The purposes of this study are to quantify color appearance with surround stimulus using a method of color matching under different surround, and to analyze the data to develop a color notation including surround effects. We regard this study as to find conditions of center and surround stimuli under which center stimuli appear to be the same color.

Computer controlled color display monitor was used to present test and reference patches as shown in figure 1. First experiment examined the effects of white surround. Reference center was fixed at (x, y) = (0.42, 0.38) in chromaticity, and test and reference surround were fixed at D65 white. Luminance contrasts of reference patch were set to certain values so that the center appeared to be certain colors ranging from orange to brown. For each reference condition, subject matched color appearance of the test center to the reference center by adjusting chromaticity and luminance of the test center under various luminous test surrounds. Second experiment examined the effects of colored surround. Grays made of white contrasts were used as reference, while test surround was colored. Red, green and blue phosphors of the monitor were used as test surrounds. For each reference gray, subject did the same task as the first experiment under various luminous test surrounds.

The results showed clear effects of blackness induction for the first experiment, and color induction for the second experiment. We analyzed the data using cone tristimulus values for center and surround stimuli. Denote that Ps, Pm and Pn are the L-, M- and S-cone tristimulus values of the center, and that Ps, Pm and Pn are those of the surround. We found the relations of Pn = Pn + CnPm, Pm = Pm + CmPs and Pn = Pn + CnPs for the centers appear to be the same, where Pn, Pn, Pm, Pm, Cn, Cn and Cm are constant when color appearance of the center is the same and Cn, Cm and Cm are always constant (n=0.7) regardless of the color. These equations can be utilized to develop color notation including surround effects.
A-017-04

COLOR VISION MODEL FOR OPPONENT AND CATEGORICAL COLOR PERCEPTION

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Names can be assigned to color perceptions in several ways. The most general one is to color vision research is an opponent-color system using elemental color naming whereby all perceptions are expressed in terms of red, green, yellow, blue, white, and black. An author is categorical color naming in terms of a limited number of basic colors: red, green, yellow, blue, purple, pink, orange, brown, white, black and gray. The goal of the present study is to construct a unified model for opponent and categorical color perception. To accomplish the purpose, we first quantify the opponent color mechanism as the function of LMS cone activities, and next analyze the neural circuit of categorical color mechanism by comparing the results of the two color naming methods. To present the stimuli we used the NRC Trichromator driven by a computer. The visual angle of the test colors was 2 degrees and their intensity was 100 Td. We used three different surround conditions. With a dark surround (no surround condition), the test colors appeared self-luminous whereas with a bright white surround they appeared as surface colors. Subjects described the appearance of 78 test colors using elemental color naming and categorical color naming methods. To analyze the relationship between the opponent responses and LMS cone activities, we plotted the data using functions of L, M and S. The results show that L-M+S and M-L-S mechanisms contribute to red/green opponent perception, and that L-M-S and M-L+S mechanisms contribute to yellow/blue opponent perception. These functions are similar to those in a multi-stage color model by De Valois et al. L and M cones are connected to the opponent system linearly but the contribution of S cone activity showed non-linear. Also, by mapping the neural activity on a color space, we were able to plot the areas of basic colors without overlapping. This result means that we can determine a function relating the categorical response to the elemental response, and can develop a color perception model. We determined an network model using AND-gate circuits of the opponent color responses for categorical color responses. Using our model we can predict color appearances in opponent and categorical perception from colorimetric coordinates. We will discuss relationships between our model and several aspects of color perception such unique hues.

A-017-05

ANALYSIS OF COLOR-OPPONENT PROCESSES IN THE RETINA OF THE PIRANHA

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Spectral responses were recorded from in vivo horizontal cells in the light-adapted retina of the piranha. The horizontal cell system of the piranha was basically the same as that of goldfish, it consisted of one L-type, and two C-types, namely RG-type and RGB-type. However, the spectral response curves of RG-type horizontal cells had some variations. Each phase of piranha's horizontal cells covered much longer wavelength in comparison with that of goldfish. Especially, high sensitivity for the far red light was remarkable. Referring to cone absorbance data, the underlying neural mechanisms for the far red vision of the piranha were discussed. It was concluded that the spectral sensitivity of red cone and green cone, and the sign-opposition of cone inputs to RG-type horizontal cells play important roles on the far red vision. An analysis of the color-opponent processes applied for the spectral properties of horizontal cells was suggested by a psychophysical method for human color vision.
A-O18-01

INFLUENCE OF COLOR MEMORY ON COLOR CONSTANCY

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When we see a color sample under various illuminations with different color temperatures in everyday lives the color sample usually appears the same so that we can recognize the same color sample. This phenomenon is called color constancy. In these situations we judge color appearance using memory since there is time delay between the first and the second look of the color sample. The present study aims to measure how much degree of color constancy is obtained when color memory is involved in color appearance judgment. The OSA Uniform Color Scales was used as stimulus color samples. Four illuminations of 1700, 3000, 6500, and 30000K were tested. The observer adapted to a test illumination for ten minutes, and saw a test color sample under the same illumination to store its color in his memory. Then after five-minute adaptation of the D65 illumination, he started selecting a matched color sample with his memory among all 424 OSA color samples. We used twenty color samples as test stimuli and adopted the cascade color matching method, in which the numbers of selecting color samples were gradually reduced in four stages. At the stage 4 the observer must select a matched color sample. It is shown in our results that degree of color constancy, defined as the distance between the \( u^* \), \( v^* \) chromaticity positions of a test color and a matched color, was quite good and almost constant across all illuminations tested. This suggests that we have a color constancy mechanism in our color memory.

A-O18-02

ABOUT COLOR NAMING

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First of all, the history of color naming as a tool for the (visual) assessment of color appearance is briefly presented and up-to-dated. Next, three experiments performed by us are described, where the color naming technique is used:

1. The (transient) time patterning conditions are quantified where the basic constraint, according to which red and green (or yellow and blue) cannot be simultaneously perceived, is violated, resulting in a compromise between transparency and discounting the background.

2. Color appearance is assessed for the caps of F-M 100 Hue test, both in isolation and paired, on various backgrounds, from uniformly black (even wearing black gloves) to increasingly structured, both in foveal and extra foveal vision. In this latter case, the concept of "reference" or comparison is faced with that of "contextual" influences (by taking "learning" into the due account).

3. All existing hue names are listed, from unique hues (ingredients of color naming through the monolectic basic terms), to those related to real and familiar objects. Through a memory exercise, the latter are located in an Atlas. The inter - and intra - observer variability is discussed in relation to perceptual constancy (the existence of which for intra-category items being a matter of controversy).
A-O18-03

DIFFERENCES IN COLOUR NAMING BETWEEN CHINESE AND BRITISH
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Colour categorization has been identified as an important cognitive function which enables people to categorize a colour into a specific colour group. Colour naming which people use to describe colours could be one of the methods to study colour categorization. In this study racial differences in colour naming between the Chinese and the British were investigated. The results were also used to study gender and age differences. This whole experiment was divided into two parts using both unconstrained and constrained methods.

Part One of this experiment included 50 British and 80 Chinese. The Chinese subjects were further subdivided into 40 adults and 40 children. All the Chinese subjects are Taiwanese who speak the same language as in mainland China (Mandarin). 200 ESCC-NBS colours were used. Each colour with a size of 150 mm x 115 mm was mounted onto a medium-grey card (300 mm x 260 mm) with a D6 of 35. Each Chinese subject was asked to name each colour under a D65 daylight simulator. The British results were obtained from the Sung and Terrane study in which subjects performed the same task but using natural daylight. The experiment resulted in a large set of colour names database. The data analyses were carried out to calculate naming frequency for each group and subgroup, and their codabilities (consensus in naming colours). Finally, those names were grouped using 7- and 4-category methods to find the cultural, gender and age differences. As a result, the most important basic and modifier terms in both languages were found.

Part Two of the experiment used a constrained method including 20 British and 20 Chinese adults. All the experiments were conducted under a D65 simulator. The Natural Color System (NCS) was used with 1526 colours (15 mm x 12 mm). Each subject was asked to find the colour for the 11 basic names (white, black, grey, red, yellow, green, blue, orange, purple, brown and pink), together with 8 modifiers of 5 constant hues in terms of one colour (focal colour) and a colour region (colurt volume). The results were then mapped on the NCS and CIELAB colour spaces to show cultural differences.

The results from the two parts of this experiment were also used to verify each other in order to establish the relationship between colour category and colour names.

A-O18-04

VISUAL DETERMINATION OF HUE SUPRATHRESHOLD TOLERANCES
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A visual experiment was performed to generate suprathreshold tolerances sampling the direction of CIELAB hue, thereby extending the RIT-DuPont dataset. Thirty nine color centers including three complete hue circles at different lightness or chroma levels and three of the four CIE recommended colors (red, green, blue) were evaluated for hue discrimination. Forty five observers participated in a forced-choice perceptibility experiment where the total color difference of 293 sample pairs were compared with a near-neutral anchor pair stimulus of \(L^*a^*b^* \). The illuminating and viewing conditions recommended by the CIE were followed. A total of 32,226 visual observations were made. The color-difference pairs varied predominantly in hue. However, due to precision limitations of the digital printers used to produce colored samples, there was significant variability in lightness and chroma. Accordingly, the statistical method, logit analysis with 3-dimensional nomrl function, was used to determine the hue discrimination suprathreshold for each color center, rather than the usual 1-dimensional probit analysis. This technique enabled estimates of only hue discrimination. The results indicated that the hue discrimination suprathreshold of observers varied with CIELAB hue angle. The suprathreshold also increased with the chroma position of a given color center. The results were compared with current color-difference formulae, CMC, BFD and CIE94, and a model derived from the visual results. CIE94 had the poorest performance \((0.56\text{ RMS error})\), expected due to a lack of hue angle dependency. However, CMC and BFD resulted in only marginal improvement \((0.45\text{ RMS error for both formulae})\). An optimised model, based on the product of a fourth order polynomial and a higher-order cosine wave, reduced the RMS error to 0.22. Combining these results with the RIT-DuPont data set may lead to improved color tolerance metrics.

NEON COLOR SPREADING IN A FIGURE WITHOUT SUBJECTIVE CONTOURS
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Neon color spreading occurs usually on subjective contour figures such as Ehrenstein patterns, Kanizsa patterns. The color of the segments inside the subjective figure spreads out all over the figure, giving rise to the perception of a slightly tinted transparent surface floating above the pattern. The close relationship between neon color spreading and perception of subjective contours and transparency has been reported in the literature.1) We report here neon color spreading in a figure without distinct subjective contours. This figure is a checker board pattern, on each crossing point of which a small square patch is placed. The checker board pattern is rotated by 45° from vertical, so that each corner of the square patches is on a line of the checker board pattern. Neon color spreading is seen in bands that connecting the patches either vertically or horizontally in the figure. In the experiment, we asked subjects the direction of neon color spreading (vertical or horizontal) with changing the luminance of the two colors of the checkers and that of the square patches. The results showed that neon color spreading occurred when the luminance condition was appropriate. This indicates that color spreads even in the figure that does not contain distinct subjective contours. On the other hand, the prediction of neon color spreading occurrence from Meselli's transparency law for variable luminance conditions shows relatively good agreements with our experimental data. This suggests that neon color spreading has closer relationship with transparency than subjective contours.

2) K. Nakayama, S. Shimojo and V. S. Ramachandran, Perception 19, 497-513(1990)

COLOR ASSIMILATION BETWEEN STRIPS DISPLAYED ON CRT WITH DARK BACKGROUND
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Color assimilation between strips displayed on CRT has been quantitatively studied with dark background. Results of experiments and possible algorithms underlying this phenomenon will be presented. As the author has previously reported[1] on preliminary results using simultaneously displayed strips of primary colors, the color of a strip changed as if the color of the neighboring strip was additively mixed. As preliminary results indicated, color assimilation occurred as homogeneous modification of hue within an elementary region of visual target within which the hue was expected to be homogenous. Extent of color assimilation greatly depended on the hue of induction strip as well as on the relative luminance of strips: in a series of experiments with changing brightness, the color of a brighter strip was apt to assimilate to the color of a neighboring darker strip. Color assimilation was observed in every combination of primary colors in some range of relative brightness, although in our previous report[1], color assimilation was not observed when induction field was green under the condition in which primary colors were displayed in their maximal brightness. The fact that color assimilation occurred in such a way that the hue of a region was uniformly modified suggests that the assimilation occurs at a fairly high level in the visual system. To investigate temporal relation between the induction strip and the test strip, additional experiments were performed in which they were displayed in short-duration, e.g. 100ms, with various time difference. The results show that the maximal color assimilation occurred with no time difference. At the same amount of time difference, color assimilation was stronger when the induction strip was displayed later than the test strip than when the induction strip was displayed earlier. This seems to be due to the fact that the impression of the induction strip after temporal display is stronger when it is presented later. In conclusion, color assimilation seems to depend on the strength of impression of the neighboring color stimuli.

B1-O19-01

DESCRIPTION OF THE PLANETARY COLOUR SYSTEM
Professor Michel Albert-Vane
ENSAD: Ecole Nationale Superieure des Arts Decoratifs de Paris

Following the HERING's theory, 6 fundamental colours are responsible for the whole of our colour perceptions. The visual field of the observer can be compared as a "window" inside which these fundamental colours enter into combinations in variable proportions to constitute the "colour groups".

B1-O19-02

THE EXAMINATION OF THE VALIDITY OF THE FOUR PRINCIPLES OF COLOR HARMONY
BY JUDD,D.B. ON STREETSCAPE EVALUATION
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In recent times, as importance of color control in a streetscape is increasingly recognized, the color harmony should be studied in order to apply to color planning. In this study, various feelings of the scale models that have color variations on wall colors were evaluated using semantic differential method. The evaluated feelings contain the scales of the four principles of color harmony by Judd,D.B. (principle of "order", "familiarity", "similarity", "unambiguity"), "harmony" and other impressions relate with streetscape evaluation.

As a result of this experiment, "order" and "similarity" feeling show high correlation with the "harmony" feeling, but "familiarity" and "unambiguity" feeling have low correlation with that. This result leads us that the color harmony feeling is based on "similarity".

Furthermore, it is indicated on factor analysis that "preference" and "beauty" relate with not only color harmony feeling but also the factor "cheerfulness".
A Study on the Influences of Color Interval and Area Factor on Color Harmony

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Le-Cherng Ou

Institute of Applied Arts
National Chiao Tung University
Hsinchu, Taiwan

Moon and Sponer's formula is probably the most ambitious and innovative attempt to propose a neat and integral formula of color harmony in the past. In this formula, color intervals and area factor dominantly affect the prediction of preference for color combinations. They classified the intervals of color combinations along the three attributes of color, respectively, into identity, 1st ambiguity, similarity, 2nd ambiguity, contrast, or glare according to the length of an interval. However, this formula has been seriously attacked for the lack of empirical evidence to support it. Furthermore, as the three attributes of color are perceived simultaneously, there is no reason to consider the interval separately. Thus, in this study, we adopt the distance between a pair of colors in a uniform color scale space as an integrated index of color interval in a series of experiments. In the first experiment, various color combinations with controlled color intervals were presented one by one on a computer monitor for subjects to rate the degree of harmony. By analyzing these data, the relation between color harmony and color interval has been established and various pleasing and displeasing intervals have been identified. In the second experiment, the subjects were asked to adjust the area of a color in a color combination on the screen until the most harmonious result was perceived. In this way, the influence of area factor on color harmony has been decided and an appropriate definition of scalar moment has been proposed. A third experiment was conducted to confirm the above findings and to survey the preferred color of each subject. Finally, based on the empirical findings from these comprehensive experiments, we have proposed a practical formula of color harmony with variables of color interval, deviation from the ideal ratio of area, and index of color preference.

Keywords: color harmony, color interval, area factor, scalar moment, color preference

CHARACTERIZING THE VISUAL PERFORMANCE OF FLUORESCENT RETROREFLECTIVE SIGNING MATERIALS USING THE FLUORESCENT LUMINANCE FACTOR, Y_F

David Bums and Norbert Johnson

3M Company, St. Paul MN, USA

The luminance factor of a fluorescent material can be readily separated into reflected and fluorescent components using one- and two-monochromator spectrophotometers capable of fluorescent colorimetry. The fluorescent luminance factor, Y_F, is the ratio of the fluorescent luminance of a specimen to that reflected by a perfect diffuser similarly irradiated and viewed, whereas the luminance factor (CIE tristimulus value Y) is the ratio of the total luminance of a specimen to that reflected by a perfect diffuser. The Y_F value is the critical parameter which differentiates fluorescent materials from high luminance non-fluorescent materials. Under the varying conditions of daylight illumination encountered in outdoor signing applications, it has been shown that Y_F values relate to the increased visual performance of fluorescent signing materials. The retained Y_F after exposure is also a good measure of fluorescent durability. It is recommended that the quantity Y_F be used as a standard measure of fluorescence.
COMPARISON OF SPECTRAL DISTRIBUTION BETWEEN A LUMINAIRE COMBINING RGB FLUORESCENT LAMPS AND A WHITE LAMP
Shigeo Gotoh, Hiroyasu Takeuchi
Matsushita Electric Works, Ltd.

We have developed a lighting system to control color and color temperature by using red, green, and blue fluorescent lamps. Separate fluorescent lamps of each color reside in a luminaire that allows the illuminance of each lamp controlled separately by the lighting control unit. Applying the principles of additive mixture by controlling dimming ratios of each lamp, this system can continuously vary the correlated color temperature (CCT) from 3,000K to 30,000K. The system can deliver white light, or it can yield colored light within the triangular region bounded by the x and y coordinates of red, green, and blue light sources on a chromaticity diagram.

We measured the spectral distributions of this system at CCTs of 3,000K, 5,000K, and 6,700K and compared them to the spectral distributions of conventional, white, triphosphor fluorescent lamps of corresponding CCTs.

We found no special difference in the spectral distributions between our system and the conventional lamps; namely, xy, CCT, and DUV are almost the same. General color rendering index (Ra) is more than 85 in all conditions.

We conclude that our system of combining RGB lamps can yield continuous variations of CCTs and colors those are unobtainable by conventional lamps in addition to the characteristics of a conventional lamp.

Cancelled
B1-O20-04

Quantitative Analysis of Color Features in Paintings
--Classification based on Distance of Color Distribution in Color Space--

Mito Kobayashi1 and Takuzi Takuzi2

1 University of Electro-Communications, 2 National Museum of Japanese History

When looking at paintings, we are attracted to their color composition. Our aim is to analyze color features of paintings quantitatively.

Our past studies are: contrast analysis in hue-tone space and in lightness-chromaticness space; analysis of color arrangement on canvas; and analysis of shape of color distributions in color space.

In this study, paintings with conspicuous traits of colors are classified into several groups, based on the similarity of color distributions in a color space. To construct a discrete color distribution, the finite number of representative colors are extracted from the image of a painting. Since it is difficult to define distances of discrete color distributions, discrete distributions are transformed into continuous distributions by applying a Gaussian function. Then usual $L_2$ distances for continuous functions are adopted to represent similarity of color distributions.

Fifty-two samples of works of three famous painters, Caravaggio, Franz Marc, and Maurice Utstil, are selected, and every distances of each sample in CIELUV space are calculated. The analysis was done by the typical method used in the computational linguistics. The results show that the mean values of distances in the works of the same painter are less than that of the other painter. Moreover, applying the hierarchical cluster analysis to draw a dendrogram, the paintings are grouped successively in the order of the similarity of their color features, so that the works of the same painter are well clustered.

B1-O20-05

THE NEW CIE COLOUR RENDERING FORMULA AND ITS TEST

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The internationally used colour rendering calculation method dates back to the early 1970s, when the uv chromaticity diagram and the $U^*, V^*, W^*$ colour space were in use. CIE TC 1-33 was charged to update this method. The TC practically concluded its task and recommends a new method based on the CIELAB colour difference formula both to determine the reference illuminant and to calculate colour differences between the test sample colours illuminated by the test lamp and the reference illuminant.

Test samples are selected from the Macbeth ColorChecker, and colour difference calculations are performed after chromatic adaptation transformation from test and reference source chromaticity to D65 illuminant using the CIE 109-1994 (Nayatani) transformation.

An adjustment of the colour difference - colour rendering index transformation constant was made so that the average of the Ra general colour rendering indices for a selected sample of current practice light sources stays constant, making the transition from the old system to the new one easier.

The paper will discuss the principles of the new method and will show what type of changes can be expected for a number of practical light sources.
B1-O21-01
THE INFLUENCE OF MEASUREMENT GEOMETRY ON THE ORDINARY AND FLUORESCENT COLOR COMPONENTS OF PRISMATIC RETROREFLECTIVE MATERIALS
Norbert Johnson and David Burns
3M Company, St. Paul MN, USA

A new two-monochromator goniospectrofluorimeter for colorimetry has been used to study the angle related fluorescent properties of prismatic retroreflective materials. This instrument uses the two-monochromator method for measurement of fluorescent color. The detector monochromator is mounted on a moveable arm such that the light from several directions can be analyzed. The light beam on both the illumination and viewing side is highly collimated. The results of the study show that the ordinary component of color is highly dependent on the exact angular setting of the prismatic reflector cube faces while the fluorescent component is less sensitive to changes in geometry. The results are plotted in the CIE system of colorimetry.

B1-O21-02
WHERE CAN FLUORESCENT COLORS BE FOUND ON THE CIE-CHROMATICITY CHART?
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The CIE chromaticity chart is the basis for colorimetry and most widespread used. It is based on the standard color-matching functions according to the systems defined by the CIE in 1931 and 1964. As such any color is found in a three-dimensional space defined ordinately by the coordinates (x,y,Y). The system can be visualised as a bounded volume also known as Rösch color solid. The boundaries are defined by so called optimal colors, that represent the maximum possible excitation purity for a given luminous reflectance at a given dominant wavelength. The maximum value for the luminous reflectance is given by the ideal total reflector and is assigned a value of Y=100, it corresponds to the maximum value attainable under normal conditions. This value is used also to normalize the color matching functions resulting thus in a bounded volume in space.

Light can also be emitted by a body as fluorescence, the light originates in excitation of molecules present in the body by absorption of light at lower wavelengths i.e. of higher energy, the energetic content of light is however not directly considered by colorimetry. Color matching functions represent parts from a trichromatic light set needed to match the observed light, they are not directly connected to the energetic content of the light. An extreme situation results when observing fluorescence coming from fluorescent optical whitening agents that increase actually the energy content of the visible light window by "pumping" energy from the invisible ultraviolet. When dealing with fluorescent dyes it may happen that the calculated color coordinates define a point lying actually beyond the boundary defining the color solid.

In the present paper the color solid has been extended to include light originating from fluorescence phenomena. This is achieved by defining a new set of optimal color stimuli that is built by mixing a given "pure" reflectance optimal color with a "fluorescent" set added on top of it. The resulting color solid is characterized by a higher total luminous reflectance than the corresponding "pure" reflectance one, it can be set arbitrarily to Y=200 or to any convenient number such that no point can lie outside of the new defined color solid. The appearance of the color solid is dependent on the illuminant used, since the spectral distribution of the illuminant influences the amount of fluorescence physically possible and is a result of the strong appearance changes of fluorescent objects under different illuminants. Color solids corresponding to different illuminants are shown and discussed, as well as coordinate shifting for actual fluorescent dyes upon changes in spectral distribution of exciting light. Special emphasis is put on fluorescent whitening agents since the appearance of white is strongly dependent on the fluorescence of the sample under observation.
B1-O21-03

MV-I of COLOUR - DIFFERENCE FORMULA
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This paper aims to give a brief review of problems occurring in the developing of colour - difference formula. Most of the problems mentioned are well known, but are often forgotten.

Work in area colour differences has concentrated on collecting reliable data and developing equations which describe the perceived colour - difference results. Equations have been developed on base of the CIExyz (CIELCH) colour space with application weighting difference components such as DL*, DC* and DH*. Weighting functions S1, S2, S3 are computed from regression analysis using linear (CIExyz(I.I)) or hyperbolic model (CIMCF(I.I)).

In this paper are some discussed problems of CIE-Helmholtz "General Form of Color Difference Formula Based on Color Discrimination Ellipsoid Parameters", second is described a new colour - difference formula MV-I. This colour - difference formula has been developed using the different orders of regression analysis using mainly textile data sets. MV-I colour - difference formula in similar structure to the BFD (R-C) formula in most respects. However, it was found on CIELCH colour space and linear regression model for weighting of lightness, chroma and hue differences:

\[ \Delta E_{MV-I} = \sqrt{\left(\frac{\Delta L^*}{L^*}\right)^2 + \left(\frac{\Delta C^*}{C^*}\right)^2 + \left(\frac{\Delta H^*}{H^*}\right)^2} \]

The MV-I colour - difference formula represents a slight improvement over the BFD (R-C) formula for acceptability results and considerable improvement over the CMC(I.I) and CIE1994 formulas, as we can see on table:

<table>
<thead>
<tr>
<th>CRITERIA / EQUATION</th>
<th>CMC (2:1)</th>
<th>BFD (2:1)</th>
<th>CIE1994 (2:1:1)</th>
<th>MV-I</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta E )</td>
<td>0.7076</td>
<td>0.7005</td>
<td>0.6847</td>
<td>0.7079</td>
</tr>
<tr>
<td>( \Delta E )</td>
<td>1.2324</td>
<td>1.2324</td>
<td>1.2314</td>
<td>1.2324</td>
</tr>
<tr>
<td>CV</td>
<td>45.6022</td>
<td>44.6043</td>
<td>43.9957</td>
<td>44.8706</td>
</tr>
<tr>
<td>( \Delta E )</td>
<td>0.3117</td>
<td>0.3117</td>
<td>0.3117</td>
<td>0.3117</td>
</tr>
<tr>
<td>( \Delta E )</td>
<td>155.6453</td>
<td>145.0246</td>
<td>147.5035</td>
<td>145.2457</td>
</tr>
<tr>
<td>( \Delta E )</td>
<td>0.7076</td>
<td>0.7005</td>
<td>0.6847</td>
<td>0.7079</td>
</tr>
<tr>
<td>( \Delta E )</td>
<td>248.2838</td>
<td>262.6897</td>
<td>258.2457</td>
<td>293.7253</td>
</tr>
<tr>
<td>( \Delta E )</td>
<td>20.2737</td>
<td>17.4263</td>
<td>22.3201</td>
<td>15.9017</td>
</tr>
</tbody>
</table>

B1-O21-04

A UNIFYING APPROACH TO THE COLOUR SENSITIVITY AND THE COLOUR CORRECTABILITY OF A COLOUR MATCHING RECIPE
Horm Slabun, Department of Mechanical Engineering, University of Maribor, Slovenia

The paper discusses the recently introduced quantities the colour sensitivity and the colour correctability of a colour matching recipe. The quantification of the colour sensitivity of a recipe was stimulated by the need to compare the stability-related properties of various possible recipes for the same target colour. The partial colour sensitivities and the overall colour sensitivity are quantified according to the colour differences caused by small perturbations of colourant concentrations in a recipe. Similarly, the quantification of the colour correctability of a recipe resulted from the need to compare the ability of correcting the colour of various possible recipes for a given target colour. The definitions of directional and overall colour correctability are based on the magnitude of the concentration changes needed to produce a unit colour change \( \Delta E = 1 \) in various directions in colour space.

In the present paper the above concepts are refined and generalised. Further, the treatment of both quantities (sensitivity and correctability) is unified either in the concentration space or, equivalently, in colour space. The concept of colour balance of a recipe is revised. The results of an experiment, where the predicted numerical values of sensitivities and correctabilities have been compared with the experimental values obtained in textile dyeing in laboratory conditions, are added for illustration.

B1-O21-05

PARAMETRIC COLOUR-DIFFERENCE EVALUATION USING LARGE COLOUR DIFFERENCE PAIRS
Shi-zhong Guan and M. Rommet Looi
Design Research Centre, University of Derby

Many viewing parameters could affect the perceived colour difference of a pair of samples. The CIE Technical Committee 1.28 on Parameters Affecting Colour-Difference Evaluation was formed to investigate this problem. A large scale experiment was conducted to study effects including sizes of colour difference (large versus small), scaling methods (grey scale against past comparison) and different parameters including separations, background colours and luminances. The results from the latter are given here using large size colour difference pairs (mean CIELAB DE of 13).

The experiment was divided into six phases according to the different parameters studied: two separations (hairline and a 3-inch gap), three backgrounds (luminance factors of 89, 24 and 4 for white, grey and black respectively), and three luminances (1200, 430 and 12 cd/m²). Wool samples were dyed using acid dyes corresponding to 8 colour centres. 8 pairs were prepared for each centre covering all directions. In total, 64 pairs were produced. For each phase, each pair was assessed 20 times by 10 normal colour vision observers using a grey scale method. The colour-discrimination ellipsoids were calculated to compare different parametric effects. In addition, the visual results from different phases were compared to verify ellipsoidal results. The results show that there is little difference for the separation and luminance parameters studied, but a systematic trend was found for white, grey and black backgrounds. Finally, this data was used to test 4 colour-difference formulae: CIELAB, CMC, BFD and CIE94. The detailed results will be presented in the conference.

B1-O21-06

PROBLEM OF RED HUE AXIS IN COLOUR-DIFFERENCE EVALUATION OF NEAR GREY COLOURS
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Linearity and additivity of colour-difference scales near threshold were studied with sets of physical colour samples produced along main axes of colour-difference ellipsoids of x,y,Y-space at five CIE colour centres. In CIE grey an abnormal situation with the red axis was observed. For the chromatic colour centres the ellipse axes at constant lightness could be identified to be rather close to appearance attributes of hue difference and chroma difference. For the grey colour centre, therefore, an equivalent identification of yellow - blue and red-green directions with the ellipse axes was expected. Indeed, this approximately was true for the yellow, blue, and green directions, however, not for the red direction which in the chromaticity diagram significantly is tilted in the direction of the yellow axis. A vector model of colour-difference scales with a bluish-red axis perpendicular to the straight yellow-blue axis better predicts scales of colour difference than a model including the tilted red axis. This reflects the situation known from atlas studies: if one approximates blue from yellow by constant hue discrimination steps via red one finds more number of steps in the bluish sector than in the yellowish sector. A colour-difference model for near grey colours, therefore, should not include the red direction as a main axis.
B2-O22-01

COOPERATION OF FIGURE AND COLOR CODE STUDIED BY REACTION TIME TO COMMONLY USED SIGNS CHARACTERIZED IN BOTH FIGURE AND COLOR CODE

Hiroyuki Shinoda,1 Shingo Nakamura,1 and Mitsuo Ikeda2
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2Department of Photonics, Ritsumeikan University

We measured subjects' reaction time to signs defined in both figure and color code. In the experiment two pairs of common signs were used, which are public convenience signs for expressing the gents and the ladies and signs used at unattended wicket gate in subway stations for expressing an entrance and an exit. The gents (or the ladies) sign is a male (female) silhouette colored blue (red). The entrance sign is a ring-shaped figure, “manu” in Japanese, colored green. The exit sign is a cross-shaped figure “batsu” colored red. The subjects were required to push a joystick in certain direction according to the figure of the sign, regardless of its color. That is, s/he had to push the joystick leftward when a male silhouette or “manu” appeared and rightward when a female silhouette or “batsu” appeared. In a few trials (inconsistent coding trials) the sign was presented in opposite color, e.g. the male silhouette colored red, in other trials (consistent coding trials) the sign appeared in its original color. The signs were successively presented on CRT in random order. The presentation was controlled and the reaction time and the tilt directions were recorded by a personal computer. The reaction time for the inconsistent coding trials were longer than that for the consistent coding trials. In addition to that, more errors were recorded in inconsistent coding trials. The result shows the cooperation of figure and color code in consistent coding while incorporation in inconsistent coding.

B2-O22-02

THE TRANSLUCENT COLORS IN HOUSING

Karine Pinaud
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Brick glass color is the subject of a contemporary industrial research. My study deals with problems caused by the insertion of a colored translucent vertical panel made up with brick glass inside an habitable space. My investigation goal consists in how to improve the connection from the person to the individual housing in an emotional and territorial dimension. This way the use of brick glass allows me to set up a new color translucent design in housing.

In this project first of all the color gives an identity to the individual housing. This notion, where the living space can be defined thanks to the colored atmosphere, it’s based all as well on the idea that this color takes part in “social style” such as it’s stated by Shigenobu Kobayashi.

Then the color has a plastic dimension. It creates seductive and cloudy effects, and has evocative mechanical properties which allow it to be actualized; to be modulated in the time, by the means of several factors like luminosity, humidity, heat...

My work will consist in showing that it’s possible to conceive the habitable space, which is at the same time a social meeting place and a private one, according to a more sensitive approach where the color creates the place and the path thanks to the colored atmosphere, and no longer according to local functions (social functions of the rooms induced movements).

The colored translucent modelisation in housing is the result of this approach.
THE COLOUR AND THE ROOM
- EFFECTS OF SIMULTANEOUS CONTRAST, REFLECTIONS AND ILLUMINATION ON COLOUR APPEARANCE IN A ROOM

Monika Billger, Department of Building Design, School of Architecture, Chalmers University of Technology, Goteborg, Sweden

A room represents a complex situation. The relation between the shape and size of the room, the illumination, the material, and colour qualities, as well as how coloured surfaces are combined, are all important for how colours appear in a certain situation. Through our studies of colour appearance in small scale models, full scale rooms, and in existing buildings, we aim for a deeper understanding of the co-operation between these factors. We have studied effects of different colour combinations and the relation between some colour combinations and different light sources in a room. In my presentation I will discuss some of the observations.

Colour research, so far, has mainly presented studies of how coloured areas affect each other in two dimensions. Colour combination effects that are perceived in pictures do not necessarily show in three-dimensional spatial situations. From our previous studies, it was obvious that equally painted surfaces had different colour appearances if they were placed (1) in a juxtapositional combination with another coloured surface, or (2) if the surfaces adjoined each other in a corner or (3) if they were placed opposite to each other. Effects of simultaneous contrast were only noticed in the first case, while effects of reflections were obvious in the latter cases. This seemed as the effects of reflections from coloured surfaces reduced or dominated the effects of simultaneous contrast. However, could these two or three-coloured rooms contain a spatial simultaneous contrast effect compared to a uniformly coloured room, despite the effects of reflections, or does the total impression of colour appearance of the coloured surfaces dominate over the effects of reflections?

These phenomena are investigated in an experimental room, in which I study combinations of two and three colours, and of the room as uniformly coloured. The room is also studied in different illuminations to compare the colour combination effects between the situations.

COLOR REPRODUCTION USING LOW DIMENSIONAL SPECTRAL REFLECTANCE

Takayuki Sato*, Yoshiki Nakano*, Teiho Ota* and Shige Umai*
*Teiho Ind. Mfg. Co. Ltd. (Japan), †Toyohashi University of Technology (Japan)

Computer-controlled color devices, such as digital cameras and color printers, are widely used for color desktop publishing in recent years, but they include the problem of device-dependent color reproduction. Therefore, a colorimetric color reproduction method is generally used for color matching. However, the difference of captured colors in the image, which depends on the illuminant, can't be corrected by this method. That is, digital cameras will capture the different colors if the illuminant is different, and we can't correct the colors.

We think the following method is one way to solve the problem. First, the device values are transformed to the spectral reflectance, which is a physical characteristic of the object and independent of the illuminants. Next, colors are reproduced using both the spectral reflectance and the chosen illuminant.

In this study, we propose the color reproduction method which uses the low dimensional spectral reflectance. It estimates the spectral reflectance from the device- and illuminant dependent color values, and reproduces colors using the illuminant information which we choose.

The estimation uses the principal component analysis (PCA) and a neural network (NN). Firstly, the color values are converted to the low dimensional spectral reflectance (PCS, principal components), which is calculated by PCA. We use NN for this non-linear conversion. Secondly, the spectral reflectance is reconstructed to PCS.

The accuracy of the estimation in this method is that the average color difference is about ΔE*ab=5.0 (CIE D50, 2 degree).

COLOR REPRODUCTION ESPECIALLY DESIGNED TO BE USED FOR NONIMPACT HARDCOPY OUTPUT DEVICES

Prof. Dr. Werner SOBOTKA
Institute for Telecommunication and Media, St. Poelten, Austria

The paper is dealing with different types of nonimpact color output devices like inkjet, electrophotography and thermography. The different types of creating color will be discussed and investigations were carried out, to find overall aspects for color reproduction, using commercial color separation programs. Investigations were also carried out, how the viewer of such products is perceiving color printed with different inks and toners. Also the optimal use of substrates for special nonimpact technologies will be shown.

How important is for the viewer, if the colorants are fused on the substrate surface or are penetrating in the paper surface. Are these facts used also as parameters for "colormanagement" for different types of output devices.

Are commercial products equipped with the possibilities to put the above mentioned data in their calibration procedures to achieve better results for the viewer.

DEVELOPMENT OF "PRINTING SIMULATOR"

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1Research Laboratory, Daishin Screen Manufacturing Co., Ltd.

As more prepress systems become open to interfacing and communicating with other systems, more prepress printing production is produced by employing computer networks, and color monitors for displaying soft proofs. Soft proofing methods provide a way to easily simulate and preview printed results on a monitor.

This paper describes a new method for rendering printed pieces realistically on a monitor based on the spectral reflectance data. It has been found that the reflected light from printed pieces can be modeled with the Extended Phong Model which is defined as an extension of the Phong Model in computer graphics. The algorithm to verify the applicability of the Extended Phong Model to color reproduction produced via the conventional offset printing process has been presented.

We apply the extended model to displaying the colors made by overprinting up to the four kinds of solid ink (i.e., cyan, magenta, yellow and black) and their gradations, by a process printing press on coated and woodfree papers. In this presentation, first, we describe the Extended Phong Model. Next, we propose an new interpolation method of the specular and body reflectance components in the reflection model. Finally, we show the results simulated on a monitor by the proposed method and compare these with the measured results.

A COLOR CONVERSION METHOD USING A NEURAL NETWORK FOR A CROSS-MEDIA COLOR APPEARANCE MATCHING
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In order to achieve a color matching under different media and viewing conditions such as the luminance and the white point of the illuminant, several researchers have proposed cross-media color imaging methods using the color appearance model. However, these methods lead to the problem of the characterization of the colorimetric device property by a color conversion. That is, while the color appearance can flexibly be predicted under various viewing conditions, a conventional color conversion method using a look-up-table or a neural network is generally calibrated for only standard illuminant (e.g. daylight illuminant D65 or D65). Therefore, if the illuminant is changed, a look-up-table or a neural network have to be re-calibrated in order to perform the color conversion accurately. To overcome this problem in a practical color appearance matching, an independent color conversion method of the illuminant changes is required.

This study presents a new color conversion method using a three layered neural network. In the proposed method, the spectral reflectance is newly adopted as an intermediate color representation between the colorimetric and the device value. A color conversion is accomplished in two steps: first, the device value of the destination device is transformed to proper spectral reflectance by a three layered neural network, and in the second step, the input value of the neural network (device value) is adjusted so that the squared norms between the given and the calculated colorimetric value is minimized by a nonlinear optimization process. For evaluating the proposed color conversion method, we transformed the colorimetric value under the F3 and A illuminant to the device value of the destination device for the D65 illuminant. The evaluation results showed that the proposed method can transform the colorimetric value to the device value with fairly good accuracy; \( \Delta E_{\text{max}} = 6.5 \) in case of A illuminant, \( \Delta E_{\text{max}} = 6.7 \) in case of F3 illuminant, respectively. From these results, we found that the proposed method can transform the colorimetric value under any illuminant with almost the same accuracy as the traditional methods, which is valid only for one standard illuminant.

IMPROVED MATRIX METHOD FOR TRISTIMULUS COLORIMETRY OF DISPLAYS
Yoshitomo Ohno and Jonathan E. Hardin
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A new calibration technique has been developed to improve the accuracy of chromaticity values obtained from a tristimulus colorimeter for color displays. Matrix techniques as the one recommended by ASTM are well known for this purpose, but they often do not work as expected due to experimental noise and errors. The ASTM method requires sets of tristimulus values accurately measured with a test instrument and with a reference instrument. Normally, \( x, y, \) and \( Y \) values from colorimeters are transformed into \( X, Y, Z \) values to apply the matrix technique. Thus, the accuracy of the luminance measurement is critical to the accuracy of the corrected results. The variation of luminance measurements can occur due to instability of the display, flicker effect on the detector, stray light from ambient reflection, interferences between the display surface and the instrument, etc., while the measurement of \( x, y \) is normally more stable and reproducible since it is a relative measurement, and the error factors mentioned above tend to be canceled out as the three channels are sampled at the same time. The developed technique is based on the \( x, y \) values only, and is independent of \( Y \) value, thus, in principle, eliminating errors due to luminance measurement variations. The correction matrix is obtained from the sets of \( x,y \) values of the three primary colors of the display measured by the test instrument and the reference instrument together with imaginary \( Y \) values which are determined using a numerical minimization technique so that the differences in \( x,y \) values for the other set of colors are minimized. Correction for \( Y \) can be made separately by conventional matrix techniques if necessary. Experiments were conducted using commercial tristimulus colorimeters and a reference spectroradiometer, measuring 14 colors of a color CRT display. The results show improvement over the current practice in computing chromaticity coordinates.

1) ASTM E1455-1996, Standard Practice for Obtaining Colorimetric Data from a Visual Display Unit Using Tristimulus Colorimeters
THE PREFERRED REPRODUCTION OF SKIN COLOR AND CHROMATIC ADAPTATION

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2 Musell Color Science Laboratory, Center for Imaging Science, Rochester Institute of Technology

The preferred reproductions of Caucasian skin on a CRT monitor operated at three different color temperatures were examined. Total of 37 images having the different chromaticities were prepared for assessing the color of skin and psychological experiments were carried out by 27 observers. Statistical analysis was employed to derive chromaticities of the preferred colors displayed at each of color temperatures. The results show that chromaticities of preferred colors at 5000K are distributed toward yellow direction and those at 6500K toward blue direction compared to those at 6500K. However, it is also found that the difference in chromaticities among them are significantly small and that the preferred reproductions of skin are not significantly affected by chromatic adaptation. The results can be also applied for calculating the degree of chromatic adaptation employed in a color appearance model.

B2-O24-02

Modified Fairchild's color appearance model for facial pattern images under various illuminants
Francisco Hidoki Imai, Norimitsu Tsunoda, Hideaki Hanesaki, Yoichi Miyake
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We proposed a modified Fairchild's color appearance model to reproduce facial pattern images under various illuminants. In previous paper, we found that original Fairchild's color appearance model did not work well for facial pattern images. We modified \( \ell_E \), \( m_E \), and \( s_E \) parameters in the coefficients of incomplete chromatic adaptation in the Fairchild's model. We introduced coefficients \( K_u, K_m, K_s \) of color balance in the expression of \( \ell_E, m_E, \) and \( s_E \) coefficients as shown in the following equations;

\[
\ell_E = \frac{K_u \ell}{\ell + M_N + S_N}, \quad m_E = \frac{K_m M_N}{\ell_N + M_N + S_N}, \quad s_E = \frac{K_s S_N}{\ell_N + M_N + S_N},
\]

where \( \ell, M_N, S_N \) are the corresponding fundamental tristimulus values of the white point of the illuminant. The substitution of the constant values 3.0 in the original Fairchild's equations by these color balance coefficients provides a way to adjust the degree of color balance for facial pattern images. Psychophysical experiments using memory matching were performed to select the optimum coefficients of color balance for facial pattern images. This modified Fairchild's color appearance model was compared with other color appearance models (von Kries, RLAB, LLAB) by psychophysical experiments using memory matching. A hardcopy in a standard illuminant booth was compared with a pair of reproductions on CRT display. Ten observers were asked to select the reproduction on CRT display that provides the best match in color appearance with the hardcopy. The statistical result of these comparisons showed that this proposed model presented the best averaged z-score for all kind of illuminants. We can conclude that the proposed modified Fairchild's color appearance model performed well as a fine tuning to reproduce facial pattern images.

B2-O24-03

EFFECT OF AMBIENT LIGHT ON COLOR APPEARANCE OF SOFT COPY IMAGES

Color Management on the Network

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With widespread use of CMSs (color management systems), it is now guaranteed that users can achieve device-independent color across different devices and media. However, current CMSs guarantee same color only if one sees color under a given controlled viewing condition. If one sees color under another viewing condition, reproduced color won’t match the original color. On the other hand, network environment helps users to send color images from one place to another that have different viewing conditions. In this case, it is impossible to achieve same color with current CMSs.

In this paper, the effect of the ambient light on the color appearance of soft copy image on CRT monitor is discussed. In a typical office environment, one uses a computer graphic monitor having a CCT (correlated color temperature) of 9300K in a room illuminated with white fluorescent light of 4150K CCT. In such a case, human visual system is partially adapted to the CRT monitor’s white point and partially to the ambient light. Our previous researches for soft copy image vs. hard copy image matching1,2 indicated that human visual system is 60% adapted to the CRT monitor’s white point and 40% to the ambient light when seeing a soft copy image. This time, visual matching experiments were performed for soft copy image vs. soft copy image under different viewing conditions. Simultaneous haploscopic matching technique was applied to simulate a different viewing condition for each eye. The experimental results showed that human visual system is 60% adapted to the monitor’s white point and 40% to the ambient as in our previous researches.


B2-O24-04

COLOUR GAMUT TRANSFORMATION USING VISUALLY ASSESSED COLOUR DIFFERENCE FORMULAS

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The visually assessed colour difference formula \( \Delta E^*_{\text{cameso}} \) for the CIELCH colour space had been presented for the first time in 1993 (1) on the basis of the colour difference formula CIE \( \Delta E^*_{\text{ab}} \), and was published in 1995 (2). It represents a correction of the formula CIE \( \Delta E^*_{\text{ab}} \) by using the saturation value \( C^* \) as the only correction parameter. The formula \( \Delta E^*_{\text{cameso}} \) is much better adapted to human perception than the established CIE formula \( \Delta E^*_{\text{ab}} \) as per a demonstration with 26 printed colour pairs. The colour differences for these colour pairs are calculated by means of the new formula and compared with visually ascertained values and those determined by the CIE formula. The new formula \( \Delta E^*_{\text{cameso}} \) also compares favourably with the values determined by the more complicated CMC formula (3) and its de facto successor CIE \( \Delta E^*_{\text{de}} \) (4).

Thanks to the simple form of the colour difference formula \( \Delta E^*_{\text{cameso}} \), it can easily be applied to any colour gamut assessment. The colour gamut transformations offered in today’s colour management programs include the risk of information losses, especially due to clipping. Any transition from the original colour gamut to the colour gamut used for reproduction should take into account the best possible correspondence which is achieved by colour lookup tables and selected interpolation algorithms. Due to the fact that neither a colorimetric nor a spectrophotometric standard exist for the quality assessment of colour gamut transformations the practical transition is influenced by the subjective taste of colour reprographers. By means of the colour difference formula \( \Delta E^*_{\text{cameso}} \), which is simple to calculate and which corresponds to the human perception of the ranges of original colours and reproducible colours are transformed bi-directionally almost any loss of information. Digital input and output devices will have to be characterised not only by their colour gamuts but also by achievable colour differences in terms of \( \Delta E^*_{\text{cameso}} \). The assessment of colour space transformations is one example of using \( \Delta E^*_{\text{cameso}} \).

1) E. Luebbe, Annual Meeting of the German Society of Colour Science (DfG) held in Cologne, Germany, 1993.
NON-ANALYTICAL GAMUT MAPPING ALGORITHM WITH GENERALIZED END
Takafumi Naguchi
Ashigara Research Laboratories, Fuji Photo Film Co., Ltd.

A gamut mapping between different color media is usually done in CIELAB space or in Equivalent Neutmi Density(END) space. However, these methods have some difficulties in handling or in accuracy so that one should find out optimum point by trial and error.

To mediate these difficulties, I propose a simple and accurate gamut mapping method which consists of Generalized END(GEND) and non-analytical algorithm. In this method, all colors are represented by GEND so as to guarantee easy handling and accuracy, and non-analytical algorithm is used to preserve the hue and adjust the dynamic range. The method is applied to the gamut mapping from color transparencies to color reflection prints and its performance is successfully confirmed.

CROSS-MEDIA PSYCHOPHYSICAL EVALUATION OF GAMUT MAPPING ALGORITHMS.
Jin Morovic and M. Ronnier Luo
Design Research Centre, University of Derby
Gamut mapping is an essential step in cross-media colour reproduction, which has not been satisfactorily explained to date. Therefore eight previously published gamut mapping algorithms have been implemented and subsequently psychophysically tested. The following gamut mapping algorithms (GMAs) have been chosen for evaluation, with the first seven algorithms using the CIELAB colour space:
(a) linear lightness (L) compression with subsequent linear chroma (C) compression, keeping hue (H)-unaltered
(b) linear L compression with subsequent knee-function C compression, keeping H unaltered
(c) linear L compression with subsequent C clipping, keeping H unaltered
(d) simultaneous L and C compression towards the centre of the L axis, keeping H unaltered
(e) linear L compression with subsequent simultaneous L and C compression towards the centre of the L axis, keeping H unaltered
(f) simultaneous L and C compression towards the cusp, keeping H unaltered
(g) gamut mapping algorithm which maps between the two gamuts depending on their relative shape in a given plane of constant hue angle, H of input colours is being shifted based on the hue angles of device primaries.
(h) simultaneous L and C compression towards the centre of the L axis in LLAB, keeping H unaltered
The paper describes the components of the above GMAs including the way gamuts are approximated, what gamuts are used and the actual mappings themselves. An overview of the colour reproduction system within which the GMAs are implemented is also given, as this has significant influence on the outcome. Finally the results of a paired comparison experiment using the simultaneous binocular matching technique are presented and analysed.
G-P01-01

SPECTRAL BASED ANALYSIS OF COLOR IMAGES

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The importance of color as a quality measure in many industrial processes is growing. The technical development of imaging devices and computers allows very accurate representations and effective analysis of color information.

The most commonly used color representations in industrial use are the Lab- and Luv-models. The RGB-models are mainly used for visualizing the color information. These three-dimensional colorspaces have two major drawbacks: 1) They can only represent that region of the electromagnetic spectrum, (283-780nm) which is visible to humans. In some applications the interesting spectral information can be in the UV-, near IR- or IR-region. 2) Several spectra may have the same three-dimensional color coordinates. This is known as the metamersim problem. Due to these drawbacks the multispectral images can contain information that cannot be detected in the corresponding gray-level or RGB-image.

In this study we show with some examples the common problems in color analysis which originate in the three-dimensional colorspaces. We used two real spectral databases, the first measured by a spectrophotometer from the Munsell color chips and the second measured by a spectroradiometer from the canopy of pine, spruce and birch forest. We synthesized multispectral images by combining the real spectra with texturized images. Our experiments show that lightness and three-dimensional color information is not sufficient to represent the color information in these multispectral images accurately.

G-P02-01

EFFECTS OF GRASPING ATTITUDE AND OBSERVING EXPERIENCE ON COLOR APPEARANCES IN KOFFKA–RING TYPE PATTERNS

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To examine the cognitive effects on color appearances under various stimulus conditions, we measured the magnitudes of hue and brightness contrasts (MBCs and MHCs) by manipulating subjects' attitudes and experiences in the experiments on visual perception. The first phase of experiments examined the effects of grasping attitude on Koffka–ring type patterns presented on a computer controlled color-monoitor. This phase asked the subjects familiar with knowledge of the experimental design to grasp the test figure (TF) either more separated or more unified while the subjects were comparing the brightness appearances of TF's right–segment half or left–segment half with those of the comparison figure. In this experiment, the MBCs between two segments of TF increased when the TF was grasped as more separated figure 1. Then, we arranged the subjects' experimental literacy to identify the difference between hardness “contrast” and “assimilation”; such a difference occurred in the perception of Koffka–ring type “striped” patterns. With the TF and inducing figure (IF) displayed on the color-monitor, the appearance of the gray TF tends to shift from the contrast to the assimilation as the TF is made wider than the IF of black–white or red–green. Results revealed that the subjects, who knew the transition from contrast to assimilation when the TF is made wider than the IF, reported the typical transition in the MHCs and MBCs under the increasing width–ratio of striped TF to IF. Contrarily, the subjects, who knew little about the above experimental design showed only the typical hue and brightness “contrast” throughout the whole range of width–ratio between the striped TF and IF. Furthermore, the subjects' experimental literacy was tailored to examine the relationship between the hue contrast and the similarity of TF's geometrical pattern (for instance, gray circle on red IF vs. gray square on green IF presented by a color-monitor or by color–prints). Further results indicated that the subjects, who were well versed in the relationship between the TF's pattern and the hue contrast, positively responded to the existence of a significant relationship between the TF's similarity and the MHCs. However, the subjects, who knew little about the experimental design showed no significant relationship as above. In conclusion, the grasping (top–down) attitude adopted by the observers with different levels of knowledge about the experimental design generate the different effects even on the more peripheral or sensitive phenomena such as color appearances. 1) T. Goto, et al., Psychologia, 38, 182–198 (1995).

- 118 -
HARMONIZATION IS NOT AN ABSTRACT TASK
Anna Litvinova, Evgeniy Agranovich-Ponomareva, Alexandre Mytskikh
Colour Centre of Belarus

Colour harmonization is a comprehension by a person his vital experience and phenomena of colour culture. The aim of colour harmonization is the search and utilization of ecologo-stimulating qualities of the colour environment.

The ecological method of approach to colour harmonization is founded on some principles:
- the construction of colour associations on the basis of the colour icon - sign, sign - indexes, sign - symbols; associations - the construction of colour with utilization of:
  - physical analogies;
  - models of emotional influence;
  - models of psychological influence.

NUMERICAL EVALUATION OF COLOUR IMAGE WORDS ON COLORIMETRY
Taeko Nakamura 1, Hiroshi Hoshino 2, Tetsuya Sato 3, Kanji Kajiwara 3
1) Nara Saka Jogakushin College, 2) Yamaguchi University, 3) Kyoto Institute of Technology

The affective tone of colour is an important factor for the colour scheme. We have quantitatively analysed the colour images of colours in terms of colorimetric values which are supposed to correlate with the affective tone.

We have chosen the pairs of “Warm-Cool”, “Light-Dark”, “Deep-Pale”, “Heavy-Light”, “Vivid-Sombre”, “Gaudy-Plain”, “Striking-Subdued”, “Dynamic-Passive”, “Distinct-Vague”, “Transparent-Turbid”, “Soft-Hard” and “Strong-Weak” as fundamental affections, and performed a visual experiment where either word to be selected from the specimens selected systematically in colour space. The results have confirmed that the colour images are affected by Munsell and CIELAB values. The visual assessment was compared with the Munsell and CIELAB values, which computed from the colorimetric values, and empirical formulae were found for respective value to represent the colour images [1,2].

In this study, we formalize the colour image diagrams according to the empirical formulae, and project the colour order systems on the diagrams. The visual assessment was also statistically analysed to afford the relationships between colour image words and colour order systems were discussed.

COLOURLAND'S LAW
A. Nemcsics
Prof. of Technical University of Budapest

Part of Colourland's laws are similar to the laws of nature, describing processes independent of us. Electromagnetic radiation is one condition of the existence of Colourland independent of us, but is also depends on a sensing and evaluating mechanism, i.e. living man. Hence, these laws also reflect laws of human cognition. Such are, among others, those of the relations between our colour sensations.

Man is a living organism, involving not only what is generally describable, but also what is individual. Another part of Colourland's laws are similar to laws of the functioning of living organism. Such are e.g. the laws of colour composition. Beyond of being a living organism, man is an entity with spirit, soul feelings, ideas, organized into a society driven by common interests, emotions. The third group of Colourland's laws are similar to those of the functioning of societies. Such are e.g. the laws colour harmony.

G-P02-05
COLOUR DYNAMICS AS A NEW SCIENCE
A. Nemcsics
Prof. of Technical University of Budapest

Colour dynamics as a new science is concerned with the relations between the surface appearance of environmental elements, and man living this environment. It studies the interrelations of colour, man and environment. Thus, colour dynamics as a science is a complex of theoretical and practical activities directed towards the disclosure of objective relations between man and coloured environment, as well as towards a conscious environment colour design.
G-P02-06

FLORIAN YURYEV'S COLOUR SCRIPT AS A METHOD OF INTERLINGUAL PHONETIC TRANSCRIPTION
Tamara Maximova
All-Ukrainian Union of Musicians

Professor F. Yuryev developed an averaged system of colour vowels proceeding from his own concept of colour harmony by comparing general and specific regularities of physiologic perception of colour and sound.

This is not normative harmony or individual association. It is proposed as the most suitable colour code of vowels. If one uses such symbolic colour designation of vowels, the consonant of a syllable is tinged with the colour of a vowel, and as a result we obtain a high-capacity syllable script saving the area of a text information carrier and revealing the harmonic picture of phonetic structure of the text.

The problem of adequacy of translation, especially poetical one, has always been and remains the subject of constant discussions among specialists. To date the possibility of objective evaluation of translation quality in a sense of its “spirit” but not its literality has not been existent. The proposed system makes it possible to bring to light the phonetic structure of the text as such and poetical one in particular, to clearly present the vocal harmony of poetical works, to perform a comprehensive comparative evaluation of translation quality, its cognition and logical imagery, expressiveness and vocal coloration.

Such method could become a fine and at the same time powerful instrument in the hands of a skilful interpreter transferring three of composition to a rather rational basis.

This method also permits to comprehensively analyze the style of any author being distinctly reflected in the colour-phonetic structure.

G-P02-07

ENVIRONMENT ENRICHED BY THE PRESENCE OF COLOR AS A WAY OF STIMULATING CHILDREN WITH SPECIAL NEEDS

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Neonatal Service of the National Maternity, Cordoba National University, Argentina.

The presence of colors in a place can produce many specific reactions in the behavior of children with special needs and should thus derive a tool to be used in the creation of optimal conditions for many activities to be done by them.

To test this hypothesis 10 children, rating high on behavior problems, are matched on the basis of pathology, age and sex to 10 controls. Each of them are tested in a waiting room specially aconditioned for this research before the neurologic control. Evaluation is done following two sequences, in one of them the group uses the waiting room when all the walls are painted in a color that is expected to be highly stimulating for this children and then when all the walls are without colors; the other sequence of spatial conditioning is the opposite situation: they are evaluated first of all in the room without colors and then with this stimulating one. They are filmed and their behaviors are analyzed considering their performance in playing activities, in relation with others during this time and after this time during the neurologic control. Long term behavioral habituation, that is activity decrease upon repeated exposures to spatial novelty, and the opposite response that is sensitization are expected to be seen and analyzed during this research.
COLOUR PREFERENCES
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In our research colour preferences are related to age, sex, selected personality
characteristics, level and type of education. Colour preferences were estimated
on representative sample of 4000 experimental persons of wide variety of age
categories and education.

We found that emotional meaning of particular colour depends on level and
type of education, age, personality characteristics, sex and some characteristics
of social environment.

We also found that experimental persons connect themselves and their parents
with different colours in dependence of characteristics mentioned above.

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Children's color preference

The Color in Art Works titled subject's side survey concerns children of 6-
10 in a school art gallery in the suburb of Budapest. After the informal
meeting with contemporary artists and their paintings the students could
analyze the color structures on their own. Following the laws of the Coloroid
system, further studies were carried out to interpret some characteristics of
color analysis, composition of color scale rates, color functions, contrast
examinations, balanced groups of colors, search for color harmonies and
preferred color combinations based on the Coloroid system.
COLOR AND PLASTICS

It is by the practice of stratified polyester that I've been sensitized to the issue of plastic materials in industry. More particularly my work aim was to deal with color of audiovisual products design. Indeed it's a domain where chromatic codes are very strong, « the black box », without relevance of those chromatic norms appears clearly, due to an industrial consensus of common places rather than technical reasons.

So my research is oriented towards possibilities for industrials to offer chromatic ranges so as to be more suitable with their contexts of use and new employments they permit.

It's all about to put in accordance with the technological wealth put into practice by these products, with tactile and visual wealth which should allow a good design.

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THE USE OF COLORS IN PICTURES DRAWN BY ART THERAPY TECHNIQUES

Kumiko Morayama, Women's Junior College of Fine Arts

In this study, a course was designed to promote the expressions of emotion among female art students. The "Division-and-Coloring Methods" was used for pre- and post-checks to gauge the effects of the course. The "Draw-a-Person-in-the-Rain" was introduced to stimulate the expressions of negative feelings. The main task in the course was a collage. Each work was self-checked by 41 Color-Symbolism-Test terms and 18 Semantic Differential Scales. In comparison with the first DC drawings, the use of colors in the second DC drawings was well planned to create effects of unity and harmony. Through case studies, it can be seen that the process of freeing expression and deepening understanding of complex feelings were manifested in a variety of ways.
H-P03-05

COLOUR DESIGN INSPIRED BY THE COLOURS OF BUTTERFLIES

Bocskidi, László - Budapest Technical University, Faculty of Colour Dynamics

Nature is the best decider of colour.
Flowering meadow, a sunset; the world of colour will always provide a beautiful and harmonious visual composition. A harmony to be found on the wings of butterflies.
The facade and streetscapes from my plan for building in a real location will demonstrate a colour-design as inspired by the colour-scheme of the butterfly.
The purpose of the colour-design is to create a colourful, yet natural and harmonious environment.

H-P03-06

COLOUR PICTURE OF HARMONIC STRUCTURE OF THE TEXT

Florian Yuryev
All-Ukrainian Union of Musicians

In the art analysis of picture coloration the analogies between pictorial and musical works are traditional. The comparisons of such kind are usually brought up to the macrolevel of image-bearing associations, they are characterized by wide subjectivism even within the narrow framework of national colouristic schools.
In the structural analysis of harmony of the painting, music, architecture, or poetry text, colour-harmonic associations arise at the microlevel of sign relations, e.g., colour—graphic sign, colour—note, colour—vowel, syllable, colour space of a picture—musical mode and phonetic harmony of a phrase. Such associations are in conformity with more objective laws of psychophysiological perception of aesthetic information common for all nations and cultures.

Therefore structure-text associations at the level of sign relations can become a basis for the formation of a universal international language of colour information the development of which is imminent.
The systems of colour-musical signs and colour-phonetic transcription are proposed as examples of applied importance. They permit to incarnate harmonic structures of a musical text in colour pictures.
A Study of Color Education by
"THE EXCERSISE SYSTEM TO DEVELOP SENSE OF COLOR"

Ken Umimoto
The rector of Tokyo Zokei University

I would like to make a proposal for a system to develop human sensitivity (theoretical understanding and sensuous judgement) which is a significant base for color education in advanced educational institutions.

This system aims at developing an analytical and synthetic skill and fostering basic sensitivity for creation such as a color arrangement through the process of developing the various phases by the interaction of different colors from the relationship between two sides of the nature of color; the analogical continuity and the digital side as a divided unit. The content as follows is just a part of this whole system.

Content

I. The adoption of P.C.C.S as a fundamental system
II. The color diagrams for the excersises to develop sense of color
III. The practical method of the excersise using Diagram A and B (in II.)
H-P04-03

COLOUR PLANING AT SCHOOL THROUGH VISUAL ASSESSMENT
Hiroshi Hoshino(1), Taeko Nakamura(2), Tetsuya Sato(3), Kanji Kajiwara(4), Yuka Miki(5), Tetsuhiro Shinno(6), Keiichi Kawano(6)
(1)Yamaguchi University, (2)Nara Saho Jogakusai College, (3)Kyoto Institute of Technology, (4)Nippon Paint Co., Ltd.

Various psychological effects will emerge from colours, where the psychological effects depend on view conditions including media, materials and observers.

The aim of the present study is to understand the mechanism of the psychological effects from the visual assessment of the colour schemes designed for classrooms.

The colour schemes were arranged on three media of real rooms, colour chips and monitors. A medium of real rooms consisted of a thirty-year used light green room and four rooms coloured off-white, light green, red and blue respectively. Colour chips and monitors were provided with matching respective colours of real rooms.

Colours on three media were assessed by about eighty observers against the eighteen pairs of colour image words. The assessment data was analysed by standard statistical methods.

In order to define the characteristics of the visual assessment, the difference due to the type of media and colour schemes will be discussed.

H-P04-04

THE SOFT ENERGY OF COLOUR (Colours in Art and Education)
Silvia Rizzo. Plastic Arts Department, Liceo Artistico N. Barabino, Genoa, Italy

Topics: Two experimentations in my teaching about colour and my artistic experience
a) "Painted Poems" Works painted by my students, suggested by some lines by the Nobel Peace poet E.Mozzacl. Paintings are based on a creative research of sensations and an exercises of interiorising, obtained through painted colour. From a scientific viewpoint, colour is the result of the emotional aspects of intelligence.
   b) "Colour for Hospitalised Children": Teaching experience with a class of art students in the department of cardiac surgery in a hospital for children (Ospedale Gaslini, Genoa, Italy). Joyful colours are arranged on a totally original -and never used before- design in order to communicate positive sensations and to deviant theplace from its negative connotations, according to the theories of the "humanised" hospital. For instance, a large clock, gamicolour, in the waiting room: time passes and it becomes "the game of time".
   c) My artistic experience, temporal dimension of colour. Documentation on works represented by Iory canvas, where colour is painted by time and air, by rain and smog.
I studied the colouring of primary school classrooms, first of all the classrooms for the 1. classes. My presentation contains some colour designs for these classrooms. I give suggestions how to colour them.

The purpose is that the children - just now coming out of the kindergarten - don't be afraid of the school, and a good atmosphere to make for a playful learning.

One is at ease in an environmental surrounding one with one's preferred colours. In such an ambience we feel well, our accomplishment at higher.

In my colour suggestions I paid attention:
- the results of colour preferences' tests of Nemcsics and Frieling,
  (At this young age saturated colours are preferred. Among saturated colours children prefer two colours: red and blue, adding up later to three: red, green and blue, i.e. basic colours of colour vision.)
- the colours associated charts of Nemcsics
  (with the concepts of silence and noise,
   with the concepts of joy and sorrow)

It's also important, that in blue light the mathematical thinking is more successful, but red light is useful in case when somebody needs good ideas working at a theme.

In schools the colour selection should be primarily controlled by colour preference and psychosomatic effects of colours.
J-P05-02

REPRODUCTION ON A CRT OF COLORS TAKEN UNDER DIFFERENT LIGHT SOURCE COLORS
Makushi Inoue and Seiki Inoue
ATR Media Integration & Communications Laboratories

In some telecommunication services, such as teleshopping, differences in color appearance will become a problem owing to light source color. Color matching degrees in both of colorimetry and appearance were investigated in the following. Thirty-two kinds of color chips were measured colorimetrically under four kinds of fluorescent lamps: D65, white, daylight and daylight-white. After that, they were reproduced on a CRT. The same spectral colorimeter, PR-650, was used to measure both color chips and the CRT in order to avoid the influence of differences between measurement tools for non-luminous objects and the CRT. Color differences between measured values of color chips and the corresponding reproduced ones on the CRT were calculated with the result that the average color difference was minimal for the case of standard illuminant, namely D65, and that it became larger as light source color went further from standard illuminant. The minimum value of the average color difference was 2.522 for the case of D65 while the maximum was 8.981 for the case of white color. A subjective evaluation test was performed to evaluate a color matching degree between color chip and the corresponding reproduction on the CRT. A three-grade-scale was used in the test. Roughly speaking, test results tended to coincide with colorimetric results. Moreover, it has been shown that schematic chips were difficult to match even in the D65 case.

J-P05-03

A SIMPLE METHOD FOR SIMULATING DESIRED COLORS ON GENERAL TVGA MONITORS
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A model with the algorithm of piecewise linear regression and progressive addition is presented for producing colors having desired CIE chromaticity coordinates and luminances on general TVGA monitors without digital graphics systems. This method takes account of the interrelations among the R, G, and B phosphors based on the white balance adjustment and calibration of the color monitor. While the monitor is being calibrated, only one electron gun is set to function and the other two are switched off for each color to reduce the measurements needed to determine the relation between frame buffer input and monitor output. For every calibration color, its CIE tristimulus values X, Y, and Z are all measured, so the interactions among the three phosphors are characterized. On obtaining the spectral reflectance of the sample color to be simulated, the frame buffer of the monitor is directly programmed and the digital input values to it are solved and then further corrected by iteration such that a vivid color is displayed on the CRT monitor.

TOWARD A DEFINITION OF A QUALITY SCORE FOR COMPUTER-CONTROLLED CRT COLOUR DISPLAYS

Andrea Raggi1, Raimondo Schettini2, Bruno Barbirol1, and Giancarlo Barbieri1

1 Department of Business Economics and Management, Technology and Resource Valorisation Area, University of Bologna, Italy. 2 Institute of Multimedia Information Technology, National Research Council (CNR), Milan, Italy

The increasing use of computer-controlled CRTs for computer graphics as well as visual colorimetric and colour appearance experimentation requires an accurate rendering of desired or pre-defined colour stimuli. Even though the colour community has recently focused its attention on CRT colour appearance issues, not many efforts have been directed toward defining a synthetic quality score obtained from an evaluation of the colorimetric properties of computer-controlled CRTs. The study we have recently undertaken aims at identifying a number of significant features of a computer-controlled CRT to be assessed in order to obtain an overall quality score for comparison and/or certification purposes. In this preliminary stage, we have investigated the accuracy of colour rendering trying to relate it to various colour attributes (lightness, saturation, etc.). A number of colours of various lightness, saturation and hue, based on the ANSI IT8.7 Agfa ColorReference, were displayed on a colorimetrically characterized Barco Calibrator colour CRT. Measurements of the radiant output were performed using a Photoresearch SpectraScan PR 650 spectroradiometer and according to standard procedures. Measurements were taken in absence of ambient lighting in order to minimize ambient flare.

Error magnitudes were computed as the colour differences between measured and predicted values for the different colour ranges considered. Starting from statistical analyses of the obtained colour differences, an attempt was made to propose a quality score for colour rendering.

Further studies will consider other computer-controlled CRT characteristics (e.g.: spatial uniformity, stabilisation time, etc.) for inclusion into an overall quality evaluation score.

A SPECFICAL-BASED MODEL OF COLOR PRINTING THAT COMPENSATES FOR OPTICAL INTERACTIONS OF MULTIPLE INKS

Keiichi Iino1 and Roy S. Berns

1 Imaging Research Laboratory, Technical Research Institute, Toappan Printing Co., Ltd.

A first-order model was derived which predicted spectral reflectance factor of colors formed using a color proofing system that simulates offset printing. This model was based on the spectral Neugebauer equation modified by the Yule-Nielsen correction in which n-value was assumed to vary as a function of wavelength. The spectral n values and mechanical dot gain model parameters were optimized using primary (cyan, magenta, yellow and black) halftone tints modulated between white and the maximum ink amount. The model accuracy was tested with a data set of 325 colors sampling the color gamut of the proofing system. The average \( \Delta E^* \) was 5.6 with a maximum error of 12.0. Systematic errors were observed for color mixtures, the predicted spectra usually were lower in spectral reflectance factor than measured spectra. This systematic error was caused by an overestimation of effective dot areas for secondary, tertiary, and quaternary colors.

This systematic error behaved in similar fashion to the phenomenon of ink trapping. Because ink trapping, ink spread, and mechanical dot gain were negligible for this proofing system; this is an optical effect, to be referred to as "optical trapping." An interaction model was derived that compensated for optical trapping. A unit dot gain function, based on the difference between theoretical and effective dot areas, was derived for each primary color. Secondary overprints at 25%, 50%, 75% and 100% theoretical area coverage were used to quantify the decrease in each primary's unit dot gain function with increasing secondary overlap. Quadratic equations were fit to these results. For tertiary and quaternary colors, the effective area coverages of each primary were assumed to be a product of the changes caused by each corresponding secondary color. Adding the optical trapping compensation to the first-order model significantly improved model prediction to an average \( \Delta E^* \) of 2.2 with a maximum of 5.5.
J-P05-06

THE METHOD FOR FABRICATING ITS COLOR TARGETS
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The standardization of ITS color targets for calibrating printing scanners has been recommended by the ISO committee in 1996. The targets are designed as tools for producing profiles in a color management system, and also as tools for resolving problems caused by metamerism due to the difference in spectral sensitivities between printing scanners and human vision. All the targets have the same colorimetric values (L*, a*, b*) and the same spatial composition, and are fabricated by using each film manufacturer’s materials. The targets are composed of color gamut area, color dye scales, a gray scale, and a vendor option area. The method for fabricating the targets according to the ISO specification will be explained, and the actual targets will be demonstrated.

J-P05-07

APPLICATIONS OF VECTOR-SUBSPACE METHODS TO COLOR REPRESENTATION
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The basis for the vector-subspace approach is that color spectra are usually strongly correlated. Decorrelating such spectra we can represent them accurately as a linear combination of a few basic spectra. Principal Component Analysis is a well-known statistical technique for linearly reducing the dimensionality of a data set while retaining as much of the information present in the data set as possible. Principal Component Analysis has been widely applied to several problems related to color and demonstrated to be an efficient paradigm for analysis of spectral data. A second motivation for using subspace approach is that the human retina contains three types of color sensors (cones) whose overlapping spectral sensitivities represent an inefficiency of the spectral coding. Decorrelating of the signals can improve the efficiency and is achieved by the eigenvector transformation (principal component transformation) of the correlation matrix of the cone sensitivities [2]. In this paper we give a brief review of the use of vector-subspace methods in color representation problems used by our research group. This includes color representation and classification [2,3,6], and simulations of defective color vision [5] and white-light adaptation characteristics [6].

J-P05-08

A NEW COLOR SPACE SUITE TO COLOR IMAGE PROCESSING
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This paper presents a new color space suit to color image processing. There are two major kinds of approaches to color image processing: component based approaches and vector based approaches. Component based approaches process each channel of color image separately, and require that components of the color space we chosen should not correlate (or almost not correlation). For example, enhance of brightness should not introduce chromaticity shift. Moreover, most of the processing approaches also require that each component of the color space should be uniform. For example, if we want to enhance brightness channel (L) of a color image, the same change in L should result in the same visual change at l1 and l2, where l1 = l2. Considered the color spaces (Luv and Lab) introduced before, we find out that they are not uniform because they blend the brightness of pure color and white light together. Then we put forth a new color space: W (luminance of white light)-C (luminance of pure color light)-H (hue of the color light) color space. Components of this space are still correlative, so we correct it by the Munsell color system—a widely known color space that more close to human's visual characteristics. We have gotten better effect than Yuv and Lab spaces mentioned above, when process images in component-wise manner.


J-P05-09

COLOR MEASUREMENT IN CINEMATOGRAPHY
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Developing a Measure-Exposure method, based on Trichromy principles, that allows cinematographers to know the contents of red, green and blue of each exposed color and its placement in the sensytometrics curve. The measure device has been done from the color separation module of a video camera. The study are on EV values. It results something like a Three Color Zone System.

Looking for a global notation. Converting some units (transparency, opacity, color rendering) in the same kind of values than EV (based in Log2) we can interact with them and predict resultant colors by simple operations. We can apply it in filters, light sources, reflectors, etc.
A COMPARATIVE STUDY ON SPATIAL CONSTRUCTION OF COLOR IMAGES BETWEEN
KOREAN AND JAPANESE FEMALES

Asai Takeo, Reiko Hashimoto and Yukie Kato
Department of Human Environment, Sogiyama Jogakuen University

The purpose of this study is to construct spatial patterns for the perception of color images by
Korean and Japanese females and to analyze and compare characteristics of their perceptions.

The test stimuli were 81 colored chips: 38 chromatic colors and 3 achromatic colors. These colors
were chosen from P.C.C.S. Each colored chip was 3.0 x 3.0 cm. The subjects were 60 Korean and 63
Japanese female undergraduates. The experiment was carried out in September and October 1996. In
the experiment, the subjects viewed the 81 chips and responded to 15 questions based on color
adjunctive terms with five categories for each color. Mean of 50 scores were obtained and factor
analysis was used to discover subject's impression of colors.

Factor analysis showed that the color perceptions of the Korean subjects were composed of three
factors: a linked factor of evaluation with activity, potency and a maturity-related factor. The color
perceptions of the Japanese subjects were also composed of three factors: activity, evaluation, and
potency.

Factor scores for the three factors were plotted on a two-dimensional space. Korean subjects showed
higher scores of Y, R and PB group < v, dh, do, 1. tone> and lower scores of YR group < dp, dk, d tone>
in colors expressing a linked factor of evaluation with activity. The linked factor is considered to be
mainly influenced by hue. In the colors expressing factor of potency, higher scores were found in Bk
and PB group < v, do, dh tone > and lower scores in pale tones. Concerning colors with a maturity-
related factor, higher scores were found in W, Bk and PB group < p, dh, d tone > and lower scores in BP-
WR group < v, do tone >. The second factor appears to be influenced by chroma. In Japanese subjects, the
colors representing the first factor of activity are warmer colors of BP-Y group < v, lt, dp tone > with
higher scores for value and chroma. W and intermediate colors in BCP group < v, lt, dp tone > showed
higher scores for the factor of evaluation. The colors expressing the factor of potency showed
similar characteristics in both groups of subjects.
J-P06-03

A COLOR DESIGNER VIEW OF THE COLORS IN BRAZIL
Fernarah Cavaleanti
Centro Frances de la Couler. -Paris, color designer, consultant.
interior designer.

The conscience of the chromatic culture of Brazil-a country of light, sun, complexity. A psycho-dinamical view of its colors. Focusing the contrasts - counterpoints in some original and cultural ideas. The multiplicity of color manifestation from its roots, the traditional, to the most recent ones: the colors' color combinations/ color uses/ the different people & races. The ART OF COLORS.

A synthesis of the skill, the mark, the most, heart & soul of colors. The most contemporary- the everyday life - showing a practical use of colors. The popular and the sophisticated. A life-style and a cultural view more than a color, to validate the designers' work to get hues, chromas, values, contrasts, color combinations.

the strategy always focusing the counterpoints, the contrasts in a country of complexity. Showing the characteristics, the ART OF COLORS from the static and transcendental aspects, to Brazil TODAY. From the essence to appearance. From the most basic to sophistication. From the genuine, own, spontaneous, exotic to the globalisation, the optic-fiber, the tele-communications, the open market. By showing these impacts, impresses, influences, diversity, gradients, plurality.

J-P06-04

Fernanda Garcia Gil.
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I've noticed in all bibliography consulted refers to the way Lewitt express his ideas only by means of geometry. These ideas range from their physical realisation and meaning, to a point farther than the geometric axioms they depart from. Besides, a less precise reference has been made to the use of colour. However, studies about colour and its recent formulation incorporate and develop considerably the idea of serial procedures and preconceived works. This is so frequent that, from my point of view, the use of the system of colours in Lewitt structures is, to a great extent, the main cause of the variety of development. That is so because the variables within this logically ordeces system, in which intuitive developments are allowed, are open.

The employ of this system, and Lewitt's wish to use it as an open one, can be clearly seen in his late evolution. All this is arranged in such a way that these features show the author's freedom, without him having to reject his first position about conceptual art.
A STUDY ON CHARACTERISTICS OF TOWNSCAPE AND FLUCTUATION OF COLORS

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There are various colors in townscape. We discriminate the objects in townscape and are able to have some impressions by means of colors. It can easily be thought that characteristics of townscape are related to peculiarities of its colors. It is not so difficult to suppose that colors in townscape have a great influence on a formation of its impression. The purpose of this study is to understand characteristics of townscape quantitatively through evaluating peculiarities of its colors. In this paper, a method to analyze two dimensional full color images which are got by scanning photographs of the streets is proposed. As an index to evaluate peculiarities of colors in townscape, fluctuation of colors is proposed and actually examined through analyzing various color images. This paper makes clear the usefulness of fluctuation as the index. Through the analysis, it was found out that various townscape were able to be divided into some visibly distinctive clusters. Especially, it is remarkable that the townscape of historical old streets were distinguished from those of modern streets quantitatively. Besides that, it was found out that townscape of modern streets had peculiarities of colors which intensified fluctuation in the red. The fact indicates that townscape of modern streets have a great deal of change in the red, therefore, they are properly more characterized by the red than by the other colors. The results show that fluctuation as the index to evaluate peculiarities of colors in townscape is useful and the characteristics of townscape are able to be grasped quantitatively.

"Dusky Bright"
THE CHARMS OF THE ARCHITECTURAL COLORS OF THE ANCIENT CITY-SHANGHAI CHINA

OUTLINE
This essay illustrates how the Ancient capital Beijing came into being and the procedure of founding Beijing mainly analysing the employment of colors to it on the basis of the result of spectrum testing and discussing the aspects of colors serving as a foil, the contrast of colors the complementary colors and the Chinese people's special taste for colors.

1 BRIEF HISTORY OF FOUNDING THE CAPITAL
2 ARCHITECTURAL COLORS OF THE ANCIENT CAPITAL
3 RATE OF THE COLOR DEGREE OF PALACES
4 RELATIONSHIP OF THE COMPLEMENTARY COLORS BEFWEEN THE ARCHITECTURE AND THE SURROUNDINGS
5 CONCLUSION
THE DISCOVERY OF AREA-COLORS THROUGH PHOTO RESEARCH
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Nippon Color & Design Research Institute Inc.

Visiting Brittany in France in 1979, it was cloudy and misty. The buildings and people’s clothes had a gray appearance and it seemed that this phenomenon was a response to the environment in which annual sunlight is low. Perhaps it is only natural for the people to find grayish colors attractive. In the subsequent survey, it was discovered that the color gray was frequently used in the regions where Celts lived. Shisopana in Yunnan province, a place we visited in China, is a rice-growing area and the GY hue was widely used in the daily life of the people and became the color which represented their way of life. In this way, a great many special hues can be observed in each region and they are handed down from generation to generation in the form of colors which represent the regional character. For this reason, in the last ten years, we have traveled in Japan, Asia and Europe and we will demonstrate the existence of the area colors we have observed using photographs.

(1) How area colors were photographed: a demonstration of how we sought to capture the local colors on slides.
(2) Examples of area colors: we classified the regional colors of cities mainly in Japan and Europe into ten hues and achromatic colors.
(3) The meaning of the existence of area colors: from environmental, historical and cultural viewpoints, we considered the color images and techniques of color combinations employed in various regions.

COLOUR IN ARCHITECTURE OF BUENOS AIRES
Andrea Pagliero, Architect of the UNLP. Universidad Nacional de La Plata, Argentine.

Colour is an integral part of architecture. Forms, textures and colours define the appearance of a building. And the users, the people, experience it, from what they see and what they touch, specially in the urban context.

Buenos Aires’s architecture is very interesting to refer particularly to the select works, where the colour has an essential role in its design:
- The area called “Boca” with its strongly colours.
- The historicals areas of San Telmo and Recoleta with its poetry of the softness’s colours.
- The brick’s architecture of Puerto Madero, recently recycled.
- The contemporary towers. Cesar Pelli’s building (República), Fortabat’s Tower and Catedralas with its glasses of different colours what appear to us in the light of the sky.
J-P07-05
COLOR USAGES IN THE PUBLIC: A CASE STUDY IN THE HISTORIC CITY OF KYOTO
Munehira Akita
Kyoto Research Group of Color Usages in the Public and Faculty of Social and Information Sciences, Nihon Fukuushi University

The aesthetic significance of color in everyday life is important in perceived environmental quality assessment. The group conducted several studies to examine the color effect for cognitive factors (image and expectation) and scene composition (roof, wall, and illumination) as predictors of perceived scenic beauty of a city. The Semantic Differential Method was used to obtain measures of attitudes and sentiments towards a number of cities, streets, and gardens. About fifty persons rated actual landscape scenes with regard to their scenic beauty and described some specific content in the image itself of them. The Factor Analysis was applied to explore statistically the number and kinds of factors underlying these assessments. Direct color measurements by a Minolta Handy Colorimeter and visual color matching with a sample book of standard color of paint provided by the Japan Paint Makers Association were also employed to determine color of roofs and walls at a lot of places in the city. In one study, a computer graphic technique was used to present a virtual scene of environment and compare it with a real scene to find the effect of some particular components in the scene. Findings suggest that integrating various results into one context as a whole yields a heuristic predictor for scenic beauty in which colors work as one of important contents when being considered with culture and tradition of a city as a background.

K-P08-01
IMPROVEMENT OF COLOR PRINTING QUALITY FOR PLASTIC FILMS BY PLASMA TREATMENT
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Recently color printing has been remarkably evolved by the progress of printer and ink. It has been used to print on not only paper, but also various materials, such as plastic film, ceramic, carbon and so on1. Particularly, color inkjet printer has been greatly progressed by a multimedia boom. For example, it is visually effective for presentation to print on plastic film by using color ink jet printer. Control of the workability (contact angle) and roughness of plastic surface are important for color printing. It has been carried out using various methods. Especially, cold plasma treatment has many advantages. Hence, it has been applied not only to modification of plastic surface, but also to that of many kinds of materials such as carbon, semiconductor and so on. In this study, we investigate the optimum for color printing condition in relation to the chemical surface property by applying plasma treatment to plastic surface. The specimen used in this investigation was a polyethylene terephthalate (PET) film (50 × 60mm). The PET film surface characteristic was estimated by measuring contact angle (workability) to water and its change with time, namely, the elapsed change. Furthermore, it was printed in color after 24 hours from the end of the plasma treatment. The type of the color printing was the ink jet one. The qualities of color printing were estimated by ink bleeding (blur), dot shape of printed ink, stimuli (X, Y, Z), spectral distribution, drying condition of ink. In case of CF, plasma treatment, the PET film surface became hydrophobic, so the dot shape was held accurately. Against this, in case of O2, (N2, Ar) plasma treatment, it became hydrophilic, so it was not held accurately. However, N2 plasma treatment is optimum for color printing because the spectral distribution of cyan ink on the surface was most similar to that on the private paper.

K-P08-02

COMPARISON OF PRINTING QUALITY BETWEEN COLOR PRINTERS WITH THE SAME RESOLUTION
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*Department of Computer and Information Engineering, Gunma College of Technology,
2Department of Electrical Engineering, Gunma College of Technology

Printing quality of color printers with the same resolution were compared using an appraising method[1-2] based on mean-additive mixture[3-4] and dot accuracy.

Dot accuracy is important factor for high quality printing. We have been studied about the relation between dot accuracy and the error of reproduced color caused by ink spread, and reported the degree of error of some printers with different resolution[5-6]. However, different resolution influenced appraisal value. In this study, we used printers with the same resolution and extract the influence of ink spread only.

As we reported, quantification process was carried out 1. test-chart printing, 2. Stimuli measurements, 3. theoretical value calculation. Ink-jet type printers and a chrome-meter were used. The appraisal value decrease as the degree of ink spread decrease.

Color printers used in this study kept dot accuracy and showed almost the same appraisal value, but the value does not decrease from certain threshold value. It is necessary to investigate what factor raise or lower the appraisal value in detail.


K-P08-03

COLOUR DIFFERENCE AND COLOUR PREFERENCE IN VIDEO IMAGING
Andrew Chalmers
Department of Electrical and Electronic Engineering, Manukau Institute of Technology, Auckland, New Zealand

The purpose of this work is to assess whether there are objective criteria that may be applicable to colour preferences in video scenes. Test sequences used in an earlier study of colour reproduction in television [1,2] have been employed in a new investigation [3] making use of digital image-analysis techniques to facilitate the measurement of colour differences between the previously-used test and reference images. This computer-based work is on-going, and it is revealing close correlations than previously measured, between the colorimetric and the subjective scales used in rating the test images.

To put these remarks into context, the earlier work [1,2] centred on a study of the colour reproduction properties of different light sources used in illuminating television scenes. The methodology was based on that proposed by the CIE Technical Committee on the Television Illuminant Consistency Index. Two test scenes were employed, one being a Macbeth ColorChecker® and the other a printed copy of a photographic portrait which contained a large area of facial complexion as well as several other coloured segments of both high and low chroma. Video reproductions of these scenes were made under the reference source (tungsten halogen) and under a range of 15 different test sources. The camera controls were used to the full extent available, in order to ensure correct (as near as possible) grey-scale rendition, leaving residual colour shifts between the reference image (taken under the reference illuminant) and the test image (taken under the test illuminant). These residual colour shifts were assessed in terms of both perceptibility and acceptability, by a group of approximately 25 observers (both experienced and novice), leading to the formulation of a Mean Subjective Rating (MSR) for each test image.

The new work has involved the digitization of all the test and reference images used previously. Computer-based image analysis techniques have been applied to assess whether there are correlations to be found between the MSR and the average colour difference between each test image and the reference image. Good correlation has been found when using the CIE-1976 colour difference, 

The current phase of this work investigates, in more detail, whether there were specific colour shifts that counted more heavily in the observers’ responses, and which may have influenced colour preferences.

To question about theory chromatic light paint
Voschikov Lev
LV laboratory, USA
Color space theory
proprietor RUSSIA 4871060, 1991 year.
(full text presented at first)

Discussed theoretical aspects chromatic paint, light, mixture pigments.
Examine practical quantity physics, mathematical apparatus, work to illustrated.

must will be presented strongly in the line Color space theory, exactly with the fig 1.
Voschikov Lev, proprietor RUSSIA, 1991 year, No 871060, ROSPATENT, Moscow.

K-P08-05

COMPUTER GRAPHICS AND COLORIMETRY; COLOR SYSTEMS, POSTSCRIPT AND DEVICE-INDEPENDENT CIE-COLORS

Klaus Richter
Federal Institute for Materials Research and Testing (BAM), Project group: Visual methods and image reproduction for NDT

A book with more than 500 color figures (many multilingual) was developed for the teaching of color at technical university. An additional CD-ROM includes the booklet and all the figures in Adobe Level 2 PostScript (PS) and Portable Document Format (PDF) prepared for full text search by Adobe Acrobat Reader, which is on the CD-ROM for MAC, UNIX and WINDOWS and menu driven in 7 languages.

The color figures are programmed by the author in PS-vector graphics and can be simply reproduced by copying the PS-files to one of 500 different PostScript devices of 60 manufacturers. PDF-files can be viewed on monitors and reproduced by "print" on any printer. Compared to color pixel graphics the PS- and PDF-file size is about 1000 times less and the transport and output very fast. The book in PS- and PDF-code shows similar properties and includes with 500 figures less than 10 MBytes in PS- and 3 MBytes in PDF-File. In Computer networks the full text index allows searching for any term in the book and figures, e. g. searching for the terms "contrast" transports only 4 of 800 pages and reduces presentation time.

A user can modify the figures without special knowledge of PostScript. He can produce his own presentations in his application. In desk top publishing systems (PageMaker, Quark Express) the figures can be freely scaled and a user can include them in any monitor, overhead or printed presentation.

Many of the colors in the figures are described by device-independent colors and therefore the output is within device-dependent color tolerances for calibrated color devices. This also allows digital reproduction within device-dependent tolerances of digital output systems via the Internet computer network.

Klaus Richter, Computergrafik und Farbmetrik; Farbsysteme, PostScript, gerätemababhängige CIE-Farben, VDE-Verlag, Berlin 1996, 288 pages including CD-ROM and more than 500 color figures, ISBN-3-8007-1775-8
K-P08-06

Colour in Film
1. Department of Beijing Film Institute
2. Beijing Science Education Film Factory
3. International Depart of Beijing TV Station(FTV)
4. China Center TV Station (CCTV) Movie Channel
5. Greenwood Cartoon Co. Ltd (Beijing)

Colour is not only the reproduction of real life in TV and movie works but also the description of the imagination of people's soul. It can not only control people's visual feeling with its remarkable ability of expression but also express the sound and give it a new meaning.

1) Time, the number of grids, the recreation of colour itself and its limitation.
2) the different demands and effects in colour, light and shadow between the aesthetic films with advertisement style and the realistic films.
3) Computers and special efforts take part in the producing of films and they has brought reforms and limitation to the realistic colour of films.
4) Cartoon's demands and the various possibilities of the choosing to colours are different from other TV and movie works.
5) Colour has a character of nationality in TV and movie works. It also has a link with traditional culture and at the same time it makes itself develop.
6) Colour's character in TV and movie works.

K-P08-07

STUDY ON THE PHOTOMETRIC AND COLORIMETRIC CHARACTERIZATION OF THE VIDEO IMAGE

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On the basis of the theory of photometry and colorimetry, the video image's photometric and colorimetric characterization measuring system is presented in this paper. A method of opto-electronic integrator is applied in this system. The optoelectronic translator is a silicon-based CCD-array which spectral responsivity functions are made to match the color-matching functions for 1931 CIE standard observer \(x(\lambda), y(\lambda), z(\lambda)\). This system not only can measure the photometric and colorimetric characterization of the CRT uniform block, but also of the 512 x 512 units of video image at one time (about 30 seconds).

K-P08-08

Evaluation of CIE 1986 whiteness formula using CIE color monitor

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Abstract
Various fluorescent whitened textile samples were so produced that they cover the whole area of color space where the CIE 1986 Whiteness formula is applicable and measured by a spectrophotometer with monochromatic illumination. From the data by the spectrophotometer, spectral radiance factor of each sample was composed for the illumination used in actual visual assessment and from that, the tristimulus values X, Y and Z and finally the Whiteness Index by CIE formula were calculated. Based on these data, following three experiments were carried out to evaluate the formula in the applicability and the compatibility to the visual assessment.

1. The samples were visually assessed and sorted in order of the whiteness by the method of paired comparison under the illumination for which the spectral radiance factors were composed and the correlation between orders of whiteness from perceived whiteness and from calculated Whiteness Indices was examined.
2. The tristimulus values X, Y and Z were converted to the control signal R, G and B for reproducing the colors on a CRT color monitor and the same assessment and sorting procedures were carried out on the images on the monitor simulating the paired comparison mentioned above, and the correlation to the calculated Whiteness Index was examined as above.
3. The correlation between the visual assessment of the actual samples and the assessment on the images on the monitor was examined and the fidelity of the images on the monitor were evaluated from the viewpoint of the applicability to such assessment.

The information from these experiments shows the performance and the limitation of the CIE formula and proves the good correlation between visual assessments on actual fluorescent whitened textile samples and those on the images on a CRT color monitor.

K-P08-09

RENDERING OF THE COLOR AND APPEARANCE OF PAINTS AND PAINTINGS WITH IMAGE SYNTHESIS

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Computer generated images elaborated with physical models describing the color appearance of paints and paintings are presented. Simulating the colored aspect of manufactured products for a standard viewer (CIE specifications) operating in various lighting conditions form a new field of research and applications. The model used here for the simulations is derived from Saunderson works and more generally from the Kubelka-Munk theory. An important part is given to the determination of the absorption and the scattering coefficients (K and S) in homogeneous film of paint. The diffuse and specular behaviour of light when interacting with painted materials are then accessible and allow to include the effect of the concentration for each species of pigment or dye embedded inside a specific binder (oil, water, resin, etc.). Since 1870 the pigments for artist paint formulations are prepared by using industrial grinding. This process of manufacturing is accurate enough to produce very regular pigments in their size and shape. When pigments were frequently prepared by the artist himself, the cause of color was made by a strictly visual determination. This method involved the great experience of the masters. The irregular distribution of pigments influences the saturation of the prepared color. Some particularities grained with the same substance appear whiter than bigger particulars do. For this reason it is very difficult to decide if a color is more or less combined with the white base or if its whiteness is only due to the size effect of the colored pigments. The applications of the model presented here are planned for color design of manufactured products as much as for virtual restoration of paintings.
The purpose of this study is to investigate the relation between the perceived texture, observed by looking at the fabrics, and their physical characteristics such as the geometrical structure of the fabric and their optical properties in reflected light. Various fabrics were systematically prepared by dyeing white cotton yarn using reactive dyes following hand weaving. Thirty kinds of fabrics were made for the experiments: two levels of brightness of red, green, blue and purple; one level each of light yellow and non-dyeing white; and three different weaves of fabric (plain, twill and satin) which were woven with the same packing density of yarn at 8 courses × 8 threads/cm².

The geometrical characteristics of the fabrics were measured by the woven counts/cm and the thickness of the fabric. The reflected light characteristics were measured as the functions of surface color by the JIS (Japanese Industrial Standard) method and/or three dimensional spectral color, and three dimensional light intensity by Goniospectrophotometer. The distributions of areas of upper lighter yarns vs. darker shade yarns of surface image of the fabrics were measured by the Image Analyzer.

Texture sensitivity arising from light stimuli of vision were examined by Shaffer's Paired Comparison Method as the measures of the eight adjective words: rough/fine, thick/thin, glossy/not glossy, soft/hard, like/dislike, bright/dark, warm/cool and heavy/light. Effects of the physical characteristics on the perceived texture were subsequently discussed. It was concluded that the reflectance (Y%) should be influenced by the weave constructions in spite of the same yarn used, with the highest reflectance on plain and the lowest on satin. The orders of the thickness and brightness of the fabrics by vision corresponded to the orders of the physical thickness in mm and Y(%), respectively. On comparisons of fabrics produced by the same dye at different brightness/saturation levels, it was concluded that the higher the saturation level (or brightness), the thinner and lighter the fabric should feel.

K-P09-02

Cancelled
In stage lighting design one of the most important problems to be faced is to see how to maintain a unit of style throughout the different changes. In this respect, it should be borne in mind that, in addition to the visual aspects (colour, intensity, diffusion, position) of the light sources, there is also a temporal aspect i.e. the visual aspects present variations in the course of time.

The lighting variations are made with the purpose of contributing to the comprehension of the play, in creating a lighting situation for a specific scene, the treatment of the light colour together with the treatment of intensity is of great importance. The intensity of a light source is equivalent to what painters call the value of colour. The problem raised is that scenery and script frequently present different requirements in relation to colour, intensity, position and diffusion of light (morphological aspects). However, the solution may be found in the good choice of a timing for the change from one light situation to another (syntactical aspects). This paper develops a syntactical point of view for the analysis of morphological factors changes in the stage lighting design.

To illustrate these ideas, I have selected a play by the Italian playwright Luigi Pirandello (1867-1936) "La Patente", for which a realistic scenery has been created.
COLOR DEVELOPMENT OF TOMATO DURING POST-RIPENING
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The respiration which is one of the primary metabolisms is taking place in most of the harvested agricultural products, and the secondary metabolism occurs from the various primary metabolites. The production of pigments forming the surface color of the agricultural products is one of this secondary metabolism. The purpose of this study is to investigate the changing way of the surface color by measuring the surface color change in tomatoes during post-ripening, and to find the relationship between the color development and the production of pigments.

As the experiment, the mature green tomatoes were stored at 25°C under ambient air conditions, and the surface color change in tomatoes was measured at periodic intervals. Surface color of tomatoes was determined using the color image processing system with the HSL (H: hue, S: saturation, L: lightness) color space. Since H and S were proved not to be affected by the quantity of light and the uneven illumination, and the uneven surface by the experiments with the standard color plates, these H and S were determined to be the index of the surface color of tomatoes.

As the results, it was found that H at each point changed logistically and the surface color changed from the several special points which located just upon the radial wall of the pericarp. Using H values, we also analyzed the changing rate of the three kinds of pigments, chlorophyll, carotene and lycopene, which play a great role in the color development of tomatoes. Since it was reported that the production of carotene was much less than that of other pigments, changing rate of the chlorophyll and the lycopene were calculated by assuming that the carotene content was small and constant in tomatoes during post-ripening. The calculated values showed the similar tendency to the extracted values of the pigments. This work suggested that the color development of tomatoes was deeply related to the metabolism and inner structure, and that the HSL color space was suitable for the analysis of the production of pigments.

COLOR DIFFERENCE MEASUREMENT FOR PLASTIC PARTS OF AUTOMOTIVE INTERIORS
Mikiko Kawasumi1, Yoshikazu Ishihara1, Miyuki Yamakawa1, Yoshihiko Tanaka2, and Hiroyuki Hino2
1 Toyota Central R&D Labs., Inc. and 2 Kanto Auto Works, Ltd.

Color matching of automotive interiors is of importance in a total quality look. Because of vagueness in subjective evaluations, we have hoped that color measurement would provide objectivity for clear-cut decisions. We set out to establish a new method of color difference measurement for plastic parts which have grain texture on the surface. As a result of our studies, however the present system had two problems, for one thing, it could not catch brightness without effect of visual gloss from surface grain texture, and for another, color tolerance in various color directions did not agree with visual sensitivity. By measurement using multi-angle colorimeter, the brightness from pigments in resin is separated from the effect of gloss, and then summation of expertlike weighted data brings good color-match quality in pairs with different gloss. Moreover the new method induced by visual sensitivity in various color directions is in use for evaluation of color tolerance in our system. While improving measurement and evaluation methods, the system attained good correlation to visual and was put in practical use.
ACCORDANCE OF SIGNS AND-COLOR CODE IN PUBLIC PLACES
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Color coding is often used in public signs such as traffic signals of red, yellow and green. In order that people can recognize the public signs easily and instantly and can move around smoothly, the color and pattern of a sign must be well accorded with. For examples, the "go" sign at a platform wicket in subway system is sometime designed as a circle. If the circle is color coded with green, which has consensus of safety, there exists accordance between the pattern and color and the sign does not create problem. If on the other hand the circle is combined with red, which has consensus of alarm, people are a little confused and any action to follow the sign might be delayed, or in some extreme case human error might occur. A survey of signs was carried out for various public places such as train stations, bus stops, schools and hospitals, and the results are presented as a table. In most cases the accordance was found good, but in other cases it was not. To mention an example, the "go" sign was designed as an arrow and "stop" sign as a cross at subway stations, and both signs were color coded with red. Production cost is much less to use a same color for both signs in this case where a diode display is used. But of course it is advisable to use green for the former. Another example is the toilet sign. It is a social custom of Japan to use blue for men and red for women, but in some places both were shown by only black. The smoothness of behavioral movement is a little bit retarded. Other examples and comments for improvement for signs will be presented.

THE COLOR OF WORLD HERITAGE -THE HISTORIC VILLAGES OF SHIRAKAWA-GO AND GOKAYAMA- THE TRADITIONAL HOUSES IN THE GASSHO STYLE
Masao Yamagishi
Kamizawa College of Art

Purpose of investigation:
By looking at World Heritage from their coloring, as compared with complexion, I intend to grasp their coloring information and finally to utilize my research for preserving precious Heritages.

It was on Dec.15,1995 in UNESCO World Heritage Committee at Berin that decided the registration of The Traditional Houses in The Gassho style at Shirakawa-go and Gokayama for World Heritage. There is no definite criterion of the influence of color on registration of World Heritage. But most of registered world heritages I saw had harmonious colors. In this research, I surveyed the traditional house in the Gassho style built between Edo and Meiji era. However some objects such as signboards has been included in my study.

Object of this survey:
The Traditional House in The Gassho style 45.6ha×59houses in Shirakawa Village Area, Gifu Prefecture.
The Traditional House in The Gassho style 10ha×21houses in Taira Village Ainosaka area, Toyama Prefecture.
The Traditional House in The Gassho style 4.4ha×9houses in Kamizawa Village Suganuma area, Toyama Prefecture.

Method of analysis:
Measuring the color print depended on by direct reading method of color difference (IEC 900 Color Measuring System, NIPPON DENSHOKU Co., Ltd.).
The color concept that explain the result is Perceived Color and Psychophysical Color.

Consideration:
Colors of Heritage area mostly tend to be beige line and Taupe, and there is continuing brownish dark gray village. It seemed to me that efforts to conserve historical building had constantly made by the people there. Munsell Value is around 3.5, Munsell Chroma regards approximately 2.5. Munsell Hue tended to YR line example of Taupe (4.0 YR 3.5/1).

This is the evidence that the climate color agreed with climate condition has been existing in these areas.
**K-P10-05**

**AN ESTABLISHMENT OF A PRACTICAL GUIDE FOR COLOR DESIGN BY IMAGE TYPES IN OFFICE INTERIOR**

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There is a tendency that the existing office buildings have not been designed for user's comfortable environments but for economic effects and benefits. With the advent of the appearance of information society and high-tech office buildings, it is the right time for designers to create more various, comfortable office buildings environment corresponding to the change of office function and its environment. Therefore, it is necessary to utilize the usage of colors divided by industrial types and to pursue the variety which enlarges the range of the existing color usage.

The aim of this study is to establish a practical guide for color design in office interior. And, this color planning is on the purpose of seeking more comfortable environment by using suitable, various colors fitted with business functions.

The process of this study is composed of four stages.
1. The interior colors of the office buildings are surveyed. And the color characteristics are analyzed.
2. The evaluation construct model is extracted by using the Repertory Grid Development Method. And the color image type is selected by the construct model.
3. For the evaluation experiments, evaluation objects are made by Color Image Processor. The parameters are hue, value, chroma and the harmony of color scheme of the wall. The experiments are carried out by color simulation using Color Image Processor. Measuring Scale is the scale by Semantic Differential method. The means of analysis are two. The one is statistical statistics and the other is the HAYASI program.
4. Finally, the practical guide for color planning in office interior is established quantitatively.

The results of this study are as follows.
1. The evaluation construct model is extracted and it is selected six adjectives - 'variable', 'comfortable', 'chic', 'clear', 'warm', 'soft' - based on the construct model as color image types.
2. The results classified by the color image types are as follows: 1) The 'variable' image was deeply influenced by the value and chroma, and it was marked high in low value and high chroma. 2) The 'comfortable' image was related to the value and chroma, and it was marked high in high value and low chroma. 3) The 'warm' image was greatly influenced by the hue and the harmony of color scheme, and it was marked high in the hue of KP, R, YR, Y and identical and similar harmony.

**K-P10-06**

**THE OUTSIDE COLOURS OF THE HOUSES IN THE NORTH PART OF HUNGARY**

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I've begun to make a study on hungarian country-houses. There are other colour preferences at the houses of different regions of popular art. I would like to treat the whole Hungary. I've started with the northern part of the country.

I'm making photos or slides about the houses and I'm measuring the colours of the various parts of the buildings /pedestal, wall, ornament, door, window etc./

I'm defining the colours in Colouroid Colour System and looking for the connection between the used colours.

In the course of my research work I've found the colours of our age based on historical colour preferences. The colouring tradition of the country houses is some hundred years old. It is based on peoples impulsive colour choice.

The possibilities to express relations to colours have always been delimited by known available pigments. Originally, coloured minerals and plant juices were used as pigments. Today the wide choice of paints are offered by the paint industry, but they are used only on a limited scale.

You can see some type of colour harmony at country-houses: complementary harmony, colour scales of colours of equal hues, but of different saturations, triadic harmony etc.
K-P10-07

RECONSTRUCTION OF A TURN OF THE 20th CENTURY SECESSIONIST STYLE MULTISTORY BUILDING, WITH FOCUS ON MAINTAINING ITS ORIGINAL FORMS AND COLORS—LOOKING AT IT TODAY

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This building is in the center of downtown Budapest, designed by Karman-Lillmann and built between 1910 and 1912. Today's reconstruction focuses on keeping the original function of the building—a luxury department store on the first four floors with a condominium complex above it. As the open stairway winds its way up to the top of the department store, one can continuously look at the remaining wall and see the original forms and colors. This meant to be a reminder of the true architectural beauty of that period. The main thrust of the interior design is to bring this traditional concept into today's environment. The foreground is the main principle in using different materials, forms and colors. The general and background lighting supplement each other in total and absolute harmony.

K-P10-08

THE COLOR SURVEY AND ANALYSIS ON THE ARCHITECTURE AND THE NATURAL ENVIRONMENT BY REGIONAL GROUP IN KOREA

Jin-Sook Lee¹, Jeong Woon Seo²
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For the color design of the architecture that corresponds with environmental peculiarity of the existing architecture and natural environment, it is necessary to investigate and analyze the local color which consists of the existing architecture including traditional architecture and natural scenery by regional groups.

This study presents the indispensable data for pleasant color environment design by investigating and analyzing the environmental color made from the architecture and natural environment and also by extracting typical local color of every regions in Korea. In order to make local colors clear, the regions to be investigated are classified into 6. And then each region is classified into 4 smaller groups in accordance with the characteristics of its architecture and its natural scenery. 4 groups are as follows: 1) the region preserving a lot of the traditional architecture, 2) downtown streets mingled with old and new architecture, 3) downtown streets of those comparatively lately constructed, 4) natural environment composed of the sky, the ground, and the tree. In order to grasp the problem of color usage and composition in the new and the old downtown streets in modern architecture regions, the color difference from adjacent building by L*a*b* is figured out.

The results of this study are as follows: 1) The color of the traditional architecture of each region is similar. And the characteristics of natural material in every region is almost similar. However, environmental color of Jeju-do Island differs from that of other regions because materials of the wall and the fences consist mainly of volcanic rocks. The hue of traditional architecture is generally Y or YR with value from mid to high, and low chroma. Therefore the color of the traditional architecture is good in harmony with nature. 2) There are no manifesting differences in the color of the modern architecture in each region. Most regions tend to be classified into 3 types; the architecture of R with mid value and low chroma, those of Y, YR with high value. The difference of color characteristic is greater between old downtown streets and new downtown streets rather than among the regions, which indicates that the materials have been changed according to the year of those constructed. 3) As the result of the analysis of the color difference of adjacent buildings in the streets, the old downtown streets mingled with new and old buildings are not in order because of great color difference. But the newly created street is in good order in color difference. The difference of trends is closely related to the materials used in the construction—such as brick, paintings, and tiles in the old downtown streets, but newly produced tiles in downtown streets. (4) Local characteristics in colors of natural are not found. The sky is the hue of B, PB, N with high value and low chroma and the tree is the hue of Y, GY with mid value and mid chroma, the ground is the hue of R, YR, Y, N with low to high value and low to high chroma.
A-O25-01

STANDARDIZED TERMINOLOGY AND PROTOCOLS FOR SPECIFYING AND VERIFICATION OF PERFORMANCE OF SPECTROCOLORIMETERS

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Recent advances in optics, electronics and documentary standards have resulted in commercial spectrocolorimeters with exceedingly good performance, but there has been little or no effort to standardize the terminology and procedures to document that performance. As a result, the commercial literature is a mess of confusing terms, numbers and specifications that are impossible to compare. J. Ladson was the first to highlight this problem at the recent AIC Interim Meeting. While he identified the problem he did not propose a solution other than some new terminology. This paper proposes standardized terms for the most common instrument features (repeatability, reproducibility, inter-instrument agreement, intra-instrument agreement, accuracy) and describes a set of measurements and artifacts which both the producers and users of spectrocolorimeters can use to verify or certify the specification and performance of spectrocolorimeters. Adoption of these standards will allow better communications between instrument manufacturers and instrument users and between suppliers of colored materials and purchasers of colored materials.


A-O25-02

TESTING FASTNESS FORMULÆ FOR ASSESSING COLOUR CHANGE USING NEW EXPERIMENTAL DATA

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In the previous study [1], the colour contours of constant grades were computed from different fastness formulae for assessing colour change including ISO, CMC, NC#, FC CIELAB. The differences between these formulae were identified by comparing these contours. It was found that there are very large discrepancies between different equations.

In this study, 94 pairs of samples were prepared surrounding 20 colour centres which covered a wide range of colour areas. Each pair was assessed by a panel of 18 observers against the standard grey scale for change in colour. This data set was tested using different formulae and the pairs shown the worst agreement between the visual results and the formulae were accumulated. Their results will be given in the conference.

A-O25-03

COLOUR OF TEETH
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Teeth are made by nature and have a particular structure in which translucency and reflectance varies through its surface. Their colour depends on many factors: the illumination light (spectral composition and spatial distribution) and the contrast against which are observed.

An apparatus to measure these appearance characteristics needs to be capable to evaluate the general impression and at the same time the particular detail of several parts on each tooth. When dentist need to repair or replace a tooth he needs to match the replacing piece with the rest of teeth.

Having in mind that he is trying to replace a human osseous part with a porcelain or and acrylic piece which not only have to do the mechanical work but to look “natural”, that is cannot be detected by casual observers, is a very hard task.

The present work summarizes research done in that area.

A-O26-01

AUTOMOTIVE EXTERIOR COLOR DESIGN IN THE 21ST CENTURY
– A MARRIAGE OF ART-ORIENTED AND PRODUCT-ORIENTED DESIGN–
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1 Color Design Center, Nippon Paint Co., Ltd., 2 Nishinobe Industries Inc., 3 Department of Precision Engineering, Osaka Electro-Communication University

Many kinds of flake pigments such as aluminium and mica, most recently, graphite and iron oxide are used for automotive exterior color. It may be possible to produce an infinite number of colors by combining these materials and pigments. However, since “automotive color” is an industrial product, it is subject to a certain condition, such as cost and product feasibility. Although the designer tries to realize his/her idea with “texture”, the original idea may not be fully achieved because of various restrictions.

As the importance of color design for industrial products has been increasing, we have attempted to search for how we can synthesize Art-oriented and Product-oriented design. First using a multi-angle spectro-photometer, we measured both two hundred seventy colors applied to the actual models and one hundred twenty colors designed for the models of the year 2000. Then we drew the color gamut for all samples in the L*a*b* color space. Thereby we can be observed differences between the applied colors and the designed colors. Furthermore we considered the “textured colors” which were beyond the description in the L*a*b* color space.

To evolve “textured colors”, the feeling of the “texture” was reconfirmed using realistic images by computer graphics. Moreover we propose the possible directions of the “textured colors” toward the 21st century.
A-O26-02

MATERIALS USED FOR RESTORATION OF BUILDING OF MINISTRY JUSTICE.
(STUDY ON BRICK MATERIAL AND COLOR);
Kenji Sugiura, Akira Asano, and Masaki Inoue

The old building of Ministry of Justice is one of the most famous brick constructions in Japan. It was planned by Enke and Beckman and completed in 1915. It was not damaged even by the Kanto earthquake (1923), because it had special design for anti-earthquake structure and reinforcing method. Its wooden part was burned down during World War II. It was rebuilt after the War, but the original building style was changed a lot. The Heisei Era (1992-1995) repair was for restoration of the external appearance of the facade. This study covers the investigation of building materials used for the original building, the Postwar Era (1946-1953) repair and for the present restoration by use of instrumental analysis. It is very important in this study to survey existing documents, because this building was built in the Meiji Era. We did a review of the documents, and interviewed the specialists of bricks to know the production method at that time. The brick used for the original building was made of the raw materials consisting of white soil and red soil with ratio of 8 : 2 respectively, and it is classified as yellow brick. The bricks for this restoration were produced at the same factory, but fired in a tunnel kiln. Some holes were opened regularly in the bricks. According to the company, the holes were not for placing mortar, nor for inserting iron bar through them, but for obtaining uniform color on firing. These bricks were called hole-bricks at that time. We found some of the bricks used for underground floor to have marks of cherry blossom on the reverse sides, indicating that these were produced at the Koyagi Plant. Germany was the third source of bricks. Traditional brick laying Omotesenki. The mortar used for laying the bricks consisted of cement, lime and stone and the mixing ratio was found to be of 1 : 4 : 6. The corner bricks were reinforced by a lead joint. The Hoffman-kiln is the method of producing bricks used for this repair works.

A-O26-03

COLOUR DESIGN THROUGH CROSS PERCEPTION
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The advancement of the total appearance concept was crucial to the various fields of human design gradually tending to replace natural design. It heralded the need for the conceptualizing of our artificial world to be superseded by a holistic one in the model of the Vanishing Nature of which we see are integral parts. However, the application of appearance profile analysis entails the cutting down of a scene into parts to be assessed either instrumentally, or/and by visual, constitutive, and aesthetic judgements.

In the author's opinion the failure of the total appearance approach is, on one hand, that it cannot stabilize a colour combination from the moment a new colour enters a specific composition and a whole-scale retouching is required. On the other hand, the work of art is an integral existence created in the "whole" of the artist's subconscious out of repressed and desensitized images melded down together into an "inner fabric". Only after its clothing with plastic effects and animation by a presence which is partly in the beholder’s eye does this new integral existence recur conscious. In what parts can it be cut down or gridded up in order to be objectively analysed? Besides, how can, e.g., natural phenomena be conceptualized by design through the total appearance concept only to analyze existing symbolisms?

In this research is put forth the probability of cross perception, i.e., translation of e.g., auditory information into visual information inside the human being. It is assumed that an auditory information may at will cause apparent motion cortical visual arousal directly translatable into apparent form/colour cortical visual around the motion pathway of visual perception being already neurobiologically detectable.

On this assumption was based a double experiment with 200 subjects who were asked to listen to two different dancing tunes, one popular greek, another modern western and fit in 16X16 square matrices 4-grey colour squares, triangles or/and quadrants in the way they liked best. The objective was to find out the relation between the formal qualities of the derived squares and of the corresponding tunes, the deviation of the prevalent qualities of one group from those of the other and the possibility of building a native form pattern for contemporary greek colour architectural design on basis of these qualities. In the right aesthetic climate artistic traditions which bind the artist both in concept and form can give more freedom than the uniformity of our time.
A-O26-04

COLORED VIVIDNESS AND COMPLEX COLORS
Isabelle Mouret
Department of Plastic Arts and Applied Arts, Toulouse II le Mirail University (France).

I would like to define a colored vividness, as part of pictorial art, according to a "complex colors" strategy and not a "simple colors". It's all about extending the field of "color" as it is usually identified, especially in artistic practices and in their analyses.

Indeed, the colored model which is accepted today by all as representative of the colors' space, of all the colors, is based on the color's perception. It takes into account the colors according to three variables: brightness, saturation and tonality. This model, most often, forshadows the shades about colors' uses, like the Shigetoshi Kobayashi's one. Yet, the identification of one type of chromatic phenomenons according to these three variables remains sometimes in excessive simplifications. Finding a colored sample for some mineral colors, for example, according to these variables involves a distortion of the colored phenomenon itself, which is identified to a flat tint. The same thing occurs for some textile's colors, especially changing textiles.

In that way I introduce the notion of "complex colors".

It's all about naming, classing and categorising colored phenomenons like "chine" or mottled, identifying them as whole colors and not as motives, for pertinence's reasons in the chromatic study. In the field of artistic and pictorial creation, the recognition of a color's complexity is necessary to analyse the color's strategy in a non-over-simplistic way.

A-O26-05

COLOR AND CHOREOGRAPHY
Vanessa Labrède
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My research deals with the relation between Plastic Arts and Performance's Arts.
My purpose is to study the means of plastic structuration, concerning the contemporary dance's performances. More exactly, it's all about knowing how to speak about vividness through the relation between color and choreography. I think it's through a common work of an organization and a symbolization of colors, on which plasticiens and choreographers, technicians and lighting technicians, stage-managers, decorators, dressers agree, etc., that the meaning of the creation can end on a new understanding of performance. So, the color and its use in the field of the creation would lose its role which is more often anecdotal, it would rather assert itself as a whole means of expression and would truly be a sign for us.

My research will consist in disclosing that modelization of choreographic color can be updated, that it can serve in concise terms. As you have understood, my project is to show that a modelization of colors related to a choreographic notation's system can be formulated, that is to say, a other form of plastic language, a writing of the movement, more adequate with actual, artistic, scientific and cultural preoccupations of our society.
A survey on affective meaning of color was conducted to a total of 576 subjects consisting of Japanese, Korean and American students. Before the subjects, a total of 35 words were presented, including those which express basic human emotions and those which represent value and the subjects were asked to select colors that symbolize their emotions.

As a result of application of factor analysis by nation to the outcome, following four factors almost common in the three nations were extracted. Two of them were factors associated with value and the other two were factors linked with a negative emotional condition.

One of the factors in factors representing a social value, including “future” and “ideal”, which will be associated with vivid blue, pale blue, light blue and white according to the factor score. The other one is factors related to a personal value such as “happiness” and “joy”, which will be linked with light warm colors, including pink, cream and vivid yellow.

One of the latter is factors connected with a negative and passive emotional condition, including “sad”, “gloomy” and “death”, which will be associated with dark colors like black, gray, brown and dark blue.

The last one in factors related to a negative and active emotional condition such as “anger”, which will be linked with vivid red, vivid orange and other dark tone colors.

Words considered most basic in researches into emotion, “love”, “happiness”, “fear”, “anger” and “sad” draw a coincident reaction in these three nations. However, reaction caused by “surprise” and “scare” does not accord. As a remarkable standard deviation is witnessed in answers from the nations for such words in which reaction does not accord, it seems that such emotions are rather unlikely to be linked with colors.

This leads to a presumption that although the structure of emotions associated with colors is common to the three cultures, some of emotions contain cultural difference to a degree.

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**B1-O27-02**

**IS THE SUN RED OR YELLOW? - A COMPARATIVE STUDY IN JAPAN, CHINA AND INDONESIA-**

Miiho Saito

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It has been said that Americans draw the sun with yellow colors and Japanese with red. In the author’s comparative study in 1983(1), most Japanese-Americans chose yellows from a color chart when asked to draw the sun, whereas Japanese most often selected reds. This phenomenon was considered a reflection of the effect of American culture on the way of drawing the sun.

In the present study, 175 Japanese, 158 Chinese and 157 Indonesian university students were asked to choose from a color chart the one color when they would use to draw the sun. The color chart consisted of 70 chromatic colors, 5 achromatic colors, silver and gold. Vivid red was selected most often in China and Japan for the sun, while approximately 60 percent of Indonesians chose either vivid yellow or light yellow instead. A high percentage (about 30 percent each) of subjects selected vivid orange in all the groups. The author also asked the same question regarding the moon and stars and found that light gray and white were frequently chosen for the moon in Indonesia and China but not in Japan. Silver and gold were most often selected for stars in all countries, but bluish colors were chosen at a significantly higher rate in China.

These results suggested that the drawing of these objects might involve certain styles or concepts which have arisen out of or been defined according to the culture of the subject’s geographical area of residence.

B1-O27-03

CROSS-CULTURAL COLOR DIFFERENCES IN STREETSCAPE BETWEEN GREAT BRITAIN AND JAPAN

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There have been a number of publications on streetscape color in Japan. However, few have referred to the international differences as to streetscape color. The author reported the regional attributes of streetscape color in south-west Japan¹ and north-east Japan². Now, a comparative study on streetscape color has been carried out in Great Britain and Japan through color investigations. The aim of this study is to clear differences of streetscape color and to interpret color attributes from a point of architectural and climatic view between Great Britain and Japan. Color investigations were made in 10 cities of Great Britain and 22 cities of Japan. In the main street, the wall and signboard colors were measured at around 110 points per one city according to the Munsell book of color. And, the color attributes of each city are extracted. As a result of data analysis, the wall color attributes are subject to the influence of wall material and related with climate. Signboard color attributes are explained by the climatic elements to some extent. Particularly, the color attributes of hues and chroma are able to be explained passably. The color attributes are made clear by the correlation and regression analysis. This study treats the present conditions of the streetscape color as they are to understand color attributes. So, from now on, the relationship between color attributes and natural environment may well be researched from the aspect of the environmental psychology, environmental science and cultural science.


B1-O28-01

TWO TYPICAL COLOR PREFERENCE PATTERN AND JAPANESE SENSIVITY.

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From ancient time, Japanese standard of aesthetic consciousness has pretty changed by it's Historical background. And according to this, it also can be seen many transition of their period style and expression on their way of life on the surface.

However, the fashion color of the General Public was developed through Edo-era. And when to compare about the color preference of the people in between Modern age and Edo-era, there is a common pattern observed in the color combination. Namely, there are two typical color preference pattern as monochromatic color tone and the natural color tone which has been flowing as undercurent through Japanese people.
DEVELOPMENT OF SIX METHODS OF COLOR PSYCHOLOGICAL STUDY
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In combination with linguistic scene and photos, colors can be used in a variety of forms for psychological studies. The following six studies are likely to become the focus of attention with regard to consumer color preference, color changes in the market and the monitoring of regional colors. The color psychological studies and the methods involved were:

1. Single-color research: the world of infinite single colors is represented by a system limited to 130 single colors from which you can select 10 colors of your choice. These are then analyzed using a Single-Color Image Scale in order to determine individual preference patterns.

2. Color-combination research: five color combinations are matched so that they become heterogeneous contrasting images. Twenty matches are observed, a preference survey is carried out, and the results are cluster analyzed.

3. Image-word research: you select 20 words you like from 180 adjectives. These words become a database which can be used for parity conversion from linguistic sense to color scheme. Preference patterns emerge.

4. Color marketing study: the single colors and color schemes employed on products sold in various regions are studied, their emergence rate is deduced and basic colors are sought.

5. Lifestyle color image research: if a preference survey is carried out employing photos and color combinations related to clothing, food and housing, tastes and lifestyles can be determined.

6. Environmental research: the color combinations of a large number of putatively pleasant and beautiful scenes are filmed. Colors which appear frequently are examined further, area colors are ascertained and a psychological study of their regional deployment is made.

HUMAN COLOR COUNSELING (COLOR PSYCHOLOGICAL TEST)

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We are surrounded by color but don’t realize the effect it has on us. Sometimes, a certain color can bring out unexpected feelings in a person, therefore feelings can be expressed through colors unconsciously. For example, one’s choice of a certain color is an indication of their state of mind at that time. The name of the test is called Color Counseling (R.C.C.) and the selected color is called the “Human Color.” R.C.C. is a patented psychological test which uses color to evaluate personality and then asserts the individual’s mea-surability. It was developed during the past 20 years through a research process which involved over 20,000 clinical cases ranging in age from 4 to 72 years old. R.C.C. expresses the image of the universe to six circles by the projection method. These six circles are then colored in by the test subject who is evaluated by the colors they have chosen. Two of the six circles are focused on particularly which indicate present and future. There is a combination of 144 color choices which the test subject has to choose from. We could say there are the same number of psychological patterns. R.C.C. can be used with a broad age group, from small children to elderly people. However, the results don’t reflect an individual’s usual mental state, but only their state of the mind at the time the test was taken. Color expresses an individual’s mental state better than words, so the test is useful when evaluating one’s personality. It is also useful for testing personality traits in small children, students, as a way of motivating employees and improving relations among individuals. R.C.C. can be employed as a tool in the marketing field, utilizing effective colors in advertisements and commercials. These examples indicate that the use of color will expand greatly in the future.
B1-O28-04

VISUAL COMFORT OF A COLORED IMAGE STUDIED BY SPATIAL DISTRIBUTION OF CHROMA
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Visual comfort of a colored image was investigated in terms of spatial distribution of metric saturation in the image. By using a specially developed device which can change only metric saturation of each part of a whole colored image of natural scene presented on a CRT display while hue and brightness are kept constant, the observer was asked to adjust the metric saturation to an appropriate point at which the image was felt most comfortable to the observer. This was defined as optimum percent chroma (OPC). The OPC data were obtained for 36 different images including living rooms, dining rooms, offices, outdoors, and so on, by using a total of 25 observers. The data averaged over the observers showed that the OPC data were in good positive correlation with the directly estimated score of comfort judgement, that is, comfort images were preferably seen in nearly original saturation while discomfort images were seen in relatively low saturation. This indicated that the visual comfort was strongly affected by the metric saturation of an image. Furthermore, by comparing the data obtained for images with the same mean metric saturation, it was found that the relative distribution of the densities of low and high saturation seemed to have an important role to determine visual comfort.

From these experimental results it was concluded that the chroma was one of the most critical determinants of visual comfort of a colored image and, as a general tendency, making the image more saturated has an effect of getting the image less comfort visually.


B1-O28-05

EXTRACTION AND ESTIMATION OF THE SENSITIVITY INFORMATION OF COLOR
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Sensitivity information received from an image is influenced strongly on a shape of an object that composes a picture, color harmony and the inside structure of object. It isn't easy that we evaluate directly the sensitivity information from an image. As a fundamental step before handling a general image, we analyze a monochromatic color. It implies that the influence of shape and structure of an object for the color harmony is excluded. We perform an experimental subjective evaluation (Semantic Differential method) that leads a numerical value of adjective couples as observing a color displayed by a CRT. The stimulus patterns that we used in this time, are chosen 201 colors of the PCCS201-L (Practical Color Co-ordinate System). The PCCS is something useful for the color combination planning, because it can easily relate a color name and an image to 3 attributes of a color. Then, we extract factors that express a sensitivity information of monochromatic color by a principal component analysis. It has been reported that monochromatic color sensitivity is composed of three factors called “Evaluation”, “Potency”, “Activity” 1). As our result, same 3 kind of factors concerning with sensitivity information are extracted. The cumulative contribution of this case is 72.4 %. From common impression receive from adjective couple of each factor, we decided it as factor name such as “Evaluation”, “Potency” and “Activity” 2). By applying the statistical estimation for our results, the confidence limit of the 95% was about 10% of the dynamic range of the factor score. Next, we estimate the sensitivity information which is the factor scores of monochromatic color that was not examined. The method used is the potential method which is the linear combination model based on the Godlove’s color difference between the unknown color and the training colors. As the result, for any unknown color, the sensitivity information can be estimated well and the estimated error is located almost within the confidence interval.

B2-O29-01

TESTING COLOR DEVICES WITH ANALOG AND DIGITAL TEST CHARTS BASED ON DEVICE-INDEPENDENT COLORS

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Device-independent color technology is an important field in image technology. For a reproducible image reproduction the failures of any color device or a combination of many devices must be corrected to get visually the same reproduction by the same original. The properties of the color devices change by new technology and the corrections must be modified to get a stable reproduction.

Reference analog and digital test charts are necessary to test color devices, e.g. color copying devices, scanners, cameras, monitors, printers and the offset or digital reproduction processes. Two DIN test charts are described which include monochrome and color elements, e.g. line screens, Siemens stars, and Landolt rings. A 5-step and a 16-step equidistant gray scale is based on the CIELAB lightness \( L^* \) and is reproduced by a standard deviation of one CIELAB unit within the range \( L^* = 0 \) to 94 on photograph white material (output resolution 3600 dpi, 2 degree observer, 45/0 geometry).

The 14 CIE test colors are reproduced in offset printing within small tolerances compared to the definitions of CIE-Publication No. 13.2. Most of the test elements including a scanned image are therefore defined by device-independent colors. The two analog DIN test charts have A4 size and their properties will be described. The digital test charts will be available in Adobe Level 2 PostScript (PS) and Portable Document Format (PDF) for the reproduction by printers and monitors in computer networks.

Measuring the reproduced colors define the failure of the color reproduction system. This failure can be corrected within the digital image reproduction system. There are different methods for these corrections which are all based on measured output differences compared to the analog or digital original. These corrections modify the digital test charts by a change of their data, by a color space transformation or by a (permanent) change of the color rendering dictionary of a display PostScript system or the master image processor (RIP). Examples of these methods will be discussed. The improvement in color reproduction in many cases reaches reproducible color reproduction, where the mean color difference of gray and chromatic colors is within 3 CIELAB units.

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B2-O29-02

Color matching system for the metallic pearl that applies Fuzzy theory.

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Most recently, in painting of automobile exterior, metallic and pearl color are much used. These paint are included many kind of flake pigments such as aluminum mica and pigments. And as these paint measure reflectance by multi-angle spectro-photometer, flopp characteristic appears. In order to develop a complete color matching for these paint, it is necessary to develop the calculate method that estimates reflectance that corresponds to each angle from a mixing ratio of metal mica flake and pigment.

In this report, it is explained about the following four items.

1. About the method that calculates reflectance of an ideal state by means of multi-angle spectro-photometer.
2. Calculation method that estimates reflectance from combination of flake and pigment. In a calculation, flake is based on a model dispersed in the transparent resin layer that is colored by pigment.
3. About a color matching method in order to calculate mixing ratio of flake and pigment. Especially, result of calculating, by combination one of the flake materials that is used for a calculation, there are the case that plural solution exist. In this situation, explain about method that calculates the most suitable solution.
4. Method that applies Fuzzy Inference in order to make a calculation precision of the color matching method that is shown in the preceding clause improve. Concretely, explain about a method of Fuzzy Inference, Fuzzy Production Rule, Membership Function and effect for color matching accuracy.
B2-O29-03
NATURALNESS AND IMAGE QUALITY: HUE, SATURATION AND LIGHTNESS VARIATION IN COLOR IMAGES OF NATURAL SCENES

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For most products in the field of color imaging one of the biggest challenges is to generate high-quality images of natural scenes. Under many circumstances, however, natural images turn out to be very critical test material. A possible explanation for this is that human observers 'know' what the appearance of these images should be. Stated otherwise, human observers can incorporate the degree of naturalness of images into their quality judgments. This suggests that perceived naturalness and image quality are strongly related. But what exactly is the relation between naturalness and image quality? And, how does this relation depend on the kind of color transformation employed?

This paper presents the results of a study investigating the naturalness-quality relation and its dependence on color transformations. Experiments are described in which subjects judged the perceived naturalness and quality of color images of four natural scenes varying either in hue, in saturation or in lightness. These variations were created by digitizing the images, subsequently calculating their color point distributions in the CIELUV color space, and finally, changing hue by adding a constant ranging from -1 to +1 rad to the hue-angle of each pixel (hue rotation around the neutral point), changing average saturation by multiplying the saturation value of each pixel by a constant varying between 0.5 and 2, or changing average lightness by multiplying the luminance of each pixel by a constant ranging from 0.4 to 1.6. The latter transformation resulted in a translation of the color point distribution along the lightness-axis.

In separate sessions, subjects assessed perceived naturalness and image quality on 10-point numerical category scales. The results confirm that there is a strong positive correlation between perceived naturalness and image quality. The relation between the naturalness-quality ratings and hue rotation, average saturation and lightness could always be described by an inverted U-shaped function. No differences were found between the naturalness and quality judgments in the case of changing hue and lightness. However, a small but systematic difference was observed when the saturation values were varied: the inverted U-shaped function for the naturalness judgments was shifted to higher average saturation values relative to the function for the quality judgments. This systematic difference reflects the subjects' preference for more colorful, but, at the same time, somewhat unnatural images. This preference for more colorful images hints at a need of higher color contrast which may be advantageous for improving object recognition. This suggestion is supported by the fact that in the present study the distances between the color points in CIELUV changes when saturation values were multiplied but remained roughly the same when the hues were rotated or the color point distribution was shifted along the lightness-axis.

B2-O30-01
REPRODUCTION OF HIGH ORDER SENSATION ON A DISPLAY AND CROSS MODULATION AMONG R,G and B

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We are studying important factors of the Extra High Quality Imaging System from the point of the reproduction of high order sensation. The strategy is to find some key assessment words. And, based on the key assessment words, we want discover important factors. A key quality assessment word that matches the change of quality due to the CRT we have found is "the depth of an image".

We have just discovered that a specific loss of image depth is observed in the use of a single gun color CRT. We are not sure, but the loss of quality appears seems to be due to a cross modulation among R,G,B color components.

Up to now, no one has pointed out that the specification of "cross modulation among R,G,B" will concern with the display of high quality images. A one gun, three beam CRT has been believed to be the best CRT to display a faithful reproduction of high quality images. However our experimental results show that such is not the case of extra high quality images. We will present in detail at the symposium.
ENCODING COLOR IMAGES FOR THE WORLD WIDE WEB

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The World Wide Web is a hypertext system based on the Internet. It was conceived primarily to allow teams of physicists to relate sets of data and sequences of interpretations of this data, independently of the physicist's location. For improved readability a simple markup language called HTML was created, which allowed the use of more readable fonts and the inclusion of graphs and images. However, for maximum platform independence, the main paradigm was that the author of a document defined the contents and the structure, while the appearance was defined by the reader.

In the meantime the World Wide Web has been embraced by the general public and savvy publishers have quickly recognized its potential as a new publications medium. Commercial publication requires strict control of the appearance, consequently a large proportion of document contents is transmitted as raster images rather than a combination of text and images. Color is used throughout to give a distinctive look to the pages for each publication.

Images require much more time to transmit than ASCII text files and many readers access the Internet from slow connections in their homes. The standard design approach is to use palitized color and to limit as much as possible the number of colors used, so that the images can be encoded with a small number of bits per pixel using the GIF file format.

HTML allows the use of a second file format called JPEG. In this encoding system full color information is preserved for each pixel, but spatial information that cannot be perceived by the human visual system is omitted. Although JPEG is used to encode color images, it is not very popular to encode colored graphics and text. The reason is that when the file is sufficiently compressed the quality of text and graphics is degraded.

We show how the parameters for JPEG compression can be selected to achieve high compression rates while preserving the readability of colored text. This allows graphic designers to exploit the full color gamut available on computer. The main idea is to design customized quantization tables for each type of graphic element, such as image, gradient, text, etc.

Sometimes the artwork is available as a hard copy original which is scanned into the computer and published as an image. Due to technical limitations of desktop scanners, the text in such color images is often fuzzy. In this paper we also present a text sharpening algorithm that operates on the compressed color image and does not require extra computation time. For each cosine basis function, we compare the energy in the original image with the energy in the scanned image. We then scale the basis elements of the discrete cosine transform so that the spatial information attenuated in the scanner is boosted.

NEW COLOUR MANAGEMENT STRATEGIES FOR INDUSTRIAL COLOUR CONTROL

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Colour Physics systems have been widely used in textile industry for colour tolerance control and recipe formulation. However, most existing systems can not fully cope with today's demands on shorter delivery time and lower production cost.

The concepts described in the paper were integrated into a system, named as Supreme Colour Physics Expert (SCOPE), which can achieve above demands. These concepts include colour "on-line", electronic colour library and "Expert Match". The colour "on-line" applies the monitor calibration techniques. Users can create a desired colour on a monitor. The colour will then be precisely transformed to colorimetric values for colour reproduction purpose. This results in a significant time reduction from design to production. Electronic colour library allows users to store and retrieve accurate colour together with recipe information. This eliminates the problem of colour changes of physical samples due to soiling and fading, and ensures the continuity of the dye recipes. The "Expert Match" effectively improves the rate of right-first-time through a self-learning process from recipe database. The SCOPE system provides textile companies a leading edge in the very competitive market.
B2-O30-04
COLOR GAMUT MAPPING BASED ON MINIMIZATION OF PERCEPTUAL IMAGE DIFFERENCE
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This paper describes a technique of color gamut mapping as an optimization problem: Find an image such that perceptually closest to the original under the constraint that all pixels are within the color gamut of the destination device. As a metric of the perceptual difference between images, PD is newly defined as a difference of band-pass-filtered images rather than the conventional average \( \Delta E \).

\[
\begin{align*}
PD(r, o) & = \frac{1}{|A|} \sum_{x,y} \left| a(x,y) - r(x,y) \right|^2 \\
& \text{where } a(x,y) \text{ and } r(x,y) \text{ are } \Delta^* \text{ values of the pixel at the position } (x,y) \text{ in the original and the reproduction.}
\end{align*}
\]

A was described by a DOG (difference of Gaussian) function to have band-pass characteristics. Peak frequency for \( \Delta^* \) is set to be slightly higher than those for \( a^* \) and \( b^* \) according to the psychophysical evidence of human's CSF. It should be noted that if delta function was used instead of \( h \), PD\((r, o)\) would give \( \Delta E \) between \( r(x,y) \) and \( a(x,y) \). From the spatial-frequency point of view, this method reduced the color difference especially for middle-spatial-frequency component, to which human visual system is more sensitive.

A psychophysical experiment (paired comparison) was also performed to evaluate the proposed method. Reproductions by the following four methods were compared: (i) direct (original \( \Delta^* \) was directly converted to CMY without gamut mapping), (ii) 90\%-normalise (reduced chroma to 90\% and converted to CMY), (iii) minimised-\( \Delta E \) and (iv) proposed method. Observers examined an original displayed on a CRT and compared it to a pair of hardcopy reproductions in the light booth illuminated by D50 light source. Observers were asked to choose which of the two reproductions is most like the original, under the paired-comparison paradigm. Observers were seated approximately 75 cm in front of the CRT and hardcopies. Peak frequencies of \( h \) for luminance and color were set to 11.0 and 6.0 c/d, respectively. All experiments were conducted in a dark room. Result shows that the proposed method performed the best (83\% chosen, \( \Delta E = 3.30 \)) while the minimised-\( \Delta E \) method was chosen as the worst in this case (33\% chosen) although the reproduction by this method has the smallest color difference (\( \Delta E = 2.05 \)). Several observers reported that a criterion for judgement of the closeness between images was the balance of color difference and preservation of contrast. Proposed method is based on a consideration to that point and this is the reason why the proposed method performed the best among the experiments.

B2-O30-05
VERSATILE SPECTROPHOTOMETER FOR CROSS-MEDIA COLOR MANAGEMENT
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This paper will address the problem of the spectral characterization of color targets and input/output devices for cross-media color management. Colorimetrically faithful color reproduction requires accurate mapping from each device specific color space to the device-independent color space of the human observer, standardized by the CIE (1931) colorimetric system. Whereas this kind of color mapping can be as easy as a linear transformation for three-primary additive displays such as CRTs, it can be far more complicated for hard copy output devices and input scanners.

We have recently developed various device characterization and color mapping techniques that use nonlinear transformations to convert between CIELAB and the device specific color spaces of scanners and printers. A particular problem arises with scanners for which the spectral sensitivity functions of their three color channels are typically not linear combinations of the CIE color-matching functions \( x=\text{bar}() \), \( y=\text{bar}() \), \( z=\text{bar}() \). Consequently, a pair of metameric stimuli for the human observer may well produce different output signals of the scanner. To handle such cases by an appropriate calibration procedure, the reflectance spectra of the calibration targets are required, rather than only their CIE XYZ tristimulus values. We set up a modular and flexible spectrophotometric system which allowed for fast spectral recordings over a wide range of optical densities. The sensor device was a PC-controlled low-cost grating spectrometer with a CCD photodiode array; the integration time and thereby the sensitivity could be controlled by varying the clock rate of data readout. Collimating lenses and optical fibers were used in combination with a PC-controlled mechanical scanning device to obtain measurements from a series of patches from various calibration target charts.

G-P11-01
Cancelled

G-P11-02
Cancelled
G-P11-03

AN ATLAS OF CESIA WITH PHYSICAL SAMPLES
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Cesia is the name given to the visual perception of the different spatial distributions of light. The sensations of transparency, translucency, mirrorlike appearance, matt opacity, glossiness, blackness, etc., are within the scope of cesia [1]. An atlas with physical samples made of pieces of glass and covering almost all the possible ranges of cesia has been devised and assembled. The samples are arranged and notated according to the following dimensions: degree of permeability (or its opposite, opacity), degree of absorption (or its opposite, luminosity), and degree of diffusivity (or its opposite, regularity). The samples are achromatic, and include all the appearances that are within the space limited by the following five elementary cesias: translucent (diffuse transmission), matt (diffuse reflection), transparent (regular transmission), specular (regular reflection), and black (almost total absorption). However, the notion behind this is that all these appearances can be produced for every color, so that for each sample in a color atlas we can have all the cesias in which that color may appear or, on the contrary case, for each sample in the atlas of cesia we can have all the colors in which that cesia may be seen.

This atlas has a main practical advantage: it is a tool for all those who need to evaluate the aspect of appearance that depends on the spatial distribution of light, by simply looking for the sample that best matches the object in question, or by interpolation.


G-P11-04

Modifying Tooth Color System

- Examination of perception for Tooth Color and the Visible Aspect for the Dental Shade Guide -

Akio Motomori  Color Land Laboratory

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In the case of repair of the front tooth, a natural color required. Therefore, it is necessary that actual conditions of tooth colors are grasped. Evaluation of tooth color is an important factor of esthetic restoration. Comparison method depends on human factors and color meter output is too complex and unfamiliar to imagine the tooth color. Both the CIE color system and CIE color difference are difficult to indicate because colors are represented three-dimensionally, adding further complexity to the study of tooth crown or shadeguide colors.

This time, concerning the distribution of tooth crown color presented in the previous study, in addition to the relation with CIEL*a*b* color system taken up ever widely in the color study, color system is made by using psychometric quantity highly relative to the multi dimensional scaling on perceptive quantity presented.
G-P11-05

CATEGORIZATION OF LIGHT AND DARK. THE PROBLEM OF COMPOUND COLOUR TERMS

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The categorization of basic colours in different languages and the segmentation of uniform colour space is a much examined and discussed problem during the recent decades. Usually the main problem is the universality or relativity of the colour categorization of different languages, their uniformity, foci etc. The purpose of current research was to examine the subcategories of basic colours, particularly in the case of basic colours modified by the words light and dark. The mutual dependence of sub- and basic categories was studied, e.g. how the usage of the words light- and dark-blue modifies the domain of the basic blue. The main emphasis was made on the boundaries of the domains and not on the foci of given categories.

The current research was based on Estonian language. The results were compared with the similar experiment (e.g. R. M. Boynton, C. X. Olson 1987) based on Russian and English. Hypothetically the role of light and dark in Estonian is more important than in Indo-European languages. In order to study the relations between sub- and basic categories four series of experiments were carried out. As the stimulus material in all experiments, the full set of OSA-UCS samples (424) was used. The stimulus conditions were close to 80%. In the first experiment, the subjects of basic group, native Estonians, were asked to name all the samples using freely chosen colour terms, monolexemic or compound word. In the second experiment, the same subjects and a control group, including four Russians, were asked to name the samples using only the monolexemic colour words or the compound words with light and dark. After that they were asked to show the best examples (foci) for all given words. Two supplementary experiments were made with the basic group. In the first one the subjects had to name the same set of samples using only monolexemic colour words; in the second they were allowed to use compound words containing of colour word modified by another colour word (e.g. bluish-green) or by light or dark. The interval between each experiment was one week. The current report covers only the data concerning light- and dark-subcategories.

G-P12-01

COLOR CODING IN A VISUAL SEARCH WITH HETEROCROMATIC DISTRACTORS

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Purpose. We examined the roles of color configuration in cone chromaticity space in determining detectability of a colored target in the presence of heterochromatic distractors of two colors.

Methods. Target detectability was determined as a function of $\theta$ (the bearing of the right bisection of the D1-D2 line from the L-M axis) with a fixed $R([D1:T-D2])$ in the color space (see figure). Stimuli were colored disks presented briefly on a white background. Observers were asked to report whether a target was present. Detection performance was quantified by the discrimination index $d'$. 

Results. Target detectability depended on $\theta$ and $\phi$. For a fixed $\phi$, the detectability decreased with increasing $\theta$. For a fixed $\theta$, the detectability of the red target was highest at $\phi = 90^\circ$ or $270^\circ$ and the detectability of the orange target was highest at $\phi = 45^\circ$ or $225^\circ$, indicating that the best performance occurred at $\phi$ orthogonal to the chromatic direction of the target. These results support the idea that a visual search task with heterochromatic distractors is mediated by the higher-order color mechanisms tuned to many different chromatic directions. 

The spectral tuning property of the mechanisms was analyzed based on the detectability function.

G-P12-02

CHROMATIC ENHANCEMENT OF COLORED PICTURES IN MEMORY

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We use memory of colors in everyday life. We studied how exactly we could recognize colors in visual scenes. A memory identification task was performed with colored pictures of natural scenes. Some variables; chromatic and luminance contrast, hue changes, were used. The experiments consisted of two phases: memory phase and test phase. In memory phase the subject observed 20 pictures successively. After 30 seconds, the subject entered test phase, in which s/he observed 40 pictures; 20 memorized pictures (M pictures) and 20 pictures newly added in test phase (N pictures). Each of them had different patterns. The half of M pictures were changed in their chromatic or luminance contrast, or hue of colors. The rest half of M pictures were the same as those memorized. In test phase, the subject judged, for each of 40 pictures, whether s/he saw it in memory phase. In experiment 1, the subject tended to remember pictures of higher chromatic contrast as same as those presented in the memory phase. This suggested that chromaticness of a picture was emphasized in memory. In experiment 2, it was found that hue changes had small effect on memory of colored pictures. This suggested that hue had little fluctuation in visual memory. Moreover the analysis of d' showed that subjects could exactly judge for N pictures in the test phase. We could speculate that the processing for pattern of a picture would be prior to its colors.

G-P12-03

CATEGORICAL COLOR PERCEPTION IN PERIPHERAL VISUAL FIELD

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Purpose: We have two classes of color perception. We can perceive small color differences, while we can perceive a color as a group of many different colors. The latter class is called the categorical color perception, which we generally experience in everyday lives. It is known that color perception is better in the central than in the peripheral visual field. Although many studies have been done to investigate color appearance in the peripheral vision, these were limited to evaluate small color differences. The purpose of our study is to clarify characteristics of categorical color perception in the peripheral visual field by comparing with those in the central visual field (fovea). Methods: The observer saw the OSA Uniform Color chips in the central and in the peripheral visual field. The test color chip, which subtended 4 deg, was presented at the fovea (0 deg), eccentricities of 30, 50, 70 deg in the temporal visual field, and 30, 50 deg in the nasal visual field of his right eye. A large gray surrounding field, made with a hemisphere, was illuminated at a moderate intensity of 150 lms, which yielded 2000 scotopic td to suppress rod activity. The observer reported color appearance of the stimulus with one of the eleven basic color terms (red, green, yellow, blue, brown, purple, orange, pink, white, gray, and black). Results: The number of samples named each basic color term showed little difference between stimulus locations from 30 deg in the nasal visual field to 70 deg in the temporal visual field. The results at the 50 deg in the nasal visual field showed remarkable difference from the other locations. The distribution of basic color category in the OSA color space showed significant difference only at 50 deg in the nasal visual field. Conclusion: Our results showed that categorical color perception in the central visual field was kept constant across wider area of the peripheral visual field, which suggest the existence of the same categorical color mechanism in the peripheral visual field.

G-P12-04

EVALUATION OF VISUAL COMFORT OF COLOR ENVIRONMENT WITH COLOR MOSAIC METHOD

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The purpose of this study was to evaluate visual comfort of color environment quantitatively using color mosaic method. An image of actual scene was transformed into a two-dimensional color array (color mosaic). We prepared thirty color mosaics as experimental stimuli. Using paired comparison method, ten subjects judged visual comfort of two color mosaics presented successively. It was shown that the comfort evaluated by the subjects showed similar tendency, indicating they had some common criteria to judge visual comfort. A questionnaire carried out after the experiment indicated that attributes of colors and their spatial arrangement affected on judgment of comfort. To extract characteristics that determined visual comfort we computed several statistics of colors of the mosaics. However we could not found good correlation between basic statistic of colors and visual comfort. Visual comfort of color environment must be influenced by more complicated factors that related to both colors and their spatial arrangement. The results of further analysis shall be reported at the meeting.

G-P12-05

COLOR APPEARANCE OF HIGHLY AND MODERATELY SATURATED LIGHTS IN LIGHT-ADAPTED PERIPHERAL RETINAS

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It has been said heretofore that we can not perceive color well in the peripheral visual field. However, it was reported that color appearance of nearly unique-hue spectral lights (2 degree diameter) in the light-adapted condition did not deteriorate largely up to about 50 degree temporal eccentricity. In this study, to investigate influence of chromaticities of colored lights on color appearance in the periphery, a color appearance experiment was performed for two types of eight colored lights of nearly unique-hue and balanced-hue in each light-adapted condition. The first type of stimuli was a highly saturated one of colored lights, and the second was a moderately saturated one. Each luminance of stimuli was fixed by equal brightness matching at 5 feet to white reference of 250cd/m² or 400cd/m², and each luminance of two adapting fields was 120cd/m² or 20cd/m², according to a highly or moderately saturated type. Stimulus of 2 degree diameter was presented during 1 sec at one of 13 positions of visual field in 60 degree meridian step for the first type, and at 17 positions in 45 degree meridian step for the second. A color-naming method with black was used. The both experimental results of two types of stimuli for each group of four subjects were approximately similar to the former ones for spectral lights of nearly unique-hue. Therefore, in the light-adapted periphery, a color zone with equal saturation was more spread to periphery than that in the dark-adapted and lower light-adapted conditions: e.g. color zones by OSA.**


**: Committee on colorimetry: Optical Society of America, The Science of Color (Washington, DC: Optical Society of America), page 103,104.
G-P12-06

VISUAL PATTERN MEMORY OF CHROMATIC AND ACHROMATIC STIMULI
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In this study, we investigate whether visual attributes of objects, such as hue, saturation, brightness, and sharpness of edge, affect on short term memory of visual pattern. In the experiment, the test stimuli composed of four simple object patterns of the same color were presented 800 msec and after 10 sec delay, the observer was instructed to recall the test patterns by drawing them on the answer sheet. During the delay time, the observer had to listen to the sound of four Japanese Hiragana through a headphome and repeat them under his voice to eliminate a rehearsal of the object patterns by the names of the object shape. Achromatic test stimuli presented on the gray background were white, light gray brighter than the background, dark gray darker than the background, and black. Our previous results indicated the tendency that when the edge of the object pattern was clear, high percent correct was obtained. Thus three different levels of sharpness of edge were prepared for each of the achromatic stimuli to examine the effect of edge distinctness. Chromatic test stimuli presented on the gray background were four vivid colors of red, yellow, green, and blue that were near the focal colors of each hue, and two dull colors of red and blue of which psychometric purities were approximately same as those of yellow and green to examine the effect of saturation. Furthermore, in order to find out the effect of the color difference between the object and background, the stimuli of vivid red on the purple and the light-green backgrounds of which color differences were about the same as that between vivid red object and gray background were added. For all of the chromatic object patterns, perceived sharpness of the edge was equalized experimentally. Four male students with normal color vision participated as observers. The results indicate that in the achromatic stimuli sharpness of edge of the object does not affect the observer’s performance, and in the chromatic stimuli saturation of the object rather than color difference between the object and background is effective for the correct recall of visual pattern.

G-P12-07

A STUDY ON VOLUME ESTIMATION OF COLORED OBJECT IN COMPUTER GRAPHICS
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Two dimensional (2D) graphics are extensively used in our living scenes, because of its easy handing, abundant expressing materials such as printing paper, CRT displays, and so on. Also 3D objects are, therefore, displayed as 2D graphics with the simulation considering the reflection and diffusion of light in computer graphics. In this study, the effects of the color and the shadowing of the fundamental model objects on the volume estimation were investigated by using a virtual space in a CRT display.

As shown in Fig. 1, each stimulus consisted of a rendered model object and a wire frame object on a black background in a 20 inch size CRT display. The couple of the objects was used for the comparison and the measuring. The model objects were monochromatic cubes and spheres colored and rendered in a virtual 3D space of a computer (Indigo 2 Impact, Silicon Graphics). The imaginary volume of the objects were 216 cm3. The colors used were red, yellow, green, blue, purple, white, and gray. The luminance and the chromaticity were measured by a spectroradiometer (Spectra Scan PR-650, Photo Research). The model objects were rendered by a commercial ray tracing program (Animater, Alias | Wave Front) on the computer. The wire frame object could be similarly rendered by the mouse operation of an experimental subject. In the experiment, the subject sat in a dark room, and was instructed to adjust the size of the wire frame object to that of the model object. The distance between the subject’s eyes and the center of CRT display was 1 m. In some cases, the subject wore a sensor goggle of a eye point recorder (Talk Eye, Teknic). After the operation, the estimated volume for the model objects were calculated from the informed size of the wire frames. The volume of the objects colored red or yellow were estimated larger than the original volume, and that of the blue ones were estimated smaller. The volume of the objects colored with high luminance colors were estimated larger than that of lower ones. The analysis of the eye point movements revealed that the subject should look at the corner and/or the border of the displayed objects in the estimating behavior.

Fig. 1 An example of the design of stimulus used
EFFECT OF PHASE ON THRESHOLD-COUNTUR IN CONE CONTRAST SPACE FOR MOTION IDENTIFICATION - ESTIMATION OF INTRINSIC PHASE SHIFT BETWEEN L AND M CONES.

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The importance of the phase shift between different types of cones has been pointed out in the literature. If the different phase shifts are found for different aspects of visual processing, that is useful to identify the underlying mechanisms for various processing. Indeed Stromeyer, Kromer, Rya, Chaparro, and Eskew found the different amount of phase shifts for luminance and chromatic motion mechanisms9. In this study we propose a new method to measure the perceived phase shifts more precisely than the previous ones. Contrast threshold for motion identification for various color directions in cone contrast space was measured to obtain threshold contours. Stimuli were combination of the two sinusoidal gratings. One grating modulated temporally along the L cone axis, while the other modulated along the M cone axis. We call them L cone grating and M cone grating, respectively. L and M cone gratings with various amplitudes were exposed for a short duration (111ms) to observers. The phase between the two gratings were varied to obtain the effect on the threshold contours for each condition. We focus on the change of the color direction of the highest threshold as a function of relative phase of the two colored gratings with the assumption that the color direction of the highest threshold is determined by the luminance mechanisms. This method is considered to be more reliable than the method investigated the effect of physical phase for only a single color direction1, because we estimate the effects measuring thresholds of various color directions.

The results showed that when the background was green intrinsic phase shifts for two of three subjects showed that L-cones lead M-cones by 9.2° and 2.8° and for another subject it shows that M-cones lead L-cones by 9.6°. When the background was red M cone leads L cone by the amount ranging from 1.3° to 26.2°. These results were consistent with previous studies on the adapting field with low luminance9.


COLOR CODING MECHANISMS FOR TETRA-CHROMATIC VISION IN THE RETINA OF CYPRINID FISHES

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It is well known that most cyprinid fishes have tetra-cone system. However, the neural color coding mechanisms for tetra-chromatic vision are obscure. In this paper, spectral responses were recorded from in vivo horizontal cells and some bipolar cells in the light-adapted retina of many cyprinid species to examine the spectral coding mechanisms of early color vision. Tetra-chromatic responses were recorded from many species of cyprinids. Among different families or subfamilies of cyprinid fishes, the basic properties of the spectral response looked the same, but some variations were found, suggesting that some evolutionary adaptations took place and modulated the neural mechanisms. Comparative study showed good coincidence between the spectral variations and ecology of the species as well as their systematic status. Finally, it was concluded that most cyprinid fishes have the apparent coding system of the tetra-cone inputs into tetra-chromatic responses of the second order neurons in the retina.
G-P12-10

ADAPTATION OF A PURELY BINOCULAR COLOR SYSTEM

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We addressed the question whether or not there exists a purely binocular color system that acts as an AND gate on color information from the two eyes. To examine the question, we used an adaptation method. The experiment consisted of an adaptation period and a matching period. In the adaptation period, there were 90 cycles consisting of a binocular "adaptation" interval and a monocular "nullifying" interval. In the first interval, red (or green) adaptation stimuli were presented to both eyes simultaneously for 1 sec. In the second interval, its compensatory color stimulus, green (or red) was presented only to the left eye for 1 second and, then, only to the right eye for 1 sec. In this way, we attempted to nullify or minimize the adaptation effect in the monocular color system and to adapt the purely binocular color system. In the matching period, subjects adjusted the color of the matching stimulus for 3 sec so as to be the same as that of the test stimulus using the right, left or both eyes. The color of the test stimuli was the mixture of the color of the adaptation stimuli, that is, yellow. The test stimuli was presented at the same location as the adaptation stimuli and the matching stimulus was located below the test stimulus. The colors were presented on a CRT screen and they were equiluminant. Data from four subjects showed that the color matched shifted more to the compensatory color when both eyes were used than when only the right or left eye was used. The result supports the hypothesis that the purely binocular color system exists in the human visual system.

G-P12-11

ADAPTATION EFFECTS OF A WHITE LIGHT ON NONLINEARITY IN THE YELLOW-BLUE CHROMATIC SYSTEM.

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Purpose. We examined the effects of the white background light on the cancellation code of the yellow-blue chromatic system. We focused on the effects of the light intensity and the wavelength of the yellowish light.

Apparatus and Procedure. A four channel Maxwellian view system was used to present the stimuli. The test stimuli which consisted of a yellowish light (540, 570, 600 or 640 nm) and a blue light (470 nm) was superimposed on a white background field. The test stimuli was presented for 200 ms, followed by presentation of the more than 5 sec interstimulus interval. The observers were asked to determine the cancellation function, the yellow-blue equilibrium point as a function of the intensity of the yellowish light for each of the yellowish lights under each of the different adaptation intensities of a white background light (540-41000cd). From the cancellation function, we derived the yellow-blue equilibrium points for the yellowish lights. Three observer participated in the experiments.

Result and Discussion. The nonlinearity of the yellow-blue cancellation code depended on the wavelength of the yellowish lights and the intensity of the background white light. As the intensity of the yellowish light was increased, the yellow/blue intensity ratio at the equilibrium point increased for 600 and 640 nm, but remained constant for 540 and 570 nm. As the background intensity was increased, the intensity ratio at the equilibrium point increased in a similar fashion for all the yellowish lights. It has been shown that the white background stimulus causes different adaptation effects of the L, or M cone and the S cone, with increasing the light adaptation level, the sensitivity of the S cone relatively increases much more than those of the L and M cones. Given this finding, the present effect of the background intensity on the nonlinearity in the yellow-blue chromatic system may be ascribed to difference between the changing properties with light adaptation of the S cone and those of the M and L cones. On one hand, the wavelength dependency of the nonlinearity may be ascribed to the distinct nonlinear properties of the yellow components at the receptor site.

Reference

G-P12-12

EFFECTS OF STIMULUS CONFIGURATION ON SIMULTANEOUS CONTRASTS IN KOFFKA–RING TYPE PATTERNS

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In our previous investigations of the simultaneous contrast phenomena in Koffka–ring type patterns, we examined the effects of separation and division of test figure (TF) on the magnitudes of hue and brightness contrasts (MHCs and MBCs). The results of these studies showed that the MHCs in undivided TFS decreased as the degree of separation decreased, whereas those in divided TFs remained almost unchanged ¹. In addition, both the MBCs and the MHCs in undivided TFs decreased with smaller degree of separation more steeply than those in divided TFs ². Further, these results suggested that although the dividing line proved to generate larger simultaneous contrasts, the various divisions of the TF produced effectiveness variations upon the MHCs and the MBCs by altering the width and intensity of the dividing line itself. Consequently, this study focused on further examination of how much and what effects the dividing line’s properties produced on the MHCs. We developed the following six steps of experimental procedure. First, we varied the width and the brightness of dividing line with the degree of separation kept constant. Second, the Koffka–ring type patterns on a computer controlled color–monitor consisted of the following three figures: a gray TF, a left–red / right–green inducing figure (IF), and a hue–adjustable comparison figure (CF). Third, the TF overlapped on both sides of the IF, and the CF was positioned below these two figures. Fourth, the TF was divided into half by any one of 16 dividing lines: four levels of width by four levels of brightness. Fifth, subjects were asked to adjust the CF’s hue to the perceived hue of either left or right part of the TF. Sixth, after one session of practice trials, six subjects repeated four sessions; each session contained all dividing line conditions. Finally, the results showed that the MHCs were significantly influenced by both the width and the brightness of dividing lines. The MHCs increased with the dividing lines being widened, and were maximized by the brightest (white) dividing lines. It is reasonable to suppose that the advancing white dividing line caused the TF to be perceived as more separated figures and therefore generated larger MHCs when compared with the returning black line. In conclusion, to confirm this hypothesis, we need further studies to examine the effects of more variety of dividing lines on the MHCs.


G-P12-13

UNIQUE HUE MEASUREMENTS AND L, M, AND S CONE RATIOS WITH ECCENTRICITY

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Unique yellow, unique blue, and unique green measurements were obtained at the fovea and at locations varying between 28 deg nasal to 28 deg temporal eccentricity in two color normal observers. For the L and M cones, we present results of small-spot detection experiments which are consistent with a constant ratio of L and M cones at all eccentricities tested. The proportion of S cones as compared to the total number of cones at tested locations were estimated on the basis of the results of Curcio et al. (1991). For the red-green system, we find that unique yellow, which depends on the L and M cone quantum catches, is constant with eccentricity; and unique blue, which depends on the quantum catches in L, M, and S cones is also constant with eccentricity. For the yellow-blue system, unique green, which depends on quantum catches in the L, M, and S cones, is constant with eccentricity, except at the fovea and ± 2 deg eccentricity, the central region where S cone density is rapidly changing. We use these results to evaluate three potential factors affecting the red-green and yellow-blue opponent sites with eccentricity: 1) changes in spectral sensitivities of the cone photopigments, 2) changes in the ratios of L, M, and S cones, and 3) changes in neural mechanisms at the opponent sites.

H-P13-01

SPATIAL INTEGRATION IN CHROMATIC INDUCTION

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Magnitudes of chromatic induction effects elicited by multicolored surrounding fields were measured by using a chromatic cancellation method with a haploscopic view and then spatial integrations of the effects induced by individual surrounding colors were analyzed in regard to the chromatic opponent responses 1). Observers viewed an induction stimulus and a reference stimulus on a color CRT monitor. The induction stimulus, which was seen with observer’s left eye, was composed of a center test disk (1 deg. diameter) and a multicolored chromatic inducing annulus (6 deg. diameter, 1 color or 2 or 4 colors out of 13 different colors of 36 to 48 cd/m²). The reference, which was seen with observer’s right eye, was a white disk (1 deg. diameter, 15 cd/m²) with the D65 chromaticity. In case of conducting experiments under imitated chromatic adaptation, the induction stimulus was observed through one of four color filters (blue, green, yellow, and red). Observers could adjust the chromaticity and luminance of the test disk to equalize the appearance to that of the reference. Stimuli were presented steadily without fixation and no time limit was imposed on the chromatic cancellation. We thus noted the amount of chromatic shift needed to make the test identical with the reference as a measure of the chromatic induction, and postulated an induction canceling model that the induction could be canceled by incremental chromatic opponent responses in the test. We adopted an adequate opponent model with channels that were linear combinations of the L-, M-, and S-cone excitations. As a result of analyzing the obtained data, the magnitudes of chromatic induction could be well represented by power functions of opponent chromatic responses, r-g and b-y, of the surrounding colors and the amounts of chromatic shifts by multicolored surrounding fields could be explained by the sums of the induction effects produced by individual surrounding colors. When the induction stimuli were viewed through color filters, the coefficients of L-, M-, and S-cones contributing to the opponent chromatic responses were varied according to the filter colors.


H-P13-02

COLOR AND PAINT

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what is the relationship between perceiving, perceived and perception? the installation I present takes place between these point of views. It is a continuation of my project Licht, Farbe, Raum (Light, Color, Space) 1)

By mixing colors of different physical presence, painted colors as well as projected colors, I tried to make an approach to the ambivalences of color appearance. The three subtractive primaries and the three additive primaries in the form of colored light and pigment colors are overlayed by a projector turning around and projecting the same six hues one after the other. So we can see 6 groups of 5 colored surfaces next to each other in the following arrangement (from left to right) : Painted color, painted color overlayed with colored light, colored light, colored light overlayed with colored light, colored light. By observing these juxtapositions of additive and subtractive mixtures we tend to be insecurity, even if the rules of color mixing are well-known. In this sense, the basic subjects of my installation are instability and relativity of color perception.

H-P13-03

TOLERABLE RANGE OF ILLUMINANCE AND COLOR OF LIGHTING FOR PROVIDING A SENSE OF CONTINUITY BETWEEN TWO ROOMS

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A series of our previous studies[1-3] has shown that we can experience a sense of continuity between two physically separated spaces by adjusting illumination of those spaces. We consider a sense of continuity can be obtained when the recognition about the state of illumination of two spaces, namely, the recognized visual spaces of illumination of those spaces are made equal.

In the present paper we measured the illuminance and color of the illumination that provided a sense of continuity between two rooms connected by a window. In the experiment the illuminance and color of the illumination of the observer's room was changed while those of the other room were kept constant. The results showed that the optimal illuminance value for a sense of continuity was influenced by the color difference between the illumination of two rooms. The tolerable range of illuminance was, however, almost constant despite changes in color difference: it amounted to 30 lx. Also the sense of continuity could be achieved within 0.04 of the difference of x chromaticity coordinate. The results obtained here would be applied to lighting system design for providing a sense of continuity.


H-P13-04

CHROMATIC AND LUMINOUS CONDITIONS OF OVERLAPPING AREA FOR TRANSPARENCY

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We can perceive a surface through another surface, this perception is called transparency. It is known that the perception of transparent layers could not be necessarily constrained by their physical transmissance profile. In the case of colored surfaces, each color of the surfaces are mixed on the overlapping area. It has been discussed which rules of color mixture realize the perception of the transparency, the additive mixture or the subtractive mixture[4-7]. In this study, we measured the ranges of the chromaticity and the luminance of the overlapping area of two colored layers to be perceived as transparent layers. The observer adjusted the luminance of overlapping area so that the area was perceived as if two transparent sheets were overlapping with each other. Various chromaticities of the overlapping area and two layers were used. Our results show that the range of luminance of the overlapping area was 0.3 log units around the equal luminance of the layers, and largest on the additive mixture chromaticity line. The range of luminance reduced on the chromaticity lines which deviate from the additive mixture line. Both the chromaticity and the luminance ranges of the overlapping area were influenced by the chromaticity and the luminance of the background. We discuss that the transparency is realized to perception of surface segregation.

H-P13-05

SENSITIVITY TO CHROMATIC CONTRAST IN THE PERIPHERAL VISUAL FIELD IS AFFECTED BY THE CENTRAL VISUAL TASK
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Visual function degrades in peripheral visual field. For example, the sensitivity to chromatic contrast is worse in the peripheral retina than in the fovea[1]. We studied how a visual task in the central visual field would affect the visual performance in the peripheral visual field. We measured chromatic contrast sensitivities in the peripheral visual field when a visual task was performed in the central visual field. We divided a natural scene into 8 pieces, and again divided each piece into 20 cells, and randomized the positions of the cells. The observer's task was to report which piece of the original picture was presented in the central visual field. The difficulty of the central visual task was controlled by changing the percentage of the numbers of randomized cells. The central visual task stimulus was presented for 4 seconds on a uniform gray background. Two series of stimuli were presented, and one of the two series contained an equiluminant sinusoidal grating in the peripheral visual field and the other did not. The peripheral equiluminant sinusoidal grating, 27° x3°, red-green, was moved around the observer's eye movements in real time. The observer was asked which series contained an equiluminant sinusoidal grating. The results show that the sensitivity to chromatic contrast in the peripheral visual field slightly decreases with the difficulty of the central visual task, which indicates that the comprehension of a natural scene affected the chromatic contrast sensitivity in the peripheral visual field. Our results suggest that the visual task in the central visual field degrades the visual performance in the periphery.


H-P13-06

MEASUREMENT OF COLOR-DIFFERENCE JUDGEMENT-BOUNDARIES IN A COLOR SPACE
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Many kinds of uniform color spaces, utilizing jnd steps, have been offered. Each of them is made for its own purpose. However, the chromatic difference defined in a color space is not always proportional to our color-difference perception. For example, the color-difference between a red and a green can not be scaled by accumulating jnd steps. We can hardly evaluate color-difference of such a pair of colors with a large distance. This non-uniformity of the human color perception makes it difficult to construct a complete uniform color space. In this study, we carried out two experiments to find out what factor should be considered for a uniform color space. First, We tested separability of colors. The observer divided a set of 424 OSA color samples into the number(2-14) of groups. As a result, we found good agreement in division of a color space among the observers. Moreover, the division increased in a hierarchical way. This result suggests that there are clear boundaries in color space. Second, We evaluated color-difference in a new method. We presented two anchor colors and a test color on a CRT monitor. The observer adjusted the chromaticity of the test color so that the test color appeared equally distant from the two anchor colors. Two anchor colors were selected at random from the OSA Color Samples. We measured the variability of adjusting the test color position. We compared this variability for pairs of colors with chromatic boundaries found in first experiment.
CONSTANT HUE LOCI FOR COLORS IN SURFACE AND SELF-LUMINOUS MODES
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It has been reported that the constant hue locus of unique red for colored light plotted on the CIE (x,y)-
chromaticity diagram is quite different from the constant hue loci of the Munsell 5R and NCS R not only
its location but also the direction of the curvature, while the constant hue loci of other unique hues for
light sources generally agree with those of the corresponding hues of Munsell and NCS systems1-4. To
our knowledge, no study has been done to investigate the inconsistency particularly observed in the red
region. Possible causes are the deviations of Munsell 5R and NCS R from a perceptual unique red, the
difference of an experimental procedure between the studies for light source and color chart, the
individual differences among the observers in the separate studies, or the difference of appearance mode
between self-luminous and surface colors. Thus we measured the hue of color stimuli presented in a
surface color mode (real color charts and CRT color stimuli with gray surround) and in a self-luminous
mode (CRT color stimuli with dark surround) using two kinds of color naming technique, an opponent
type, and a categorical type, for the same observers. The results of six observers showed that the unique
red locus is located near the constant hue loci of the Munsell 5R and NCS R in the color chart
experiment. It is suggested that the mode of appearance is the most effective cause for the displacement
and change of shape of the unique red locus on the chromaticity diagram.

2) SWEDISH STANDARD S5919103-1982.

BRIGHTNESS-TO-LUMINANCE RATIOS OF COLORED LIGHTS IN VARIOUS
SURROUNDS
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It is widely known that the luminance defined by the current photometric system does not necessarily
evaluate brightness of color stimuli correctly. Highly saturated colors usually look brighter than
achromatic stimuli of the same luminance known as the Helmholtz-Kohlrausch effect. Degree of the
discrepancy between luminance and brightness is usually evaluated by the brightness-to-luminance ratio
(B/L ratio), the ratio between the luminance of the reference stimulus (L) and the luminance of a test
stimulus (L) when they are matched in brightness. The CIE is endeavoring to establish a new
photometric system by introducing a concept of an equivalent luminance, a photometric quantity that
correlates to an object brightness. The B/L ratio is used to calculate an equivalent luminance. Although
a number of studies have been reported on the distribution of the B/L ratio in the chromaticity diagram,
most of the studies used simple stimulus configuration such as a circular bipartite field with a dark or
gray surround. Visual environment in real life, however, contains many colors with various luminances,
and an average luminance and a distribution of color vary as the scene changes. In order to examine
whether the B/L ratio depends on surround condition, we measured the distribution of the B/L ratio on
the chromaticity diagram under five kinds of surround, one is a dark surround comparable with those in
previous studies, and others are the pictures of real sceneries categorized into four groups, daytime
residential area, daytime residential area, daytime city area, and nighttime city area. For three
observers' results, no systematic change with different surround conditions was found. The results
imply that the database and the theoretical model to derive the B/L ratios under a dark surround condition
are applicable to practical use at least in such visual environments similar to those examined in this study.
Visible persistence was measured by the paradigm of simultaneous perception when two stimuli frames were successively presented. One stimulus presentation consisted of two frames (T1 and T2) of the display with an inter-stimulus interval (ISI) between them. Each frame contained an orthogonal pair of light spots so that if both frames were superimposed, two pairs of the spot lights, i.e. four as a whole, appeared to be placed on the corner of a right square. The exposure durations of T1 and T2 were 35 ms. ISIs were varied from 0.0 to 159 ms in nine steps. The border between T and Background was blurred. The stimulus was set under control of luminance intensity and colorimetric purity with a chromatic substitution technique. In the first experiment, visible persistence which was measured with both chromatic stimuli and achromatic stimuli increased as luminance contrast decreased. The second experiment showed that the persistence had a decreasing function of colorimetric purity of the stimuli. These results suggested that the well established 'inverse intensity effect' consisted of 'inverse luminance contrast effect' and 'inverse chromatic contrast effect'.
SPECTRAL LUMINOUS EFFICIENCY AND ADDITIVITY TEST FOR SHADING PERCEPTION
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We investigated whether the shading perception is based on the luminance mechanism or the brightness mechanism. We measured the spectral luminous efficiency for the shading perception, and tested luminance additivity law. We also measured the spectral luminous efficiency for flicker photometry and brightness matching. Stimuli consisted of a reference white and a test color. Their luminance profiles were cumulative Gaussian functions along horizontal axis with the slopes in opposite directions. When one of these colors was darker than the other, shading could be seen. The observer adjusted the luminance of the test color to minimize the impression of depth due to shading (we call this setting the shading disappearance). The spectral luminous efficiency for the shading disappearance was closer to that for the flicker photometry than for brightness matching. In addition, the luminance additivity law held for shading disappearance. These results suggest that shading perception is mediated by a luminance or luminance type additive mechanism.

DISCRIMINATION OF COLORS WITH COLORED SURROUND UNDER WHITE ADAPTATION
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Simultaneous color induction has been often considered to result from the subtractive interaction between the opponent-color mechanisms. On the other hand, divisive interaction between the opponent-color mechanisms may be another candidate that causes color induction. In this study, to examine the contribution of the divisive interaction, color discrimination thresholds on various color directions were measured under the stimulus configuration of simultaneous color induction. The stimulus consisted of the four test disks surrounded by an isoluminant inducing field with different colors. The test disks with the inducing field were briefly (150 ms) presented by changing the colors from an adapting white. One of the four disks, randomly located on any trial, differed slightly in color from the other three disks. Observer's task was to report which of the disks was different from the others. A stair case procedure was used to determine the color discrimination threshold. The measured discrimination thresholds were compared with the thresholds measured with white inducing field. The results showed that, with the inducing color on a cardinal axis (the L-M axis or the S axis), the discriminations along the axis were severely impaired, but those along the orthogonal axis were not affected. Control experiments showed that this elevation of the discrimination threshold was not ascribed to the adaptation to the inducing field. The prediction based on the subtractive interaction does not fit the data of the threshold elevations, even though the putative response functions of the opponent-color mechanisms are not linear. The results were well predicted by the divisive interaction, cooperated with the subtractive interaction. Furthermore, the identical effects on the discrimination threshold were also found with the inducing color on the non-cardinal axis; the thresholds along the axis were elevated but those along the orthogonal axis were not affected. The result is not expected by the opponent-color theory. This may favor the hypothesis that the effect is mediated by the higher-order chromatic mechanisms tuned to many different directions of color.

H-P13-13

VISUAL EVOKEO POTENTIALS IN HUMANS ENCODE COLOURS

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Multidimensional scaling of the direct estimations of differences between colours varying in hue, saturation and lightness revealed four-dimensional structure of colour space in normal trichromats. The Cartesian co-ordinates of the colour points could be interpreted as red-green, blue-yellow, brightness and darkness neuronal channels [3]. The EEG mapping technique showed that colour evoked potentials (EPs) are mostly spread in occipital, inferotemporal and parietal scalp areas. It was found that amplitude and temporal characteristics of the EPs depend on colours. The differences between EPs taken on a city-block matrix composed a symmetrical matrix which represents colour differences. Separate matrices were constructed for two epochs and for different scalp recording sites. Multidimensional scaling of the intertemporal EPs differences in 50-150 ms epoch revealed two orthogonal axes red-green (R+G-) and yellow-blue (Y-B-) being similar to the colour opponent functions. Surprisingly multidimensional scaling of the occipital EPs differences revealed the similar colour opponency but in more late epoch (150-400 ms). It might be suggested that there are at least two colour coding areas - V4 and inferior temporal cortex. The colour iconic memory presented in V4 is characterized by diminution of colour coding neurons but the early responses to colours could be masked by contribution of shape coding mechanisms [1]. The inferior temporal cortex contains the long-term memory neurons some of which represent the colour memory units established in the processes both of orthoconic development and of learning [2,4].


H-P13-14

LUMINANCE-BASED MULTI-SCALE RETINEX

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Multi-scale retinex (MSR) processing has been shown to be an effective way to enhance image contrast. It is particularly good in improving images of scenes where there is a wide range of scene brightness, as for example when strong highlights and deep shadows appear in the same image. The major shortcoming of MSR is that it tends to make all image colors grayer than they should be. This graying effect occurs because in MSR the R component (similarly for G and B) of each pixel is replaced with the ratio of its intensity to the average R component of its neighboring pixels and then taking the logarithm of the result. Unless the image color varies significantly spatially, a pixel's color will be similar to its neighbors and the ratios in all three channels will be one; thereby resulting in gray as the output. Recent MSR work has tried to overcome this graying effect by introducing a color correction step which replaces some of the color that is lost during the contrast enhancement step.

We improve on the previous work on multi-scale retinex in two ways: (1) contrast enhancement is done using image luminance so that only image intensity, not hue, is changed during processing; and (2) color constancy preprocessing is included to adjust for changes in the spectrum of the overall scene illumination. The results (subjective comparison of images) of improvement 1 show that the new method retains the contrast enhancement benefits of the original MSR technique and eliminates the need for a separate and ad hoc color replacement step. Improvement 2 handles cases where the color balance of the input image is poor.

Algorithm Summary: Luminance is defined in the standard way as L=R+G+B and chromaticity by r=G/R, g=G/B, and b=B/L. Three circular convolutions (via FFT) are performed with a Gaussian smoothing filter at 3 scales (e.g., sigmas of 5, 20, and 50) yielding 3 output images. These ratio images are then formed by dividing the input image with the smoothed images on a pixel-by-pixel basis. The logarithms of these 3 images are then summed to produce a log luminance estimate. The log luminances are then clipped and scaled as in standard MSR. A color image is then formed by scaling the r,g,b chromaticities whose luminance is necessarily 1 by this new luminance estimate so the resulting image is guaranteed to have the same hue everywhere as the original. Color constancy preprocessing to remove the effects of scene illumination for which the imaging system is not balanced is carried out before contrast adjustment using the method described in.

JAPANESE SENIOR CITIZENS' LEGIBILITY OF LETTER WITH COLOR

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The rapid increase of the senior citizen population is a serious issue in Japan. It has become imperative to study how to cope with these changes in society and how they relate to our existing resources. One of the issues is the legibility of public signs. In order to make it clear if these public signs are communicable to senior citizens, the Division of Color and Design in the Japan Society of Home Economics have conducted research targeting the nonhandicapped and healthy senior citizens. The research consists of differentiation of text size, color and background color in order to find out how legible these signs are.

The resources used in this research include Japanese, Alphabets, and Number which vary in height from 2mm to 9mm. From this, we found the difference in visual abilities and graded from 1 to 8. The three background colors used were black, white and gray, and the eight colors used for the text were red, yellow, green, blue, purple, black, white and gray. The color of the text always differed from the color of the background. This study included senior citizens from everywhere in Japan of whom 566 ranged in aged from 65 to 74 and 511 of them were age 75 and older.

This study revealed that the color of the background affected the text. For a white background, text in yellow was very difficult to see, and the same applied to a gray background with yellow or purple text and a black background with blue text. In addition, the 9mm font size was said to be difficult to see by some of them. Especially, for those 75 years and older, individual differences of visual ability were more common. This group also seemed to show some other kinds of handicap in their everyday lives.

COLOR PREFERENCE OF JAPANESE SENIOR CITIZENS

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In order to obtain fundamental data on color planning for comfortable lives of the Japanese senior citizens living in a longevity society, social surveys on color preference were conducted by Division of Color and Design in the Japan Society of Home Economics. Survey samples were 2,008 (647 men and 1,361 women) in 1987, and 2,100 (574 men and 1,526 women) in 1993, of more than 65 years old, and survey spots were Northern districts of Tohoku, Kanto (except Tokyo), Tokyo, and Western districts of Kansai of all Japan. The method of survey were three colors of most favorite, second and third preferred were selected from 80 different colors in the chart. After the selection, impression of each color was rated on 20 adjective scales with 5 point categories. Principal component analysis were treated and color image profiles were drawn.

Colors of blue, green and white were preferred by male subjects, and deep purple, pale purple were selected by female. The high average scores of color impression were adjectives of like, comfortable, elegant and beautiful, and low scores were fashionable, plain and strong. On the contrary, in addition to the above, non-preferred color for senior citizens were black, dark grey and for men vivid red, vivid yellow. The senior citizens did not choose colors of bright, showy and impressive.
**H-P14-03**

A therapeutic system phased from Yellow-Black alternate coloring method to integrative story making method — An art therapy for promoting better self-recognition through sensory-perceptual process

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I designed a therapeutic system combining some methods. A sequence of methods begins with "Yellow-Black Alternate Coloring Method (YB-We)" which consists of alternate operations between client and therapist, projective stage, structuring stage and story making stage, later finishes by making an integrative story. The process of practicing these methods is as follows.

First, the YB-We is carried out in a usual manner. With a completed picture drawn by YB-We. The client is encouraged to project his mind into the picture in the same way an Horschach blot. Then the client clips the projected objects out of the picture and structures a scene with them (the projective stage). It enables the client to survey his/her own problems. Next, he/she tells a story about the structured scene (the story telling stage). In this phase the client is supposed to connect each of his/her fragmented experience by means of language, and make an effort toward integrating his/her own problems. The therapist structures another scene, making use of the unclipped parts of the picture drawn by the client. The client and the therapist alternately make a new stage by connecting the two scenes (integrative story making stage).

In this system, the client can get a sense of accomplishment, no matter which stage the therapy is terminated at. Furthermore he/she can exercise his/herself in building good interpersonal relations, and have better relationships with others. What is important in psychotherapy is, I think that the client promotes better his/herself recognition through creative activities without straining his/herself in order to solve his/her problems.

**J-P15-01**

**CHROMATIC INTERFEROGRAMS EVALUATION BY COMPUTER DIFFERENTIAL COLORIMETRY**

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Newly developed technique based on a combination of computer differential colorimetry, image synthesis and colour Fizeau interferometry for evaluation and visualisation of thin film thickness distribution is presented. It is especially intended for visualisation of quasi-static and dynamic phenomena, such as local fluctuations of film thickness caused by various physical or physical-chemical effects, taking place in thin film lubrication.

The interference colour evaluation technique is based on the idea of replacing of human eye by differential colorimeter realised by computer system. This system performs four-step process including chromatic interferogram capturing and digitization, colour difference measurement between 'standard' and 'sample', film thickness evaluation, and its visualisation. As a standard, digital colour chart is used. It contains colour coordinates of all interference colours produced by the film in dependence on its thickness and is obtained by observing interference system with known geometry. Sample is each digitized interferogram recording interference colour distribution in measured layer. Colour differences between \( L^* a^* b^* \) triple in each sample pixel and all \( L^* a^* b^* \) triples of the standard are evaluated with the help of CIELAB colour difference equation. Two colours with corresponding film thicknesses with the least colour differences are chosen from the standard and the final film thickness is determined by their interpolation. Image synthesis procedures are used for film thickness distribution reconstruction and its visualisation with mesh or shaded surface that can be animated.

This technique has been demonstrated to be a powerful tool for investigation of thin lubricant films. It has been found that technique resolution is better than 3 nm within the range 60 - 800 nm and spatial resolution, limited by the optical resolution of instrument used, is about 900 nm. The main advantage of this technique is fully automatic interferogram processing with no requirements of prior fringe order knowledge that can be almost done in real time. Some examples of lubricant film shape obtained by the above mentioned technique and the comparison with monochromatic interferometry are presented.
COLOUR RENDERING PROPERTIES OF HIGH INTENSITY DISCHARGE LAMPS
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For the specification of colour rendering properties of light sources, the CIE recommended the uniform colour space \( U'V'W' \) in 1974 to calculate colorimetric quantities of test colours under test and reference illuminants. However, this colour space has been used only for the calculation of the colour rendering indices and not for other colorimetric purposes. This space is inadequate to specify coordinates of colours because of spatial distortions in the regions of red and green colours. Recently, a new method for the assessment of colour rendering using CIE chromatic adaptation formulae and the uniform colour space \( L'\ast a'\ast b' \) is also proposed to CIE Technical Committee 1-33. In \( L'\ast a'\ast b' \) space, however, chroma is estimated larger in the yellow region, and conversely smaller in the blue region. For the reason of these spatial distortions in the \( U'V'W' \) space and the \( L'\ast a'\ast b' \) space, three components of colour shift, i.e., differences of hue, value and chroma, cannot be represented orthogonally independently.

A new uniform colour space NC-IIIC has been developed in our laboratory. Spatial distortions in the NC-IIIC space have been compensated by introducing nonlinear opponent functions, and Y-B and R-G opponent responses cross at right angles each other in this colour space. As the result, the new colour space NC-IIIC is able to indicate colours in accordance with colour perception under the CIE standard illuminant \( D_65\), the CIE standard illuminant A and various fluorescent lamps.

High Intensity Discharge (HID) lamps have been used in the field such as a stadium and an open space until quite recently. HID lamps, however, come into general use inside a room recently. Accordingly, it is necessary to specify colour rendering properties of HID lamps.

In this study, in order to investigate perceived colour shifts under various light sources, visual evaluation experiment for 24 colour samples, i.e., test colour samples prescribed (TCS) in Publication CIE No.13:2 and Macbeth Colour Checker (MCC) proposed in CIE TC 1-33, are executed under HID lamps, a Xenon lamp and an incandescent lamp. In addition, colorimetric quantities of TCS and MCC under various light sources are calculated in the \( U'V'W' \) space, the \( L'\ast a'\ast b' \) space and the new colour space NC-IIIC. Moreover, predicted colour shifts calculated in each colour spaces are compared with perceived colour shifts. As results of this study, it is found that metric quantities of test colours under HID lamps in traditional colour spaces cannot represent precisely perceived attributes of test colours. Metric quantities, however, of test colours under HID lamps in the new uniform colour space NC-IIIC are properly correspond with perceived attributes of test colours. Therefore, in specifying of colour rendering properties of light sources, the NC-IIIC space is superior to the \( U'V'W' \) space and the \( L'\ast a'\ast b' \) space.

Moved
requires governing light sources used for color evaluation

There are three requirements and three cautions to be employed in light sources illumination to permit a correct evaluation of color.

Requirement[1] : The average color rendering evaluation number of the light source shall have a minimum 90 preferably close to 100.


Caution[1] : The characteristics and capabilities pertaining to the three requirements shall not deteriorate as a result of aging.

Caution[2] : The spectral distribution of light shall present a continuous spectrum and such spectrum shall not contain any luminescent line which represents energy in excess of 1.5 times its perimeter.

Caution[3] : All of the three represents shall be respectively satisfied and no single requirement may be discarded.

TAKU SATO, IKIO SADO (SERIC Ltd.)

J-P15-05

Optimal filters design for measuring colors using unsupervised neural network

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An unsupervised neural network method is proposed to design filter functions to analyze color. The learning algorithm is the isobar algorithm with the competition transfer function, which have property to trace the center of an input data space. We can design any number of filter functions by choosing the number of neurons. The learning data of this network in two sets of different color. One of them is a set of interference colors which were obtained by changing optical path difference of the interferometer from 0nm to 1000nm. The other is Munsell color set. After the design of filter functions, the learning color spectra are filtered by them, and the original color spectra are recovered from the values after filtering by using the General Inverted Matrix (GIM) method. The error of this recovery is evaluated and compared with that of the K-L expansion. Both of the methods perform almost equally well. The difference between the results is that the 3 filter functions is enough to measure interference color and for Munsell color set it needs more than 4. It is because that the Munsell space include almost every colors but interference colors are in a restricted space.
METHOD FOR SPECIFYING COLOR RENDERING PROPERTIES OF LIGHT SOURCES BASED ON A COLOR APPEARANCE MODEL

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In CIE TC 1–33, a modification of the present CIE method (Pub.No.13.2 or 13.3) for specifying color rendering properties of light sources has been investigated. The purpose of TC 1–33 is to prepare a report on a proposed method based on a color appearance model that will replace CIE Pub. 13.2 or 13.3. However, TC 1–34 "Testing color appearance models" needs more years to recommend a single model for practical use. For this reason, TC 1–33 prepared an interim revised method for field trial based on the CIE publications such as CIE chromatic adaptation transform and LAB color space without using a color appearance model.

The purpose of the present study is to propose a method based on a color appearance model. In the present study, the Ra and Ri values of various light sources were calculated by the method based on Nayatani color appearance model, and these Ra and Ri values were compared with those given by the TC1–33 method and the present CIE method (CIE Pub. No.13.2 or 13.3). The computed results classified that the Ra values given by Nayatani color appearance model coincided well with those given by TC 1–33 method and present CIE method. Similarly, the special color rendering indices Ri based on Nayatani color appearance model correlated well with those obtained by TC 1–33 method. Consequently, the method based on Nayatani color appearance model may be replaced TC 1–33 method without any problem.

ACCEPTABILITY OF THE ROAD TRAFFIC SAFETY COLORS UNDER VARIOUS LAMPS

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Since colors are useful for recognizing and identifying items, various colors are used in signs, signals, and displays. From the view point of the recognition of the safety colors, categorical color identification is more important than critical color discrimination.

Appearance of the road traffic safety colors (used for signs and lane markings) were estimated by the elemental color naming and the acceptability of categorical color appearance under various lamps with different color rendering properties.

Using the method of elemental color naming, appearance of the road traffic safety colors were separated into the perceived Chromaticness-Achromaticness, Yellowishness-Bluishness, and Reddishness-Greenishness. Based on the results obtained, the Gamut Area of the road traffic safety colors was performed subjectively.

As a result, the acceptability of categorical color appearance was correlated well with the Gamut Area derived from the elemental color naming, and it had a better correlation than color rendering index Ra.
AN EVALUATION AND VISUALIZATION OF SPECULAR GLOSSINESS OF ARCHITECTURAL TITANIUM SHEETS
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In this decade application of titanium sheets to roof and exterior wall of buildings has been rapidly increased because of titanium's excellent corrosion resistance, low specific of gravity, low thermal expansion coefficient and aesthetic surface appearance. Therefore it is natural that metallic luster or glint and color as a measure of esthetic surface appearance of the titanium sheets for building construction materials should be architects' great interest. Although JIS 8741 specifies the method of specular glossiness measurement, it is not sufficient for this method to evaluate and represent three dimensional distribution of metallic luster of materials. And the value obtained by this method can not be directly utilized in aesthetic scene simulation with using computer graphics. Phong's illumination model (1), a defacto standard in computer graphics was applied to analyze and visualize specular glossiness of architectural titanium sheets. Commercially pure titanium thin sheets obtained by passing shot-blasted and pickled sheets through dull cold rolls with different surface roughness in a laboratory temper-rolling mill were used. Three dimensional distributions of reflectivity coefficient of these titanium sheets were measured by using a three dimensional spectrometric colorimeter (Nihon densyoku, OC-290) with CIE standard light source C and analyzed with respect to Phong's illumination model (Eq.1).

\[ \rho(\theta_s, \theta_v) = K_{\text{diffuse}} \cos \theta_s + K_{\text{specular}} \cos \theta_v \cos \phi \]  

where \( \rho \) is reflectivity coefficient, \( \theta_s \) and \( \theta_v \) are incident and viewing angles, \( K_{\text{diffuse}} \) and \( K_{\text{specular}} \) are diffuse and specular reflectivity coefficients respectively, \( n \) is specular component and \( \phi \) is an angle between the mirror reflection direction and a viewing direction. Incident angle was fixed at 45 deg. and viewing angles were changed from 30 deg. to 150 deg. with 2.5 deg. interval for three dimensional spectrometric colorimeter measurement for each sample. The horizontal component of the incident beam direction vectors were fixed parallel to rolling, diagonal and transverse directions of the sheets. \( K_{\text{diffuse}}, K_{\text{specular}} \) and \( n \) were obtained by using regression analysis of spectrometric colorimetric data with respect to Eq. (1).

Specular component \( n \) of the titanium sheets obtained in this study is ranging from 7.81 to 152.01 and its corresponding \( G_R(45 \text{ deg.}) \) is ranging from 16 to 280. It was found that there is a linear relationship between \( n \) and \( G_R(45 \text{ deg.}) \). The visual surface appearance including specular glossiness of the real materials is closely related to fine surface morphology of the materials such as dimples, ridges and micro-faces on the surface. The effects of these morphological characteristics on spectrometric colorimetric data, \( K_{\text{diffuse}}, K_{\text{specular}} \) and specular component \( n \) will be discussed.


K-P16-01
Cancelled
RELATIONSHIP BETWEEN SUBJECTIVE EVALUATION OF MAKE-UP SKIN COLORS UNDER LIGHT SOURCES WITH VARIOUS COLOR RENDERING PROPERTIES AND THE COLOR RENDERING INDICES CALCULATED BY CIE 1996 MODIFIED METHOD OF COLOR RENDERING INDEX.

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Subjective evaluation of skin color made-up with different foundation colors under three-band type fluorescent lamps with various color rendering index were carried out. The relationship between the results of subjective evaluation and the physical parameters such as the gamut area of test colors for color rendering calculation, the metric chroma of skin color and the color rendering indices Ra,R9,R15 calculated by the present method as well as the CIE 1996 modified method were investigated. It was shown that the metric chroma of directly spectrally measured skin color were especially most correlated with the results of the subjective evaluation, though Ra,R9,R15 calculated by both CIE1996 method and the present method could also estimate subjective evaluation of skin color.
K-P16-04

Spectral reflectance data base system
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This paper introduce TOYO INK's internet Home page that include the very important spectral reflectance data and the digital image of several objects such as human skin, flower, sky, etc. Anyone engage in color science, human visual or color psychology can download these data from TOYO INK www home page to their computer and use freely them for their research or study without profit.

A spectral reflectance data is a measurement of the wavelength composition of light leaving the surface. It is a complete description of color information which is independent of a light source and a human visual system. Almost colorimetric values such as CIEYxy, CIEL*a*b*, CIEL*u*v* are calculated from these spectral reflectance data under the several conditions.

Especially, It is well known that illumination affects the color of observed and recorded objects. For these problem, some color correction method are researched based on spectral reflectance, moreover has been tried to reduce the dimension of the data.

While, recently color management system which can realize a color image reproduction on any kind of color devices are developed and used for color control and communication. However, the system generally uses a CIE colorimetric values depend on illuminant, many problem are pointed out such as visualization under different light source.

A spectral reflectance is the most important data for a color science. We believe that our spectral reflectance data system is very useful for many kinds of color researcher, and must contribute for progress of color science.

Spectral reflectance data base outline

Measurement system: SpectraScan 706, 604 (made by PhotoResearch)
Data: 380~780 nm every 4 nm (101 points), ASCII


K-P16-05
DEVELOPMENT OF HIGH SPEED GONIOSPECTRO-PHOTOMETER AND THE APPLICATION FOR EVALUATION OF FOUNDATION
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A high speed goniospectro-photometer has been expected for numerical evaluation of cosmetic foundation, because usual goniospectro-photometers need much time to measure all the reflectances of skin and foundation in every directions. Therefore, we have developed a new type of goniospectro-photometer which illuminates skin by halogen lamp with rotating 31 interference filters, and detects reflectance by 48 silicon photocells distributed on a hemisphere. This instrument takes about 20 seconds to measure colors in 48 directions and measuring error is under 0.2%, which seems suitable for evaluation of skin and foundation. The reflectance spectra are processed to the value of L*a*b* color space. It is found that human skin generally has higher value of hue angle for larger reflect angle, i.e. hue is higher when skin is looked at side views than looked at front views. Further more, some foundation makes the range of hue more smaller than another does.

The change in the application of foundation is detected by this instrument numerically. In the next step, we will find the relation between the appearance of skin with foundation and the values obtained by goniospectro-photometer.
K-P16-06

NEW WEIGHTING FUNCTIONS FOR THE WEIGHTED CIELAB COLOUR-DIFFERENCE FORMULAE
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In 1994, the Commission Internationale de l'Eclairage (CIE) recommended a new colour-difference model, the CIE94 formula. CIE94 in fact the simplified version of the CMC L*a*b* formula, which was developed by the Colour Measurement Committee (CMC) of the Society of Dyers and Colourists, UK. The CMC formula has been extensively used for colour tolerance work, especially in textile coloration industry, and is now adopted as an ISO standard for the fastness testing of textile samples.

CIE94 has two main differences in CMC: no weighting for lightness differences, and no dependence of hue tolerance on metric hue-angle. The source of these differences is thought to be caused by use of different physical viewing conditions. Thus, the effects of the background and the gap (both seem to be most probable causes of the discrepancy, and are the parameters of high industrial interest) on colour-difference perception were studied by use of 248 colour-difference pairs made from painted samples.

The lightness tolerances and the chromaticity discrimination with respect to the position of a standard colour in CIEXYZ space, and in relation to above two physical parameters were investigated. The experimental data was also used for evaluating the performances of 4 colour-difference formulae (CIELAB, CMC, IFD and CIE94). New suggestions for the weighting functions that were obtained by optimising data sets from this study and two previous studies (Lu and Rigg, and JUT-Dupont) will be presented.

K-P16-07

ANALYTICAL SYSTEM FOR THE DETERMINATION OF THE SPECTRAL REFLECTANCE WITHOUT ANY CONTACT WELL ADAPTED TO THE COLOUR MEASUREMENT OF WORKS OF ART
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A portable device (spectrophotometer and pen notebook) based on optical fibers and units delivered by Ocean Optics, Inc. (spectrometer with gratings, linear CCD array and 500KHz A/D data acquisition system) was designed for the measurement at distance without any contact with works of art kept in museums. A Y bifurcated optic fiber is built with strands randomly mixed. The common branch enables the lightening of the selected spot to be measured and the detection of the backscattered light (chosen incidence angle : 45°). There is an exact coincidence between the enlightened area and the measured spot, which ensures a precise and exact reproducibility of the measurements. A collimator while changing the working distance allows to adjust the area of the measured spot between 1 and 10 mm. The measurements are compared with a halogen white standard.

Two easel paintings by Fernand Léger ('Composition Murale, 1926' et 'L'Homme au Chapeau Bleu, 1937') have been examined and the precise and reproducible measurement of the colour (0.5 L* a*b* unit) confirms the apparent homogeneity of each different coloured area painted by Léger. Special interest was focused on the white colours of L'Homme au Chapeau Bleu, where 3 different groups were determined, associated to different chemical composition. The measurements were obtained with a light similar to this in the museum galleries. These three whites show besides a different behaviour under UV light. That is the reason why it was decided to measure the colour without any UV in order to disregard the fluorescence effects and, on the other hand, to be in the same conditions of observation as the visitor. Examination of the same areas should be analysed by the same way under UV-visible light to measure the fluorescence.
On the thermo
cromism of some ma

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The importance of color measurement has come more and more important during last few decades. This is mainly due to increased requirements of quality set by customers and development of measuring instruments. When the accuracy has improved it has been noticed, that some unexpected factors affect the color of different samples. One of these factors is for example the temperature of the sample. The color of an object depends on its reflectance or transmittance and illuminating light source. The phenomenon where an object changes its color as the temperature is changed is called thermo
cromism. It has been noticed, that for example ceramic reference tiles used for the calibration of colorimeters and spectrophotometers are temperature dependent. The long wavelength reflecting like yellow, orange and red samples appear to be effec
ted most. Therefore, in calibration laboratories recommendations for color measurements require the temperature during the measurement to be set to temperature 25 ± 1 °C.

In some cases the behavior of absorbance and therefore transmittance as a function of temperature is known. In crystalline materials the absorbance of many impurities has homogeneously broadened absorption band. The shape of absorption band usually obeys either Gaussian or Lorentzian shape. The half widths (HFW) of these bands at high temperatures including room temperature (RT) have T² dependence. Anyhow the integrated absorbance, which means the area under the absorption band, remains constant. It means that, as the temperature increases, the half width of absorption band increases and the height becomes smaller. The peak position also changes toward smaller energies i.e. longer wavelengths, but that change is negligible compared with the previous one.

We present theoretical calculations in different color coordinate systems how thermo
cromism appears in different materials. Some comparisons with practical measurements are also presented.

References:
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