

The Art and Science of Depiction

Limitations of the Medium, compensation or accentuation: Contrast & Palette

*Fredo Durand
MIT- Lab for Computer Science*

Hans Holbein

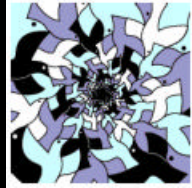
The Ambassadors



Limitations: contrast & palette

2

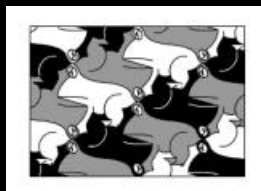
Makoto Nakamura



Limitations: contrast & palette

3

Makoto Nakamura



Limitations: contrast & palette

4

Makoto Nakamura



Limitations: contrast & palette

5

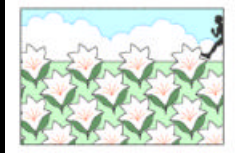
Makoto Nakamura



Limitations: contrast & palette

6

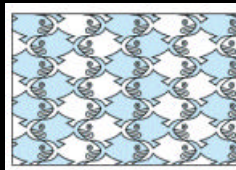
Makoto Nakamura



Limitations: contrast & palette

7

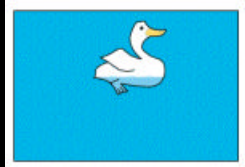
Makoto Nakamura



Limitations: contrast & palette

8

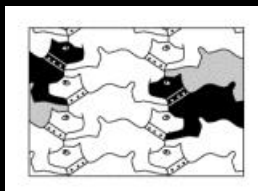
Makoto Nakamura



Limitations: contrast & palette

9

Makoto Nakamura



Limitations: contrast & palette

10

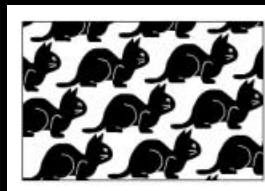
Makoto Nakamura



Limitations: contrast & palette

11

Makoto Nakamura



Limitations: contrast & palette

12

Assignments for Monday 16.

- Solso *Cognition and the Visual Arts*
 - Chapter 5 & 6
- Essay
 - Exploratory or Picture comment
 - Choose subject
 - Outline of the issues

Limitations: contrast & palette

13

Personal Meeting II

- Class
- Essay
- Project

Limitations: contrast & palette

14

Plan

- The picture is flat
- The viewpoint is unique
- The image is finite, it has a frame
- The picture is static
- The contrast is limited

Limitations: contrast & palette

15

Context

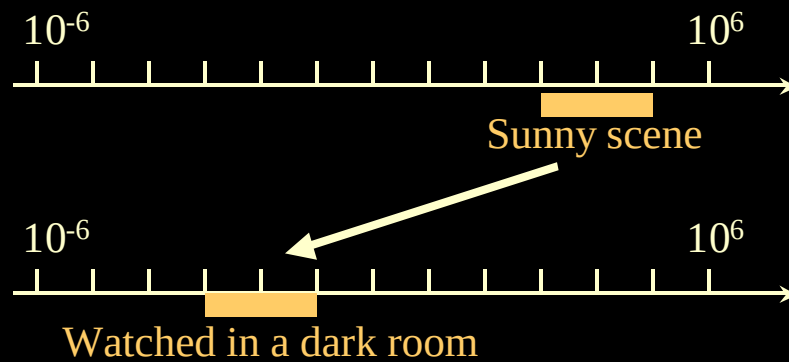
- Real world: 10^{-6} to 10^6 cd/m²
- Picture
 - Max contrast 1:500
 - Typically 1:50

Limitations: contrast & palette

16

Two problems

- The image intensity does not match the real conditions

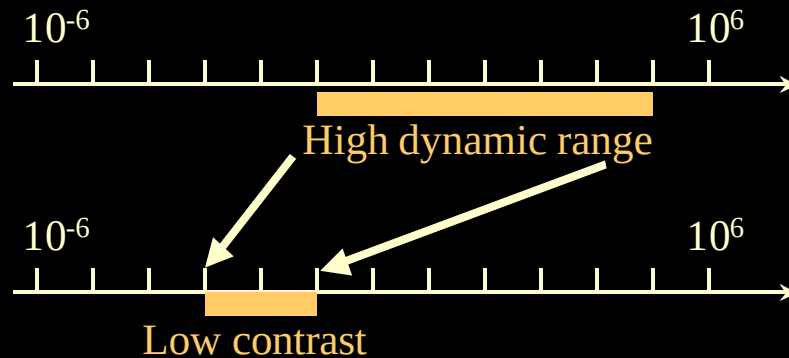


Limitations: contrast & palette

17

Two problems

- The image intensity does not match the real conditions
- The contrast is not sufficient



Limitations: contrast & palette

18

Three contexts

- Photo
- Computer Graphics
- Painting and drawing

Limitations: contrast & palette

19

The limit of illusion

- Pozzo's ceiling: the Sky is not bright enough



Limitations: contrast & palette

20

The limit of illusion

- Bruneleschi's experiment
 - Used a mirror for the sky

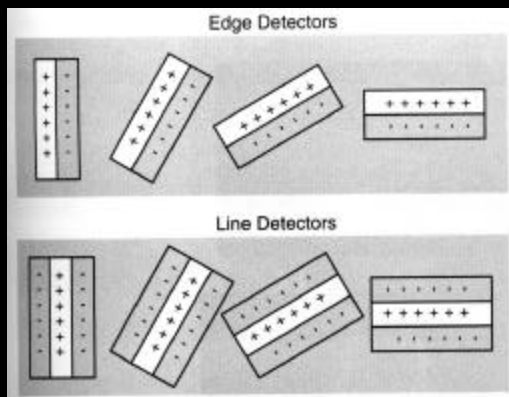


Limitations: contrast & palette

21

Edge detection

- Similar to center-surround
- Measured using micro-electrodes

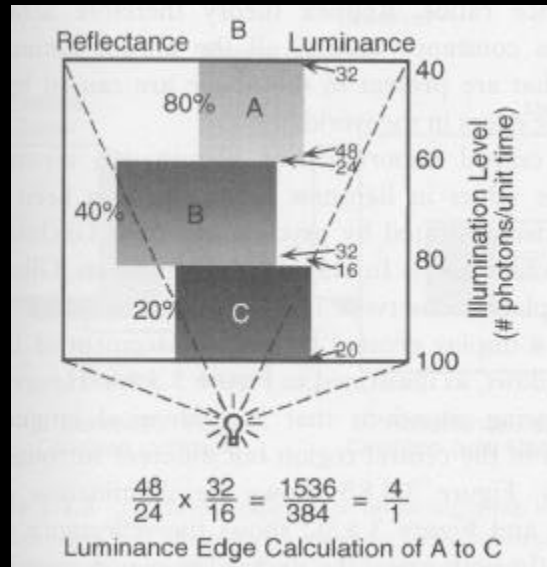


Limitations: contrast & palette

22

Land Retinex

- Local contrast



Limitations: contrast & palette

23

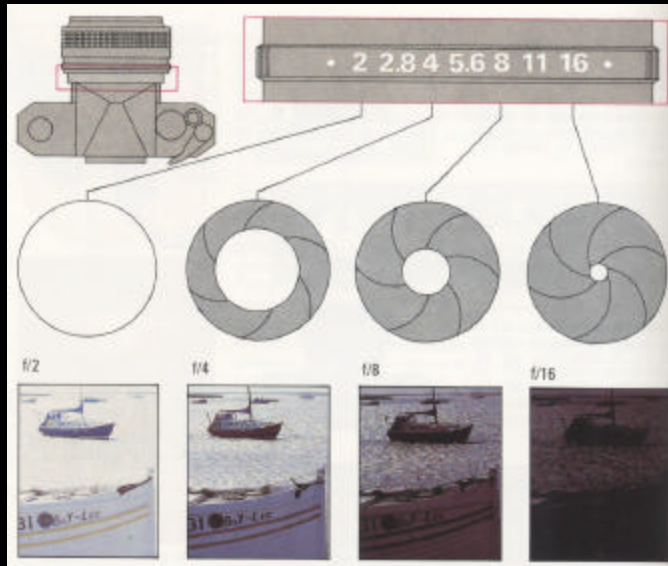
Plan

- Problem 1: intensity does not match
 - Exposure
 - Viewing conditions
 - Night scenes
- Problem2: insufficient contrast
 - Tone Reproduction
 - Lighting
 - Tone mapping in CG
 - Flares
 - Painting

Limitations: contrast & palette

24

Photo exposure

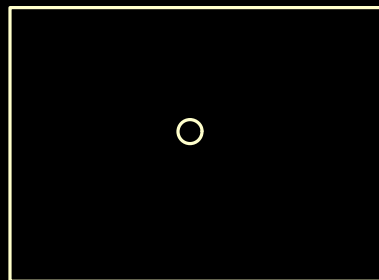
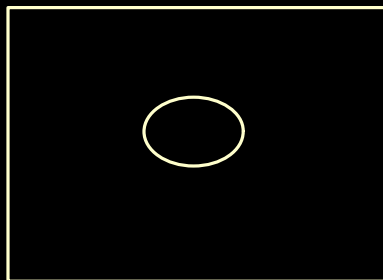


Limitations: contrast & palette

25

Metering

- Centered average
- Spot
- Incident
 - Measure incoming light



Limitations: contrast & palette

26

Nikon 3D Color Matrix

- Database of 30,000 photos
- Multiple captors (segments)
- Exposure depends on
 - Brightness from each segments
 - Color
 - Contrast
 - Distance
 - Focus (where is the subject)

Limitations: contrast & palette

27

Plan

- Problem 1: intensity does not match
 - Exposure
 - Viewing conditions
 - Night scenes
- Problem2: insufficient contrast
 - Tone Reproduction
 - Lighting
 - Tone mapping in CG
 - Flares
 - Painting

Limitations: contrast & palette

28

Hunt and Stevens effect

- Stevens effect
 - Contrast increases with luminance

Limitations: contrast & palette

29

Hunt and Stevens effect

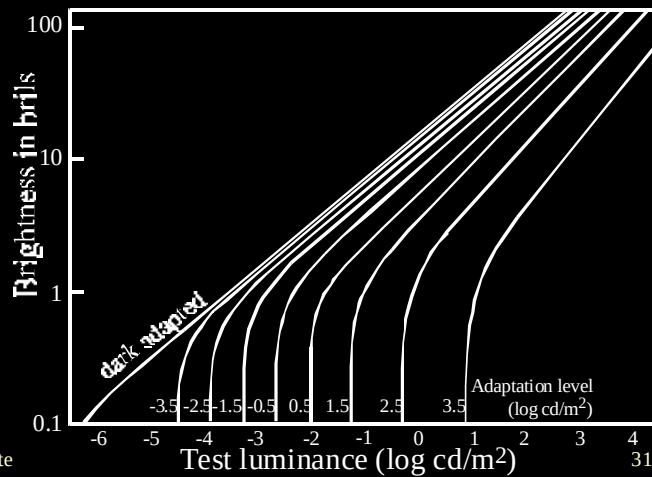
- Stevens effect
 - Contrast increases with luminance
- Bartleson-Breneman effect
 - Image contrast changes with surround
 - A dark surround decreases contrast
(make the black of the image look less deep)
- Hunt effect
 - Colorfulness increases with luminance
- Hence the need for gamma correction

Limitations: contrast & palette

30

Suprathreshold

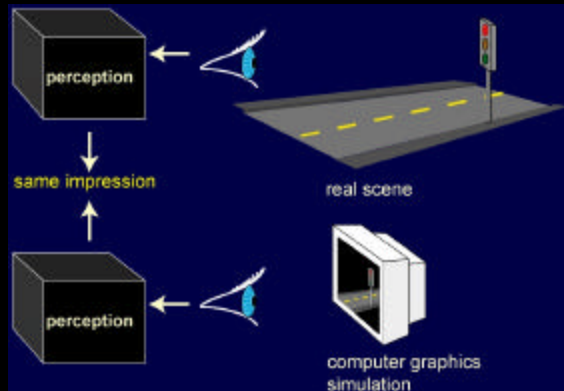
- Subjective brightness
- Power law
- Exponent
 - 0.33 to 0.5
- Gamma correction



Limitations: contrast & palette

Tone mapping

- Real scene: large range of luminance
 - (from 10^{-6} to 10^6 cd/m²)
- Limitation of the display
 - 1-100 cd/m²
- Goal:
Reproduce
a faithful
impression



Limitations: contrast & palette

Perceptual tone mapping

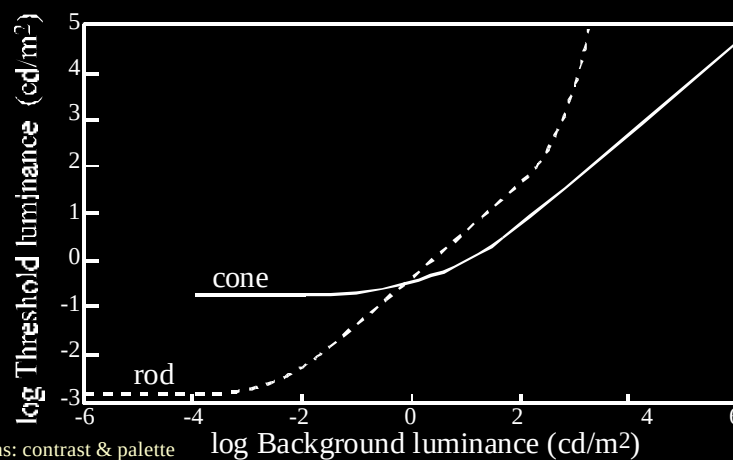
- [Ferwerda et al. 1996]
- Match the smallest perceptible intensity in the simulated scene and in the display condition
- Rod and cone vision

Limitations: contrast & palette

33

Threshold

- Smallest perceptible stimulus
- Smallest perceptible stimulus difference



Limitations: contrast & palette

34

Perceptual tone mapping

- [Ferwerda et al. 1996]



Limitations: contrast & palette

35

Time-dependent tone mapping

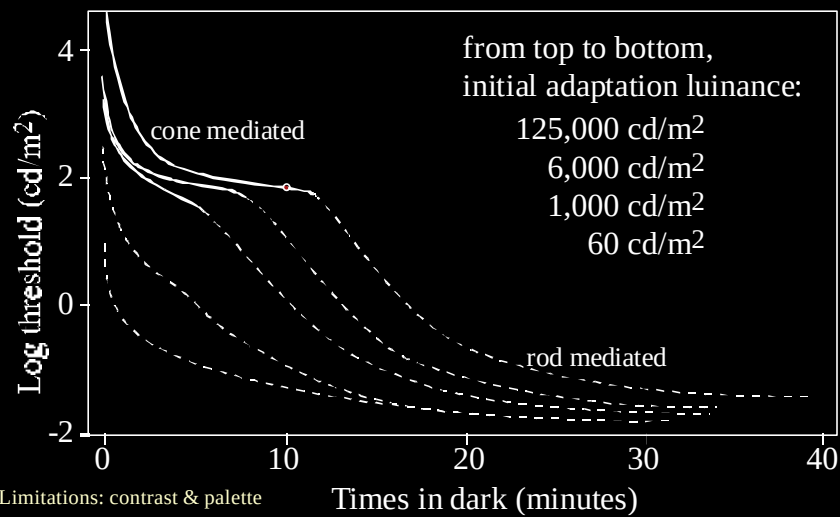
- Dazzling
- Slow dark adaptation

Limitations: contrast & palette

36

Dark adaptation

- Slow recovery after dramatic decrement



37

Time-dependent tone mapping



Limitations: contrast & palette

38

Plan

- Problem 1: intensity does not match
 - Exposure
 - Viewing conditions
 - Night scenes
- Problem2: insufficient contrast
 - Tone Reproduction
 - Lighting
 - Tone mapping in CG
 - Flares
 - Painting

Limitations: contrast & palette

39

Representing night scenes

- Rods, no color vision
- Blue shift
- Lower acuity
- Unable to adapt in shadows

Limitations: contrast & palette

40

Representing night scenes

- Pissarro, Montmartre



Limitations: contrast & palette

41

Representing night scenes

- James Abbott Mc Neil Whistler
Nocturne in Blue And Silver The Lagoon Venice
1879-1880



Limitations: contrast & palette

42

Representing night scenes

- Whistler, *Old Battersea Bridge*



Limitations: contrast & palette

43

Representing night scenes

- Archibald J. Motley Jr, *Gettin' Religion* 1948



Limitations: contrast & palette

44

Night scenes in the movies

- Often *Day for night*
- Film during the day
- Few fill light (dark shadows)
- Add blue cast
- Avoid the sky

Limitations: contrast & palette

45

Plan

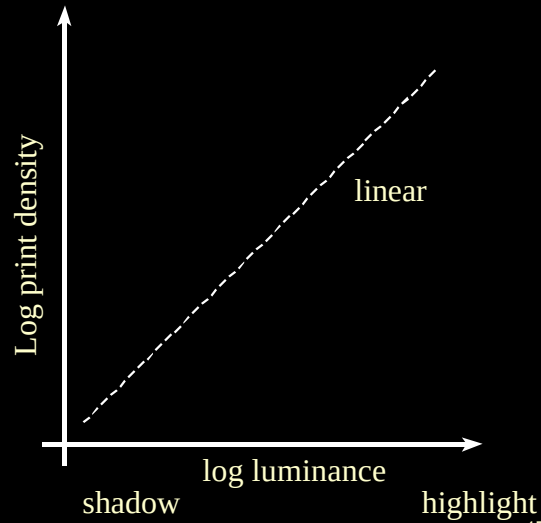
- Problem 1: intensity does not match
 - Exposure
 - Viewing conditions
 - Night scenes
- Problem2: insufficient contrast
 - Tone Reproduction
 - Lighting
 - Tone mapping in CG
 - Flares
 - Painting

Limitations: contrast & palette

46

Tone Reproduction

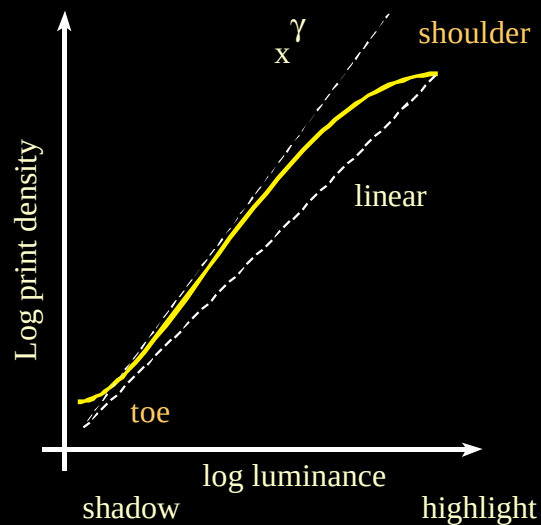
- Not linear



Limitations: contrast & palette Shot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching 47

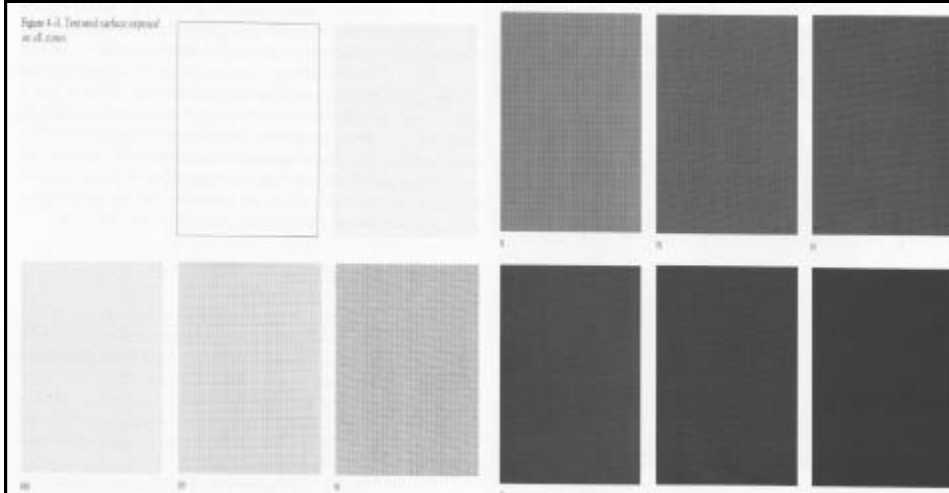
Tone Reproduction

- Not linear
- Gamma correction



Limitations: contrast & palette Shot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching 48

Texture and contrast

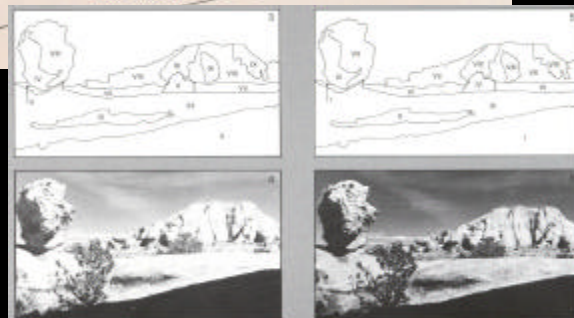
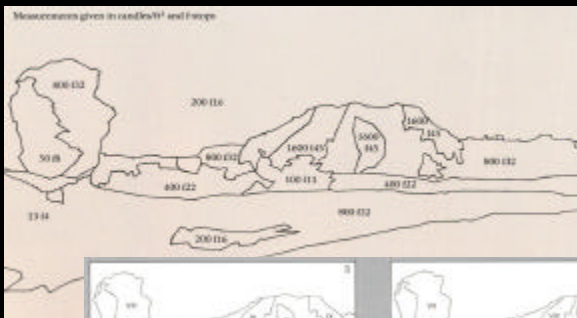


Limitations: contrast & palette

49

The Zone System

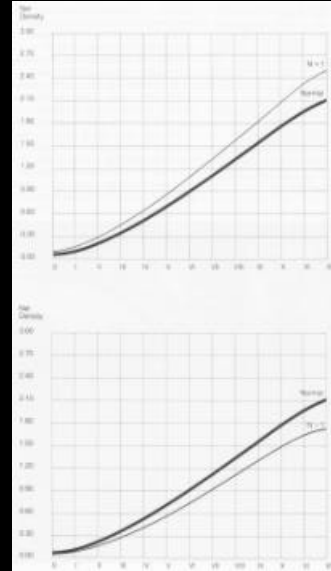
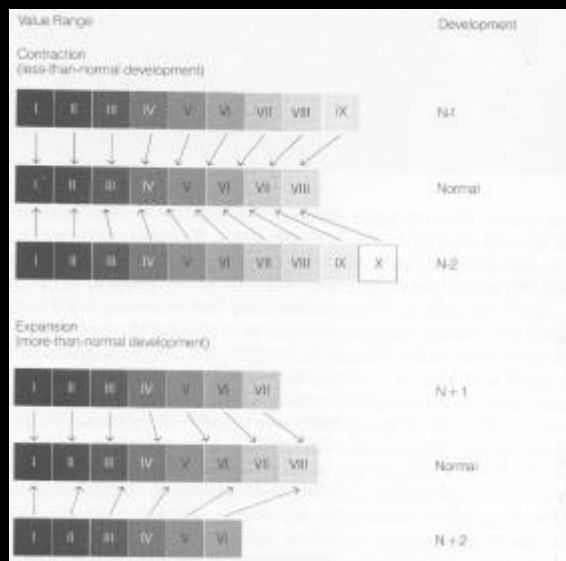
The Zones	
0 Solid black; the same as the film rebate	
I Nearly black; just different from Zone 0	
II The first hint of texture	
III Textured shadow; the first recognizable shadow detail	
IV Average shadow value on Caucasian skin, foliage and buildings	
V Middle grey; the pivot value; light foliage, dark skin	
VI Caucasian skin, textured light grey; shadow on snow	
VII Light skin; bright areas with texture, such as snow in low sunlight	
VIII Highest zone with any texture	
IX Pure untextured white	



Limitations: contrast & palette shot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching

50

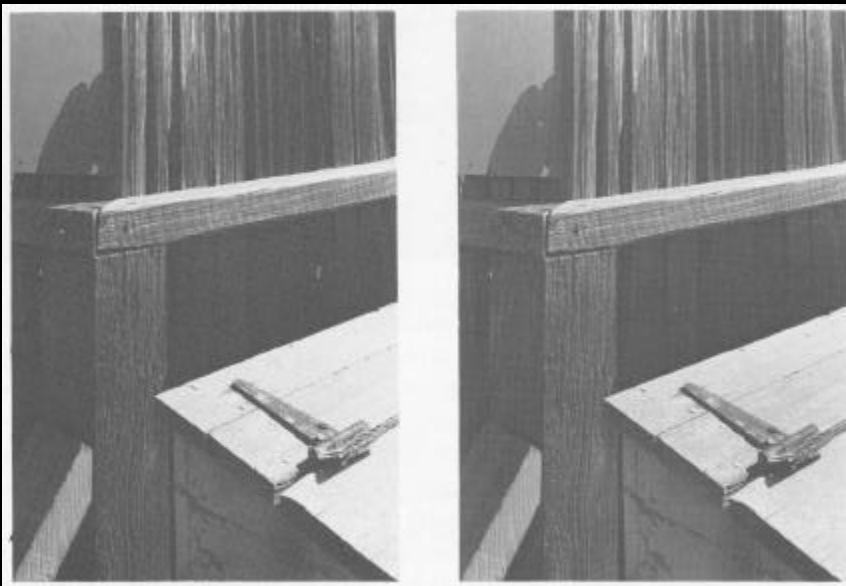
Expansion and contraction



Limitations: contrast & palette

51

Contraction

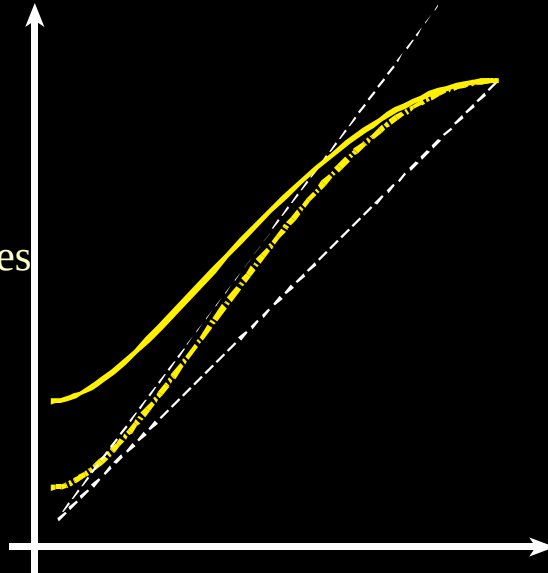


Limitations: contrast & palette

52

Pre- exposure

- Expose with uniform white before taking the photo
- Raise the dark tones



Limitations: contrast & palette

53

Pre- exposure

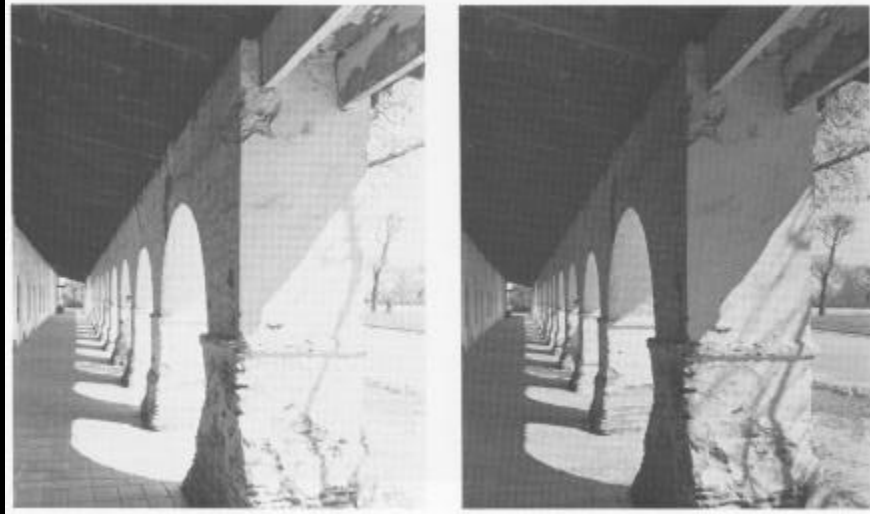


Limitations: contrast & palette

54

Two-solution development

- Different development of high and low value



Limitations: contrast & palette

55

Red Filter



Limitations: contrast & palette

56

The Print

- W. Eugene Smith photo of Albert Schweitzer
- 5 days to print!

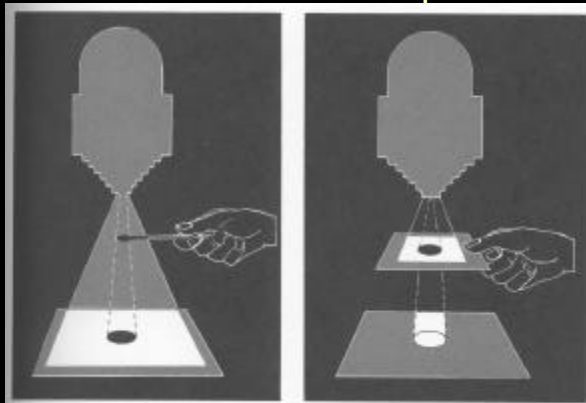


Limitations: contrast & palette - shot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching

57

Dodging and Burning

- Locally darken or lighten
- Use masks to expose some parts less
- Has to be done for each print!



Limitations: contrast & palette - shot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching

58

Dodging/burning



Limitations: contrast & palette

59

Gradient Filter

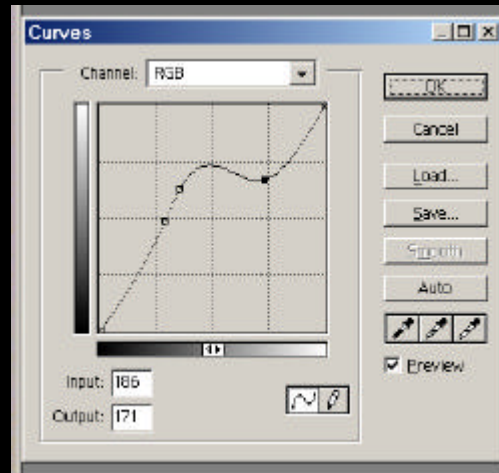
- The sky is too bright
 - Gradient filter for the top of the photo
- The house is too dark
 - Gradient filter for the bottom of the photo



Limitations: contrast & palette

60

Curve tool in photo editing software



Limitations: contrast & palette

61

The infamous 8 bits

- Digital photography
- 8 bits means 1 to 255 contrast
- Enough for display
- Not enough for
 - Editing
 - Tone reproduction
 - Dodging & burning
 - Etc.

Limitations: contrast & palette

62

Plan

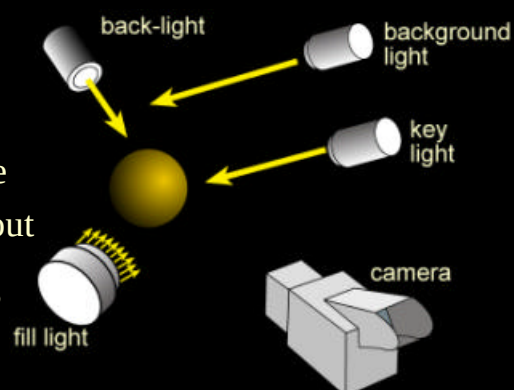
- Problem 1: intensity does not match
 - Exposure
 - Viewing conditions
 - Night scenes
- Problem2: insufficient contrast
 - Tone Reproduction
 - Lighting
 - Tone mapping in CG
 - Flares
 - Painting

Limitations: contrast & palette

63

Three Point Lighting

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



Limitations: contrast & palette, shot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching

64

Lighting

- Fill light

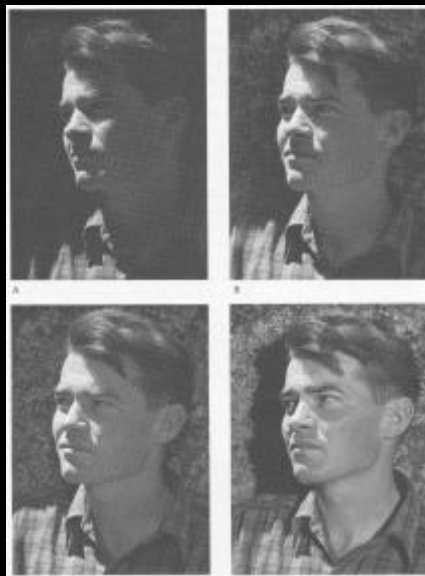


Limitations: contrast & palette

65

Portrait Lighting

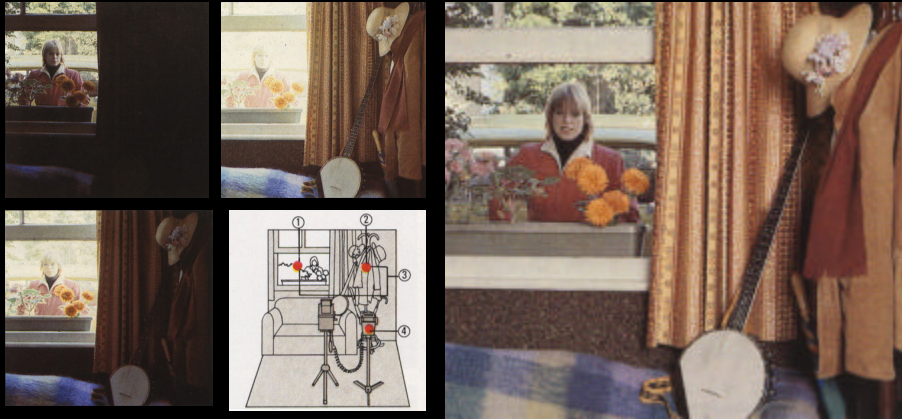
- Ansel Adams



Limitations: contrast & palette shot-Perspective-Speed, aperture-Filter-**Lighting**-Processing & Print-Make up-Retouching

66

Fill-in

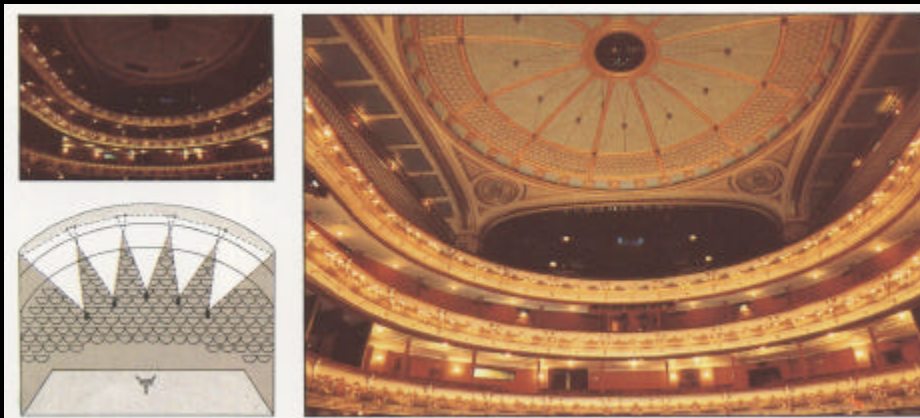


Limitations: contrast & palette, shot-Perspective-Speed, aperture-Filter-Lighting-Processing & Print-Make up-Retouching

67

Lighting

- Painting with light



Limitations: contrast & palette

68

Plan

- Problem 1: intensity does not match
 - Exposure
 - Viewing conditions
 - Night scenes
- Problem2: insufficient contrast
 - Tone Reproduction
 - Lighting
 - Tone mapping in CG
 - Flares
 - Painting

Limitations: contrast & palette

69

Local contrast



Limitations: contrast & palette

70

Local compensation

- Use local average to compensate
- Haloing effects



Limitations: contrast & palette

71

Local contrast

- [Tumblin 1999]
- Organization into regions



Limitations: contrast & palette

72

Local contrast

- [Tumblin 1999]
- Organization into regions

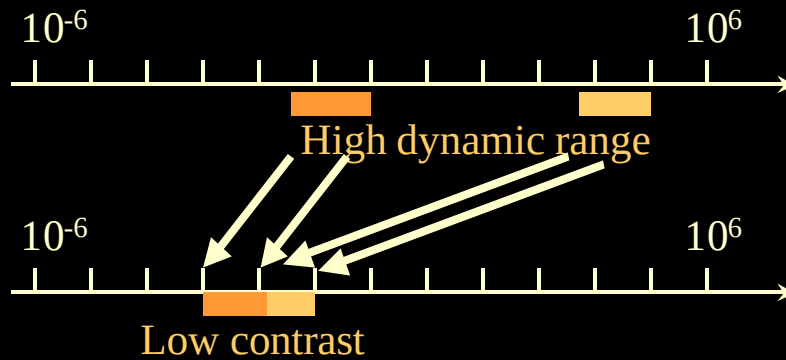


Limitations: contrast & palette

73

Histogram adjustment

- [Larson et al. 1997]
- Disregard empty portions of the histogram



Limitations: contrast & palette

74

Histogram adjustment

- [Larson et al. 1997]
- Disregard empty portions of the histogram



Limitations: contrast & palette

75

Plan

- Problem 1: intensity does not match
 - Exposure
 - Viewing conditions
 - Night scenes
- Problem2: insufficient contrast
 - Tone Reproduction
 - Lighting
 - Tone mapping in CG
 - Flares
 - Painting

Limitations: contrast & palette

76

Flare, halo

- Le Corbusier, *Notre Dame du Haut*, 1950-55



Limitations: contrast & palette

77

Flare, halo



Limitations: contrast & palette

78

Flare, halo

- Van Gogh, *Le Semeur*, 1880



Limitations: contrast & palette

79

Blue-yellow

- Karl Schulpig, 1925

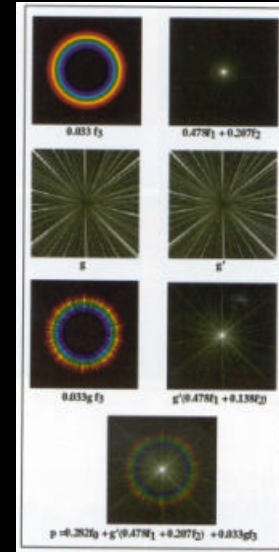
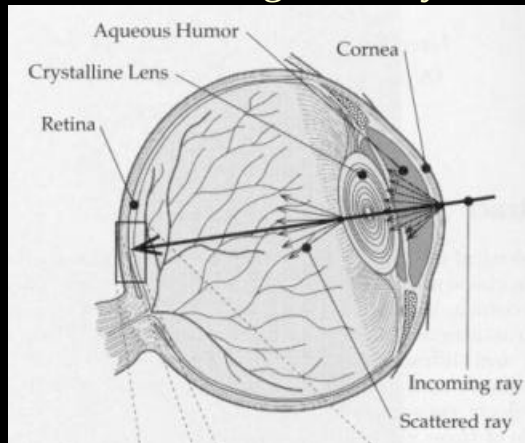


Limitations: contrast & palette

80

Flare in CG

- [Spencer et al 1995]
- Flare: scattering in the eye

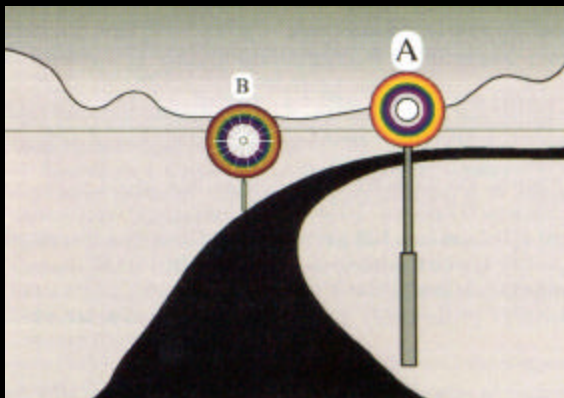


Limitations: contrast & palette

81

Flare in CG

- [Spencer et al 1995]
- Flare: scattering in the eye
- Size is constant

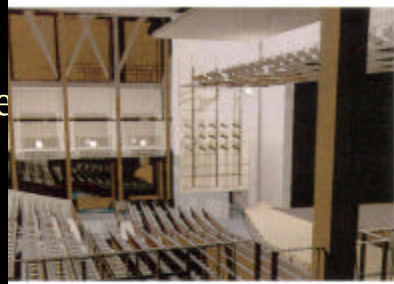


Limitations: contrast & palette

82

Flare in CG

- [Spencer et al 1995]
- Flare: scattering in the eye
- Size is constant



Limitations: contrast & palette

83

Plan

- Problem 1: intensity does not match
 - Exposure
 - Viewing conditions
 - Night scenes
- Problem2: insufficient contrast
 - Tone Reproduction
 - Lighting
 - Tone mapping in CG
 - Flares
 - Painting

Limitations: contrast & palette

84

Local lighting

- Typically Florence Renaissance
- Mostly to reveal shape
- Raphael



Limitations: contrast & palette

85

Chinese painting



Limitations: contrast & palette

86

Tenebrism

- Early 17th
- Caravaggio



Limitations: contrast & palette

87

Rembrandt



Limitations: contrast & palette

88

Radial balance

- Georges de La Tour, Joseph the Carpenter, 1645



Limitations: contrast & palette

89

White

- Filippo Lippi



Limitations: contrast & palette

90

Silhouette

- Wolfrang Weber
The Lash Bird Dancer
On Madagascar
Late 20s



Limitations: contrast & palette

91

Contrast

- Bert Stern



Limitations: contrast & palette

92

Pure drawing

- Diego Riviera
Mother And Child
1936



Limitations: contrast & palette

93

Pure color

- Henri Matisse, *Harmony in Red*, 1908-1909



Limitations: contrast & palette

94

Pure color



Limitations: contrast & palette

95