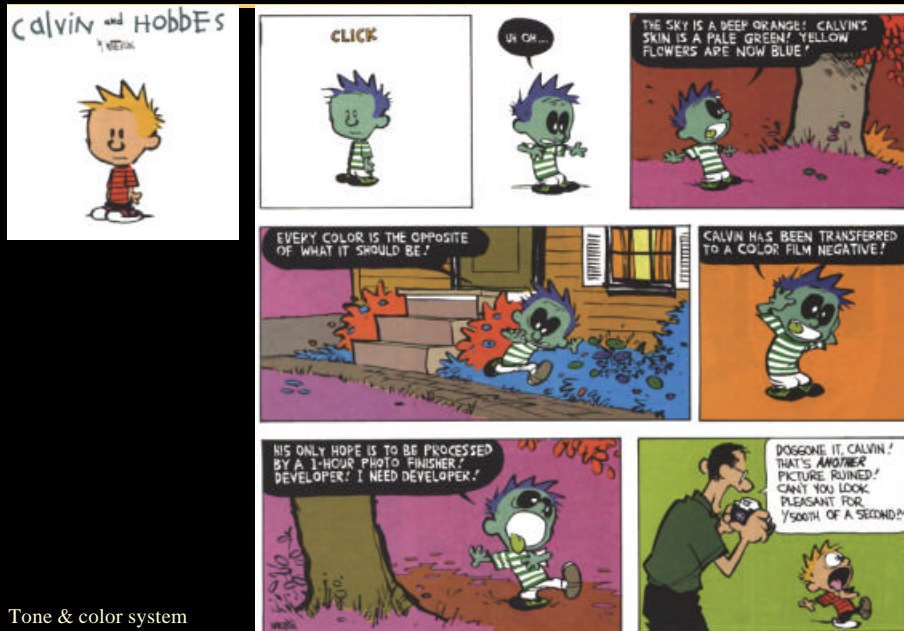


*The Art and Science of Depiction*  
**Tone and color system**

*Fredo Durand*  
*MIT- Lab for Computer Science*

**Color and Tone System**



## *Representation systems*

---

- Drawing and projection
- Denotation
- Tone & color

## *Tone & color system*

---

- (Often a mix)
- Extrinsic
- Intrinsic
- Symbolic

## Extrinsic color

- Renzo Piano  
Tjibaou  
cultural  
center  
1991-98



Tone & color system

5

## Extrinsic black and white

- Gordon Park,  
*Red Jackson*  
*Gang Leader*



Tone & color system

6

## *Optical intrinsic*

- Boticelli *Primavera* 1482

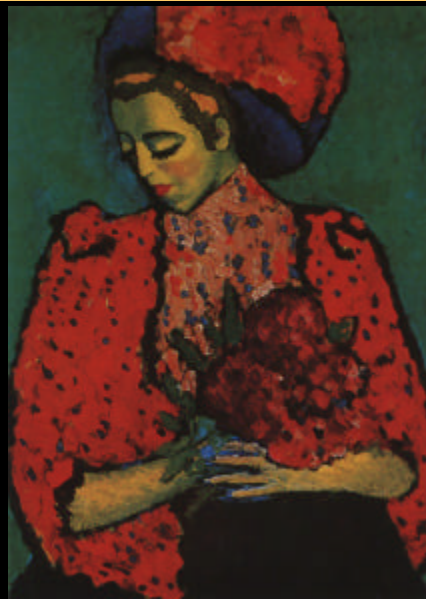


Tone & color system

7

## *Pure intrinsic colors*

- Jawlensky  
*Girl with Peonies*
- +symbolic+harmony



Tone & color system

8

## *Plan*

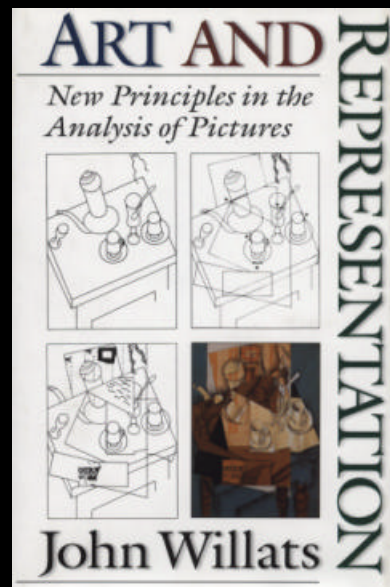
---

- Intro
- Shading
- Shadows
- Atmospheric perspective
- Light transfers
- Photography

## *Why a separate system?*

---

- Willats discusses it only/mainly for the optical denotation system
- But historically it is the major issue with drawing
- It is clearly a different problem from that of dimension and denotation
- Relevant as well for other denotation systems



## *Denotation system and tone & color*

- Silhouette: color of the regions
- Line drawing
  - Line color
  - Line thickness
- Optical
  - Point color & tone
  - Texture
- More an “attribute system” than just tone & color

Tone & color system

11

## *Denotation system and tone & color*



Tone & color system

12

## *Denotation system and tone & color*



Tone & color system

13

## *Denotation system and tone & color*

- Braque Un Poeme Dans Chaque Livre



Tone & color system

14

## *Denotation system and tone & color*

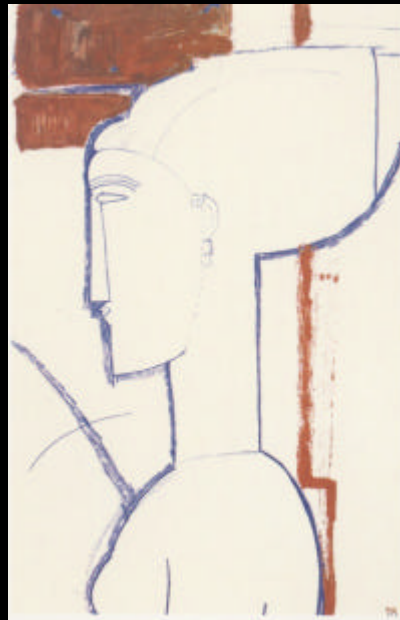


Tone & color system

15

## *Denotation system and tone & color*

- Amedeo Modigliani  
*Tete et buste de profil  
avec boucle d'oreille*  
1912



Tone & color system

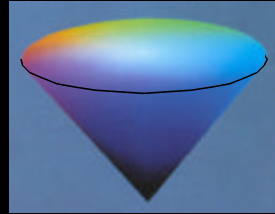
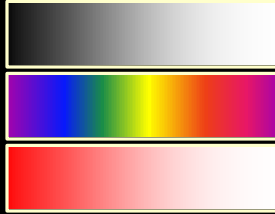
16



## *Picture color dimensions*

---

- Tone
- Hue
- Saturation



- Simultaneous contrast



- Texture



## *Beyond color*

---

- Material properties
- Painting
- Gold
- Etc.

## *Color origin*

---

- Physical extrinsic
- Physical intrinsic
- Symbolic/importance
- Color harmony
- Limitation compensation (or accentuation)

## *Color and symbol*

---



## *Issues*

---

- 2D/3D
  - 2D color composition
  - Color linked to the 3D scene
- Per mark/per primitive
  - Is the color constant on a mark?
  - Is it constant on a primitive?
  - Does it vary in the mark

## *Example*

---

- Paul Klee  
*Hoffmanneske Szene*  
1921



## *Example*

Tone & color system



23

## *Palette and medium*

- Different media permit different ranges of colors
  - E.g. pastels, pencil, watercolor, b/w photo
- The medium can be chosen for the palette



Tone & color system



24

## *Color and aging*



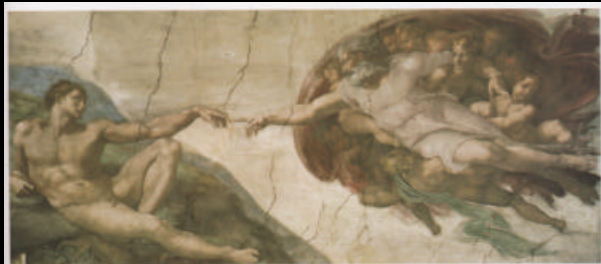
Tone & color system



25

## *Restoration*

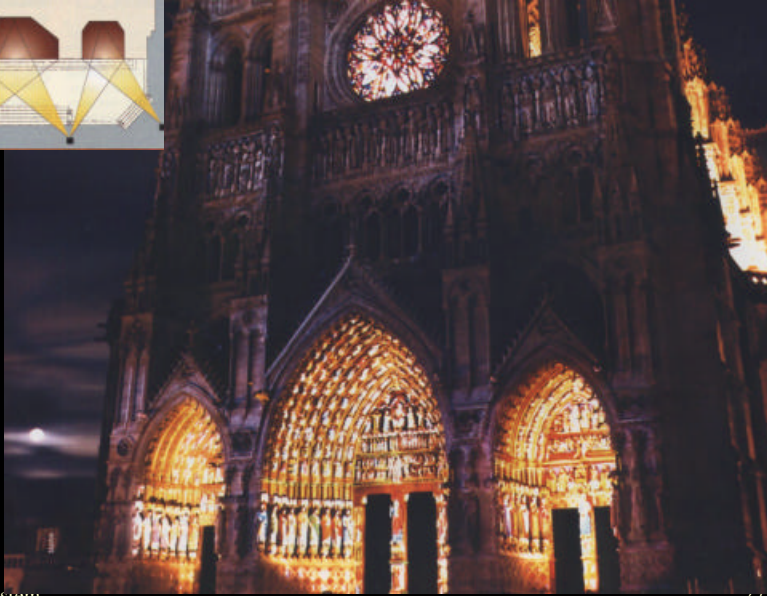
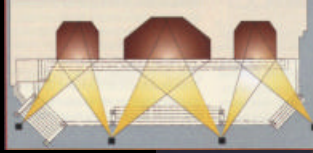
- Michelangelo The Creation of Adam 1508-1512



Tone & color system

26

## *Church and color*



Tone & color system

27

## *Church and color*



Tone & color system

28

## *Light in the scene*

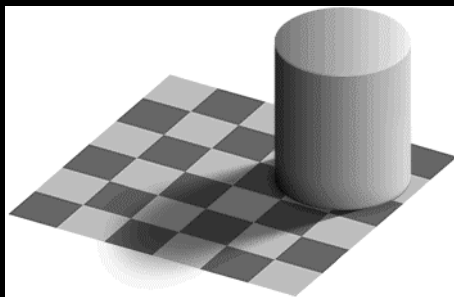
---

- Intrinsic reflectance
- Different light sources
- Outgoing light
- Shadows
  - Self shadows
  - Cast shadows
- Shading
- Inter-reflection
- Atmospheric perspective

## *Constancy and scene analysis*

---

- Segmentation into layers
  - Illumination
  - Reflectance
  - Transparency



## *Light*

---

- Point light source
- Directional light source (sun)
- Extended light source
- Hemispherical light source (sky)
- Ambient light
- Global illumination

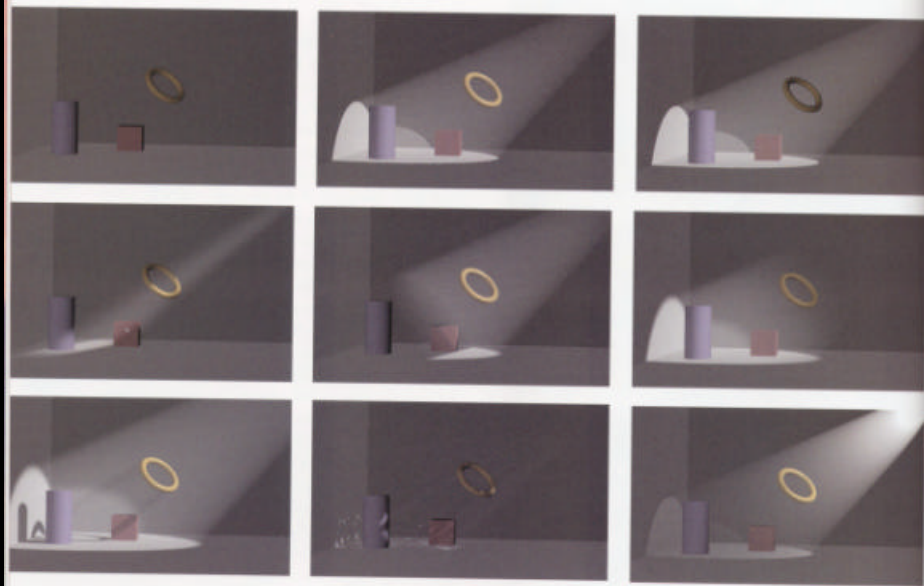
## *Light*

---

- Fall-off
- Attenuation



## *Light in CG*



Tone & color system

33

## *Plan*

- Intro
- Shading
- Shadows
- Atmospheric perspective
- Light transfers
- Photography

Tone & color system

34

## *Light and shape depiction*

- Shading
- Highlight
- Shadow
- Inter-reflection

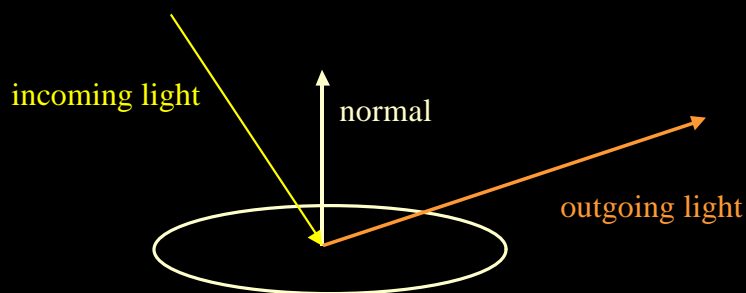


Tone & color system

35

## *Shading & BRDF*

- Bi-Directional Reflectance distribution function
- Ratio of light arriving from one direction bouncing in another direction
- 4D function (2\*2 angles)

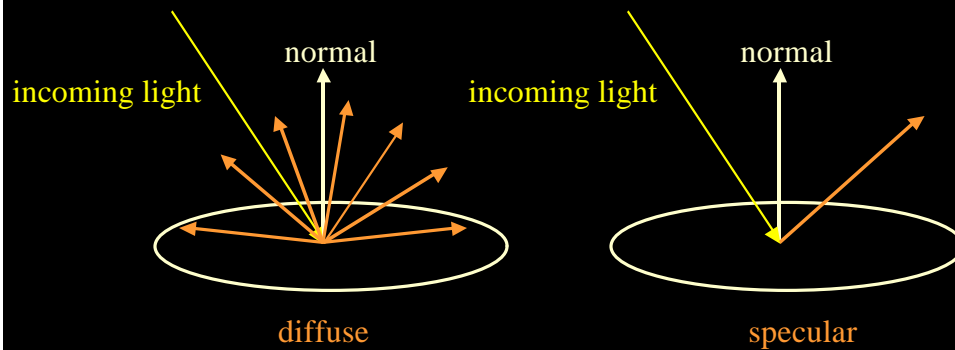


Tone & color system

36

## Shading & BRDF

- 2 main components
  - Diffuse (omni-directional)
  - Specular (directional) : highlight

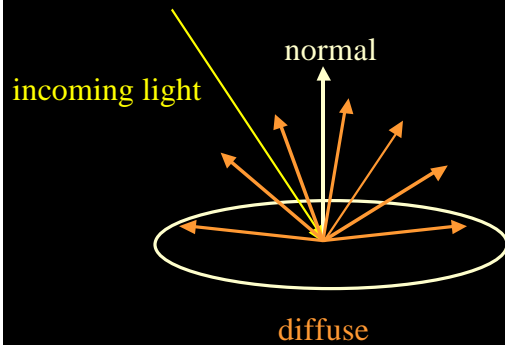


Tone & color system

37

## Shading & BRDF

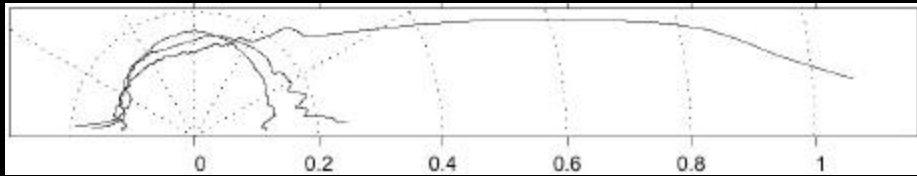
- Diffuse
  - Depends on angle between light and normal



Tone & color system

38

## Shading & BRDF



Tone & color system

39

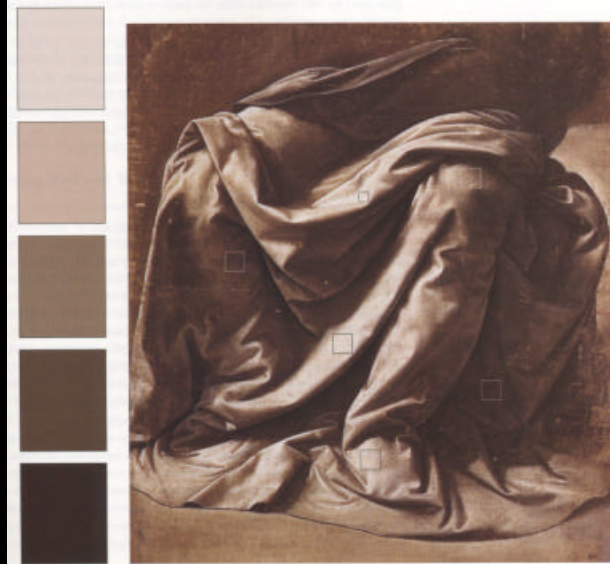
## Shading & BRDF



Tone & color system

40

## Chiaroscuro



Tone & color system

41

## Saturation shading

- Andreas Mantegna, *Madonna and Child with St John the Baptist and Mary Magdalene*, 1495

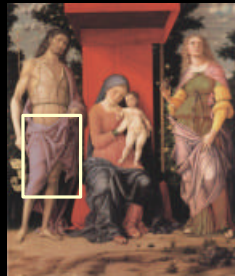


Tone & color system

42

## Saturation shading

- Andreas Mantegna, *Madonna and Child with St John the Baptist and Mary Magdalene*, 1495



Tone & color system

43

## Shading and make up

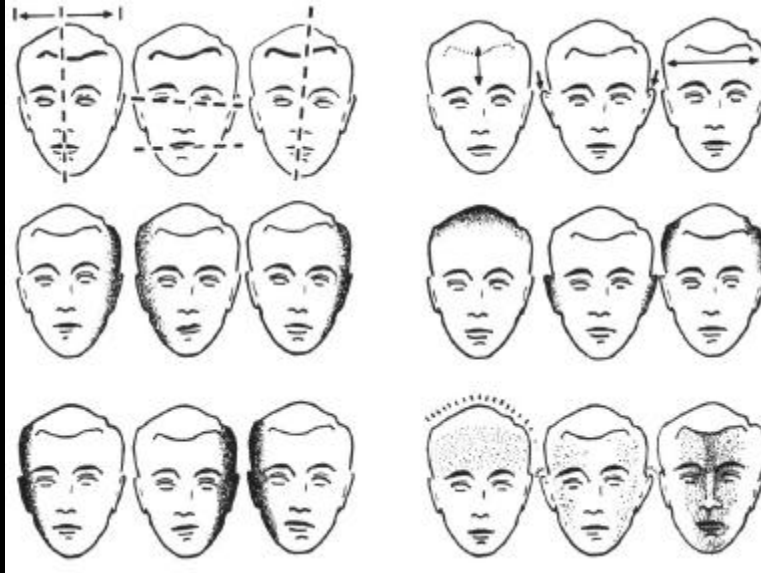


Tone & color system

Snapshot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching

44

## *Shading and corrective lighting*



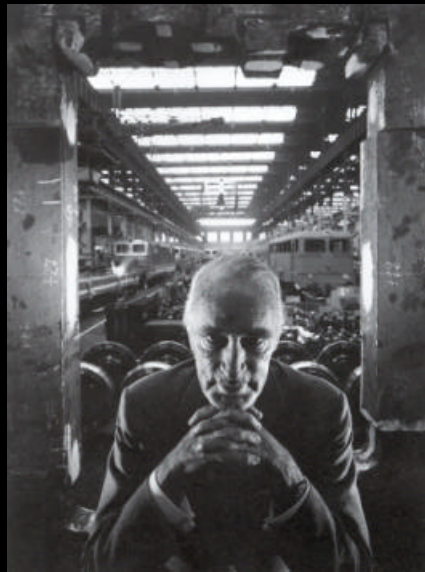
Tone & color system

Snapshot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching

45

## *Lighting and shading*

- Alfred Krupp photographed in 1963 by Arnold Newman
- Because Krupp had benefited from the nazis
- Un-friendly lighting



Tone & color system

46

## *Plan*

---

- Intro
- Shading
- Shadows
- Atmospheric perspective
- Light transfers
- Photography

## *Shadow*

---



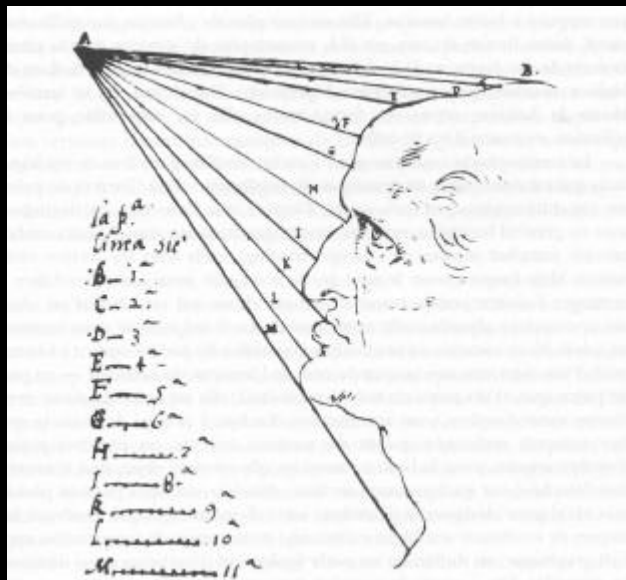
Plate 18  
David Allan,  
*The Origin of Painting*  
(*The Maid of Corinth*),  
1775. Oil on wood,  
38.7 x 31 cm. Edinburgh,  
National Gallery of  
Scotland.



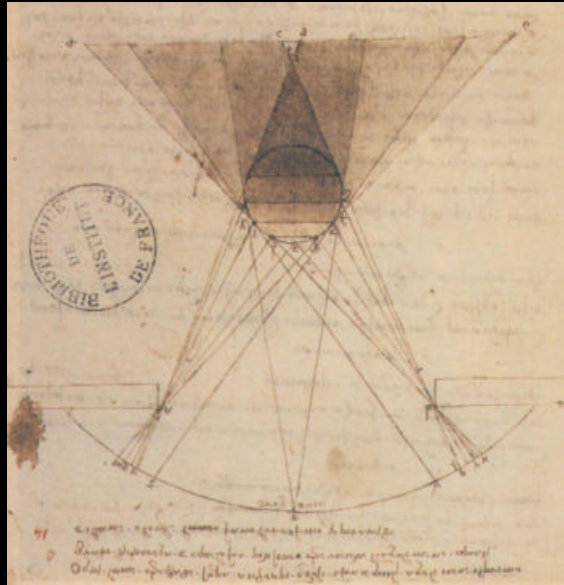
## *Shadow*

- Self , cast and attached shadows
  - (or primary and secondary, double shadow, etc.)
- Not local
- Can be distracting
- Have been depicted or not depending on period
  
- Hard/soft shadow

## *Self and cast shadow*



## *Soft shadow*

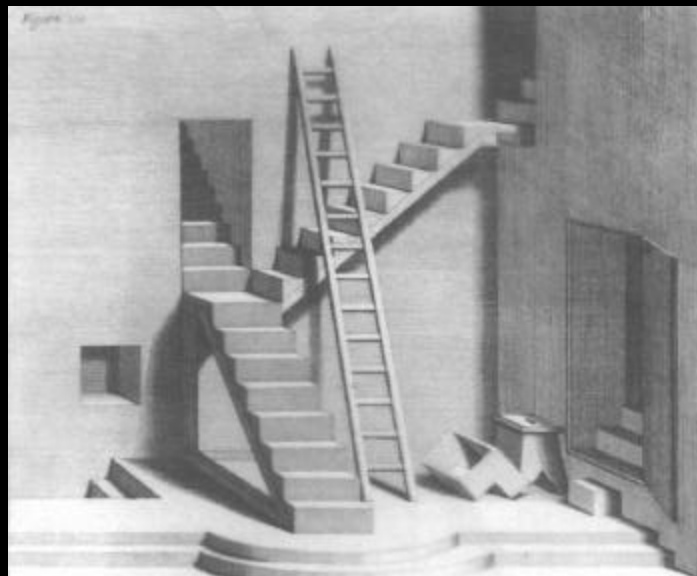


Tone & color system

51

## *Shadow*

- Pozzo

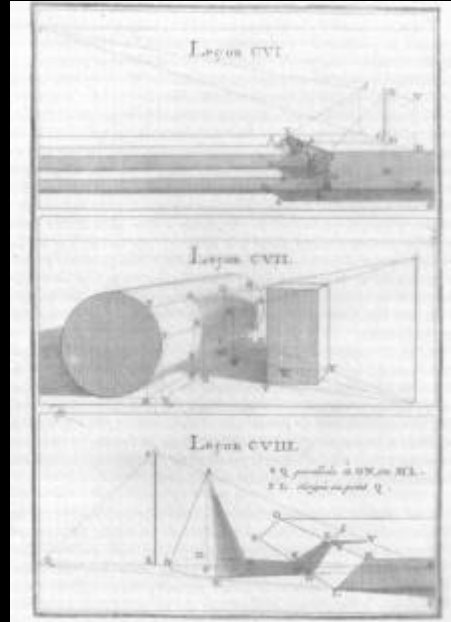


Tone & color system

52

# Shadows

- 18<sup>th</sup> century

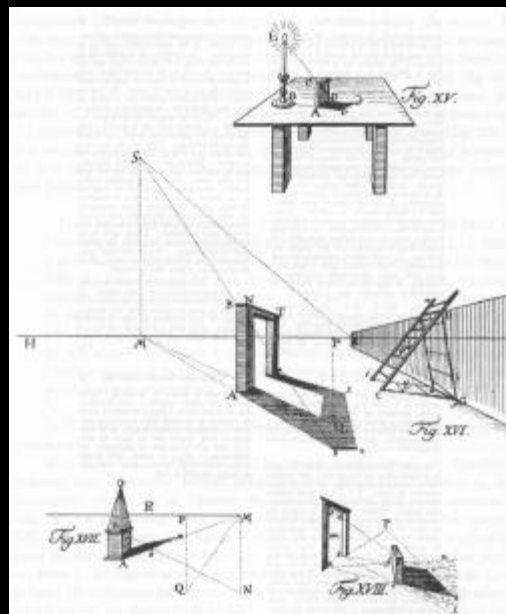


Tone & color system

53

# Shadows

- 18<sup>th</sup> century
- Lambert



Tone & color system

54

## *Shadow*

- Raphael vs. Master of the Mornauer



Tone & color system



55

## *Shadow*

- Campin, *Trinity* 1427-32



Tone & color system

56

## *Shadow*

- Caravaggio The Supper at Emmaus 1601



Tone & color system

57

## *Shadow*

- Guardi 1755



Tone & color system

58

## Shadow



Plate 30 Gerrit Berckheyde, *The Marketplace and the Grote Kerk at Haarlem*, 1674. Oil on canvas, 51.8 x 87 cm. London, National Gallery.

Tone & color system

59

## Shadow

- Rembrandt



Tone & color system

60

## Shadow

- Follower of Rembrandt A Man seated reading at a table in a lofty room 1631-50



Tone & color system

61

## Shadow & Trompe-l'oeil

- Rembrandt



Tone & color system

62

## *Shadow & Trompe-l'oeil*



Tone & color system

Plate 27 Unknown Swedish Artist, *Portrait of a Woman of the Noble Family*,  
c.1700. Oil on silver fir, 35.7 x 40.8 cm.  
London, National Gallery.

63

## *Shadow reveal shape*



Tone & color system

64



## *Colored shadow*



Tone & color system

65

## *Shadow reveal*



Tone & color system

66

## Shadow reveal



Tone & color system

67

## Shadow reveal



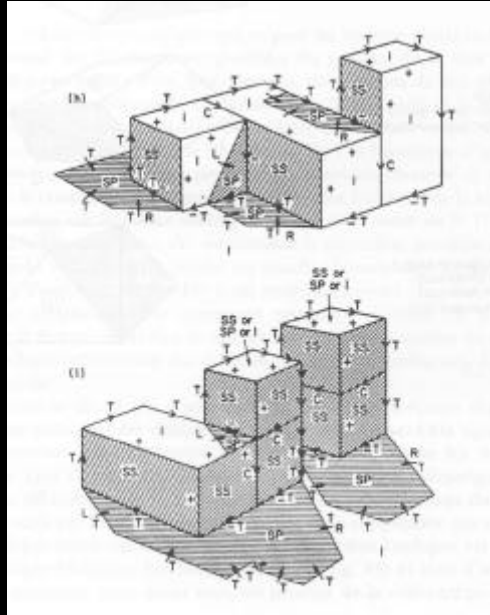
Plate 52 Grandville, *The Shadows (The French Cabinet)* from *La Caricature*, 1830.

Tone & color system

68

## Shadow

- [Waltz 75]



Tone & color system

69

## Plan

- Intro
- Shading
- Shadows
- Atmospheric perspective
- Light transfers
- Photography

Tone & color system

70

## *Atmospheric perspective*

---

- Saturation
- Hue
- Precision

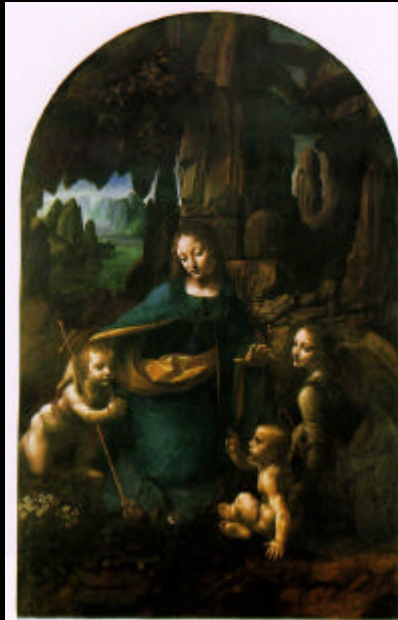
Tone & color system

71

## *Atmospheric perspective*

---

- Leonardo



Tone & color system

72

## *Atmospheric perspective*

---

- Titian, *Bacchus*



Tone & color system

73

## *Atmospheric perspective*

---

- R. Earlom, *Pastoral Scene*, 1774



Tone & color system

74

## *Plan*

---

- Intro
- Shading
- Shadows
- Atmospheric perspective
- Light transfers
- Photography

## *Global illumination*

---

- Light inter-reflection
- Each surface is a secondary light source
- Crucial for indoor scenes

## *Global illumination*



Tone & color system

77

## *Global illumination*



Tone & color system

78

## *Global illumination*



Rendered using the Lightscape Visualization System.  
Courtesy of Isao Nagata and Joe Pinski. Copyright (c) 1999 Digital Architecture (New York, NY)

Tone & color system

79

## *Global illumination*



Tone & color system

80



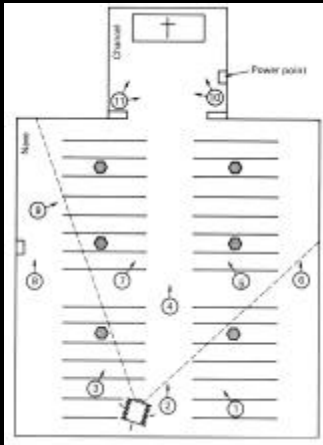
## *Global illumination*



Tone & color system

81

## *Counter-example: painting with light*



Tone & color system

Snapshot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching

82

## *Global illumination & production*

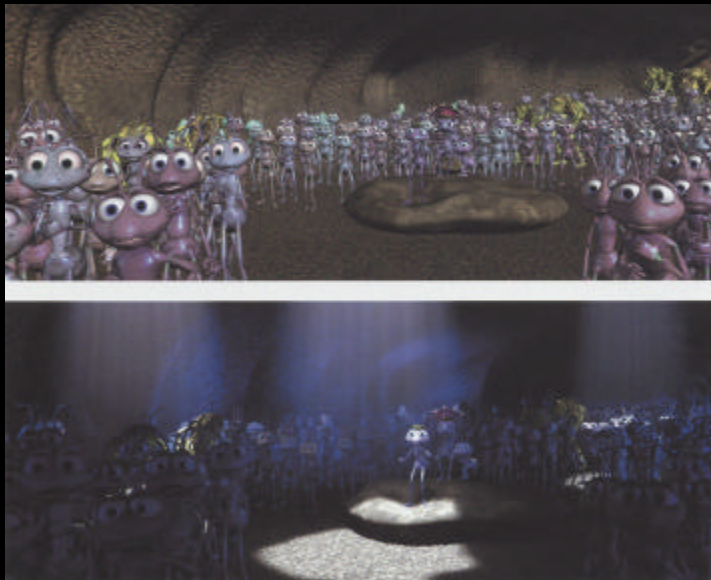
- Mostly unused
- Because artists want local control



Tone & color system

83

## *Global illumination & production*



Tone & color system

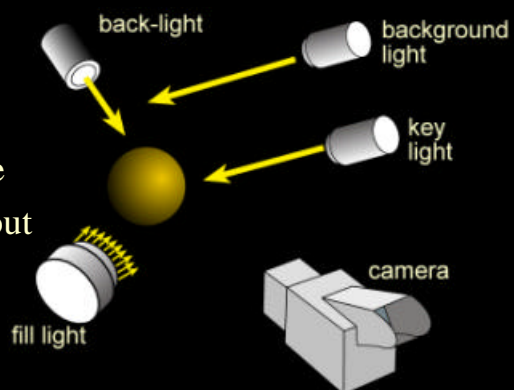
84

## *Plan*

- Intro
- Shading
- Shadows
- Atmospheric perspective
- Light transfers
- Photography

## *Three Point Lighting*

- Key light
  - Main and visible lighting
- Fill light
  - Fill-in shadows
- Back light
  - Emphasize silhouette
  - Make subject stand out
- Independent lighting



## Portrait lighting



Tone & color system

Snapshot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching

87

## Filter for black and white



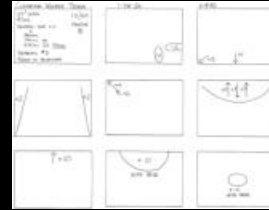
Tone & color system

Snapshot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching

88

# Dodging and Burning

- Clearing Winter Storm



Tone & color system    Snapshot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching    89

# Haze filtering

- Haze is bluish



No filter

Blue filter

Red filter

Tone & color system    Snapshot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching    90

## Example

- Edgar Degas  
*Ballet Dancer  
in Position  
facing 3/4 front  
1872*



Tone & color system

91

## Example

- Tom Purvis 1935



Tone & color system

92