Global Illumination

Radiosity

Visual Imaging in the Electronic Age

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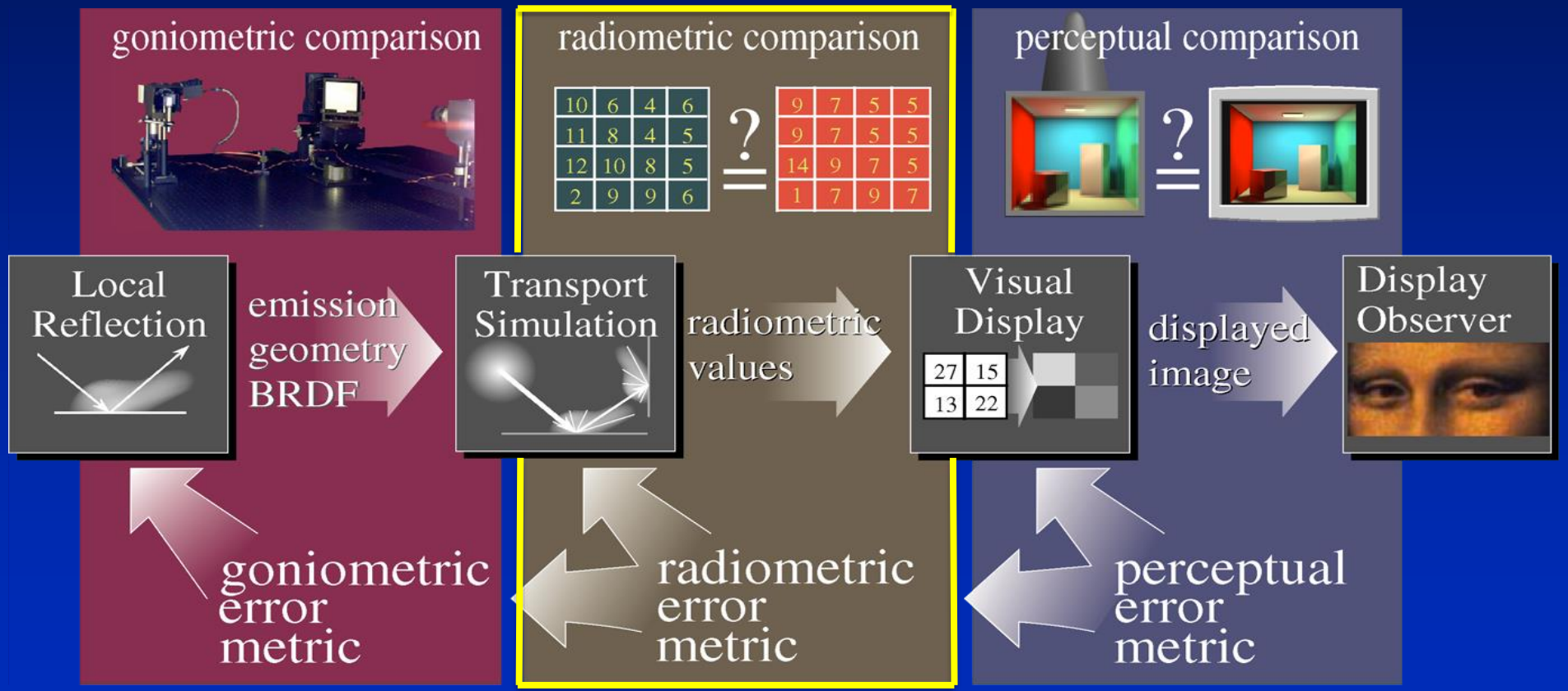
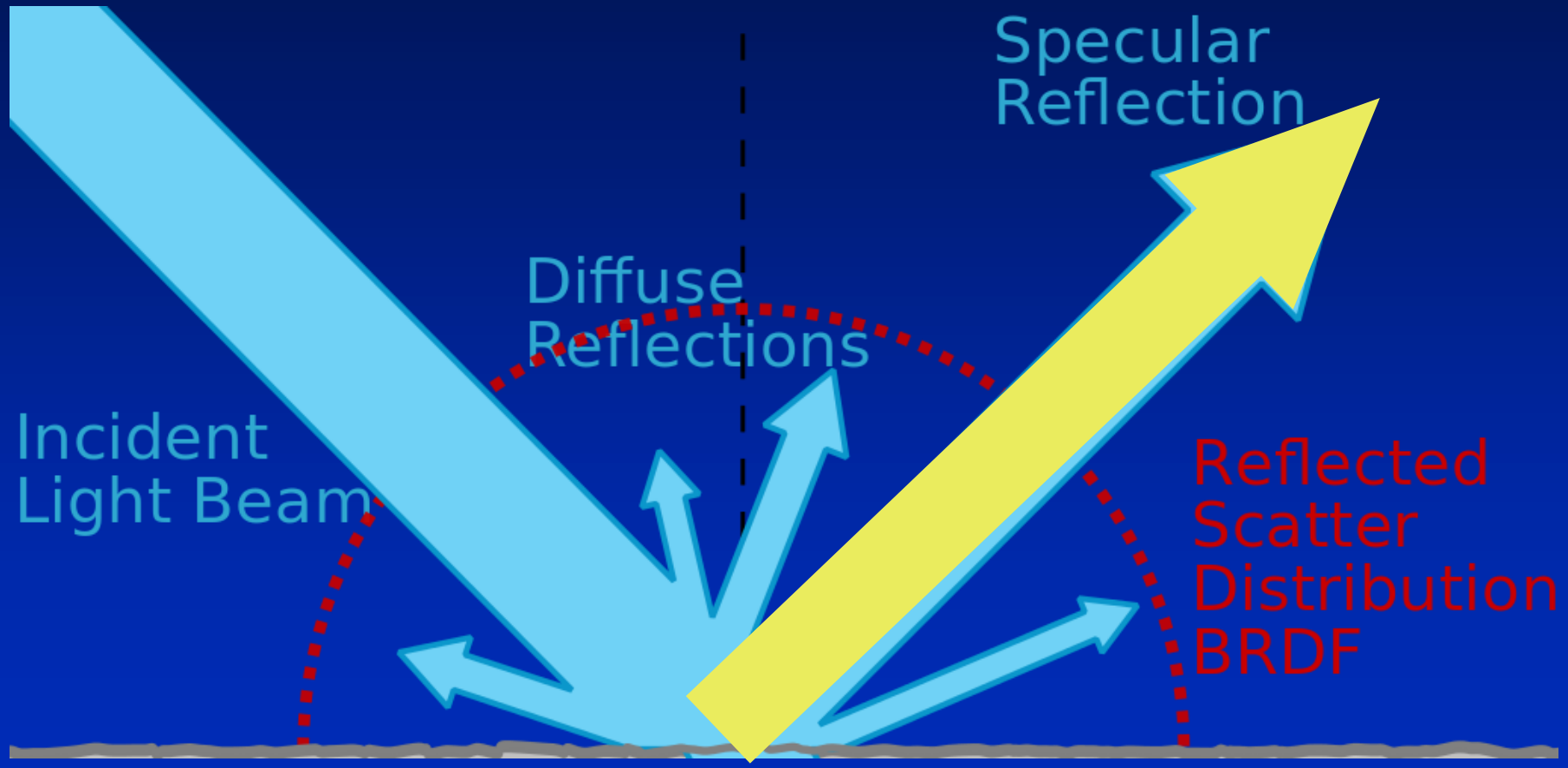
November 3, 2020

Lecture #17

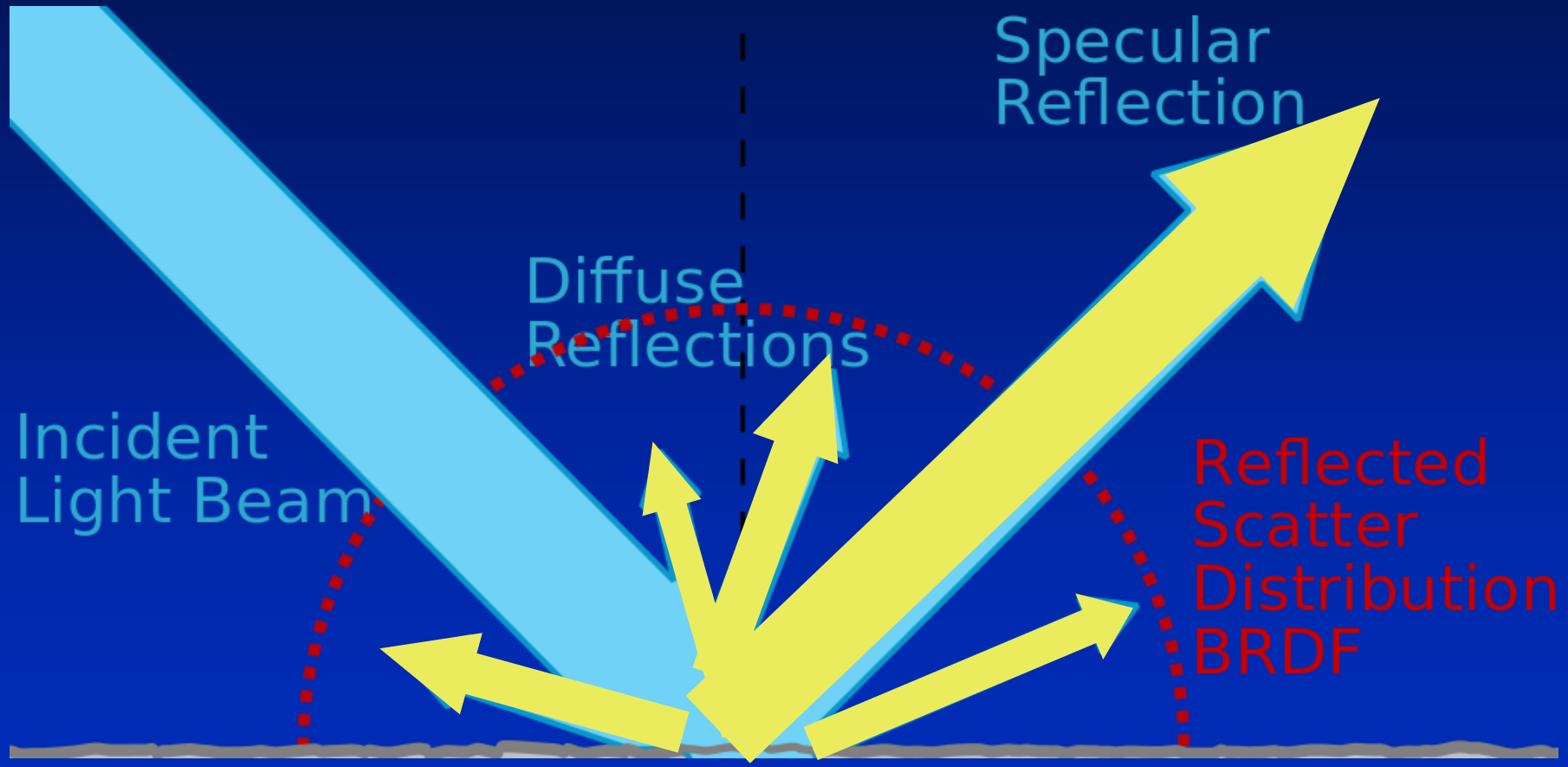
Rendering Framework 1997



Ray Tracing


Specular
Reflection
Diffuse
Reflections
Incident
Light Beam
Reflected
Scatter
Distribution
BRDF

Path Tracing

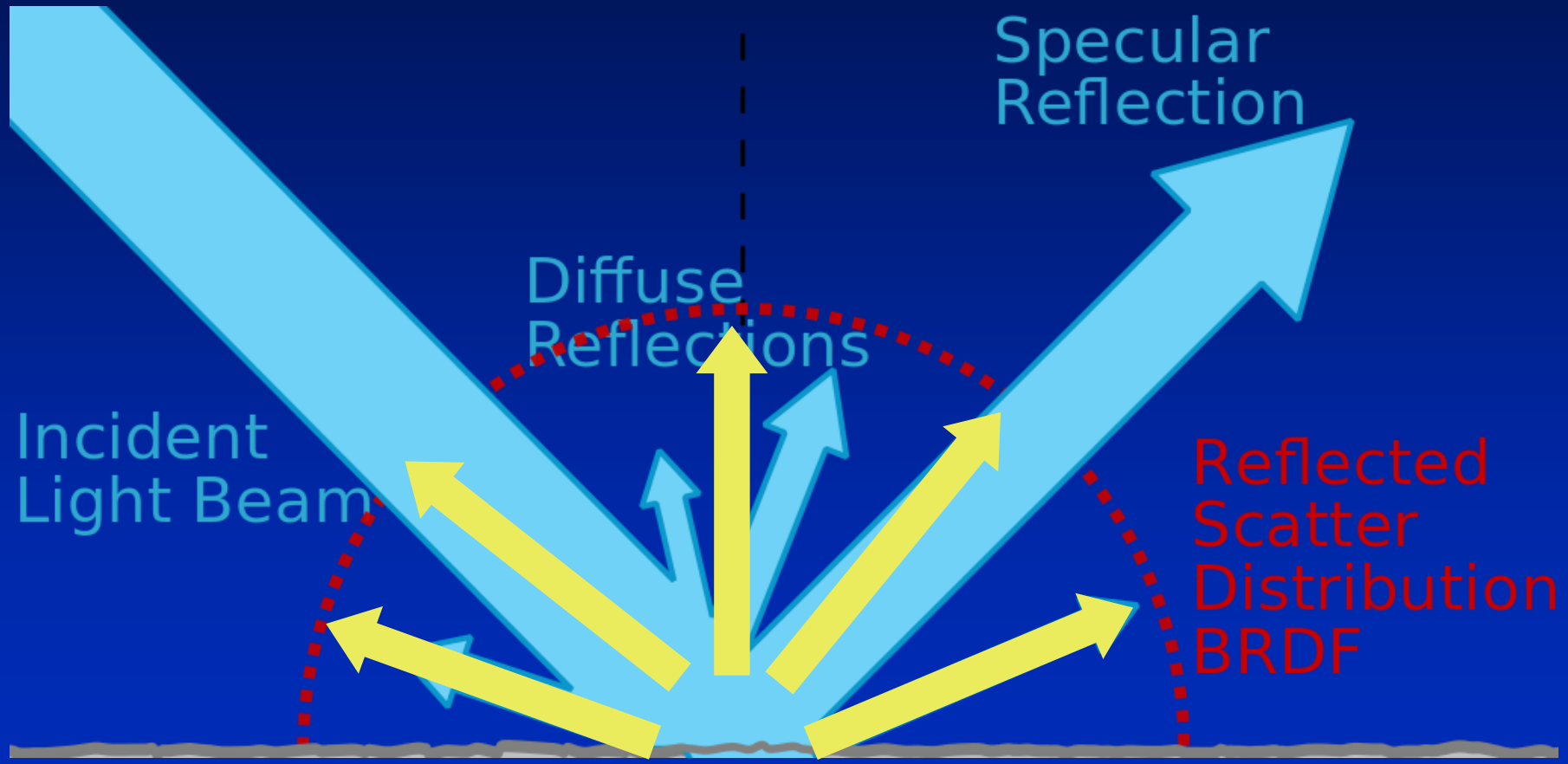


End of Review

Global Illumination Methods

- Ray Tracing
- Path Tracing
- Radiosity

Radiosity


Specular
Reflection
Diffuse
Reflections
Incident
Light Beam
Reflected
Scatter
Distribution
BRDF

Steel Mill

Wallace 1988

If each polygon is considered a light source, how can we compute and render the scene?

Steel Mill Statistics

Wallace 1988

VAX 11/780 ($250,000)

1 MIP Machine

- 30,000 Patches
- 50,000 Elements
- 190 Hours Processing Time

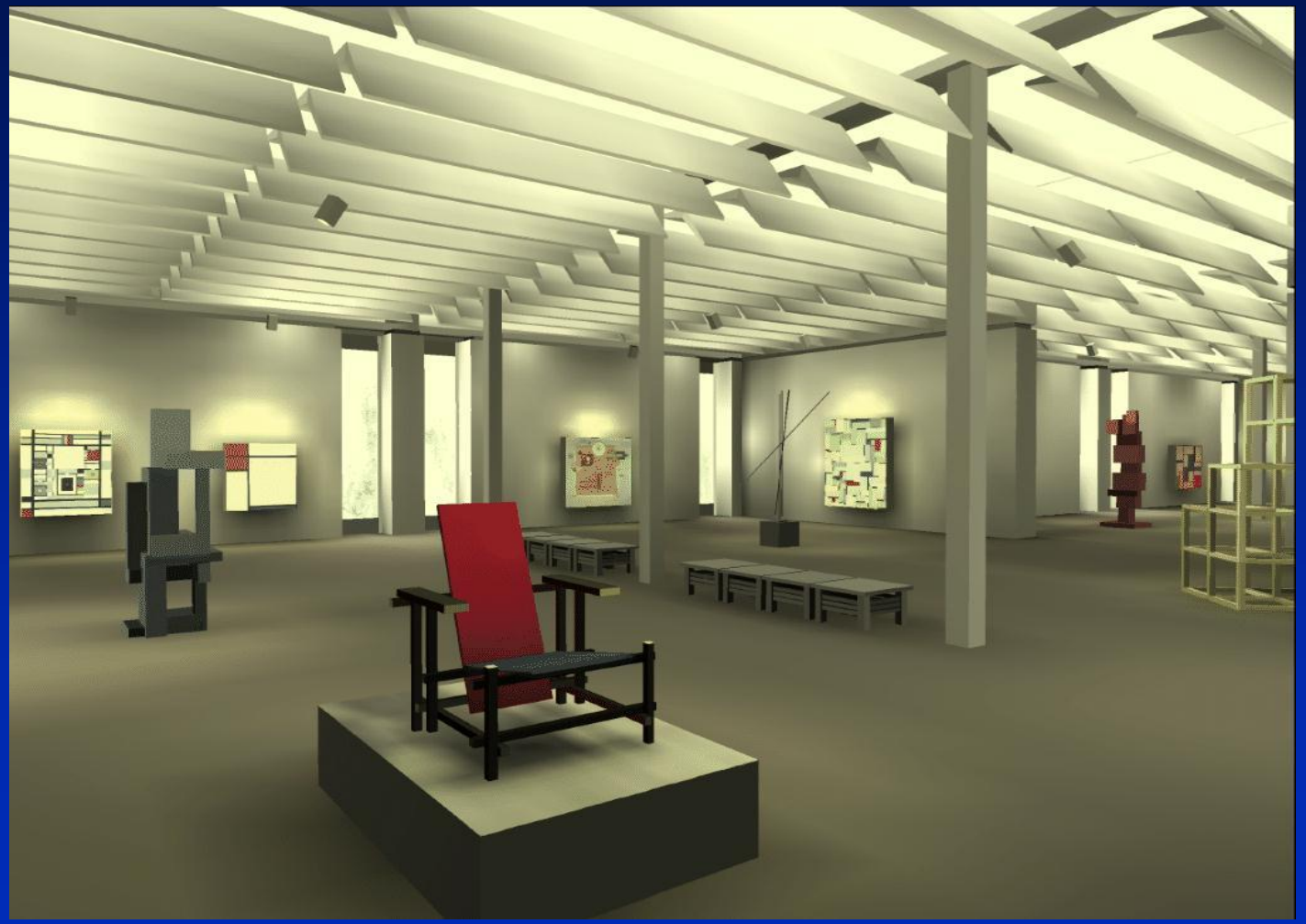
Diffuse Environment

Diffuse Student Environment

Radiosity Algorithms

- Polygons only
- Diffuse BRDFs only
- Diffuse light sources only
- Static scenes only

Museum Simulation



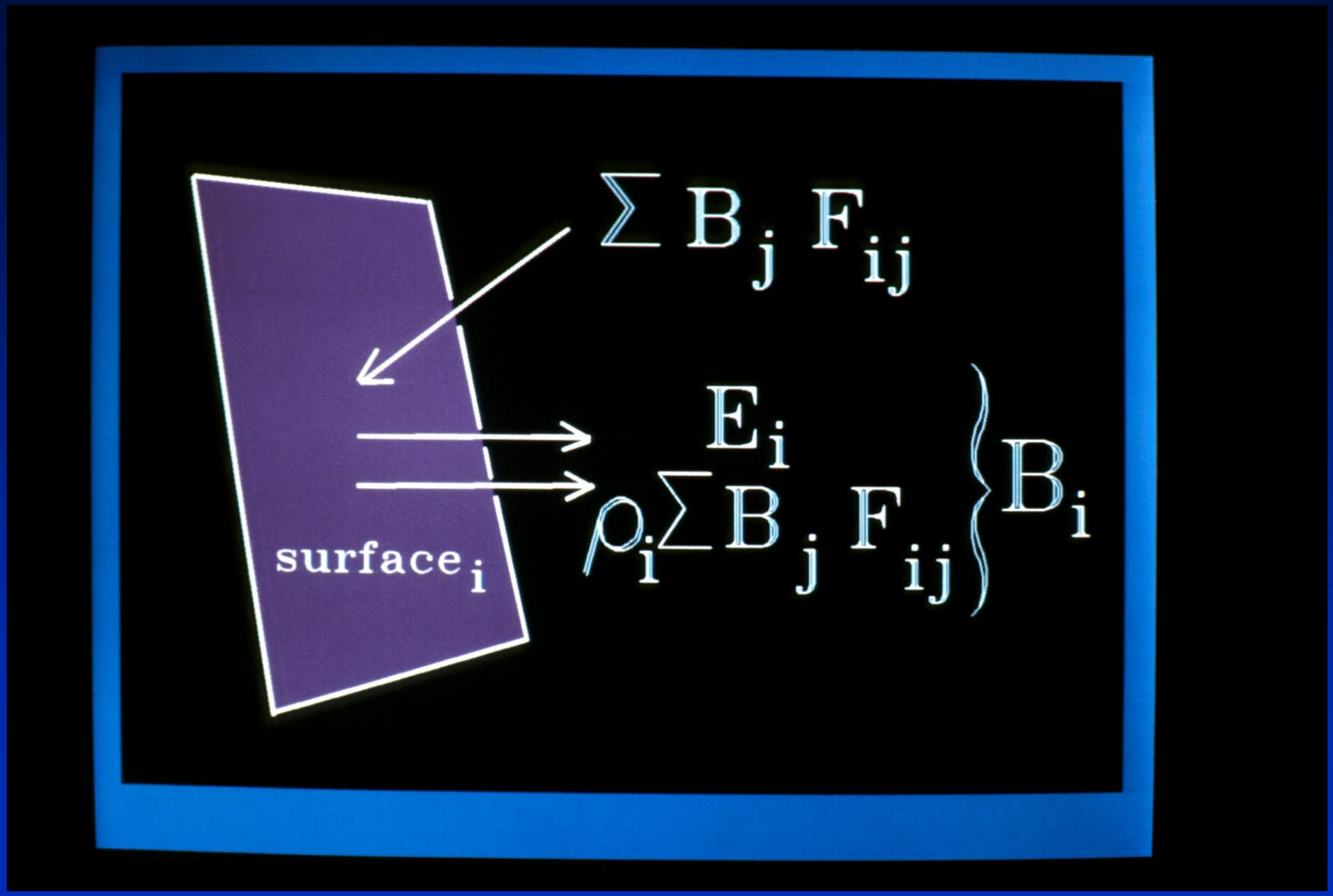
(Chen et al. 1988)

Radiosity Advantages

- Physically based approach for diffuse environments
- Can model diffuse interactions, color bleeding, indirect lighting and penumbra (area light sources)
- Accounts for very high percentage of total energy transfer

RADIOSITY =

EMITTED +
RELFECTED LIGHT


$\sum B_j F_{ij}$
E_i
$\rho_i \sum B_j F_{ij}$
B_i
surface$_i$

The Radiosity Method

$$B_i = E_i + \rho_i \sum_{j=1}^{n} B_j F_{ij}$$

$B_i = \text{radiosity of patch i}$

$E_i = \text{emission of patch i}$

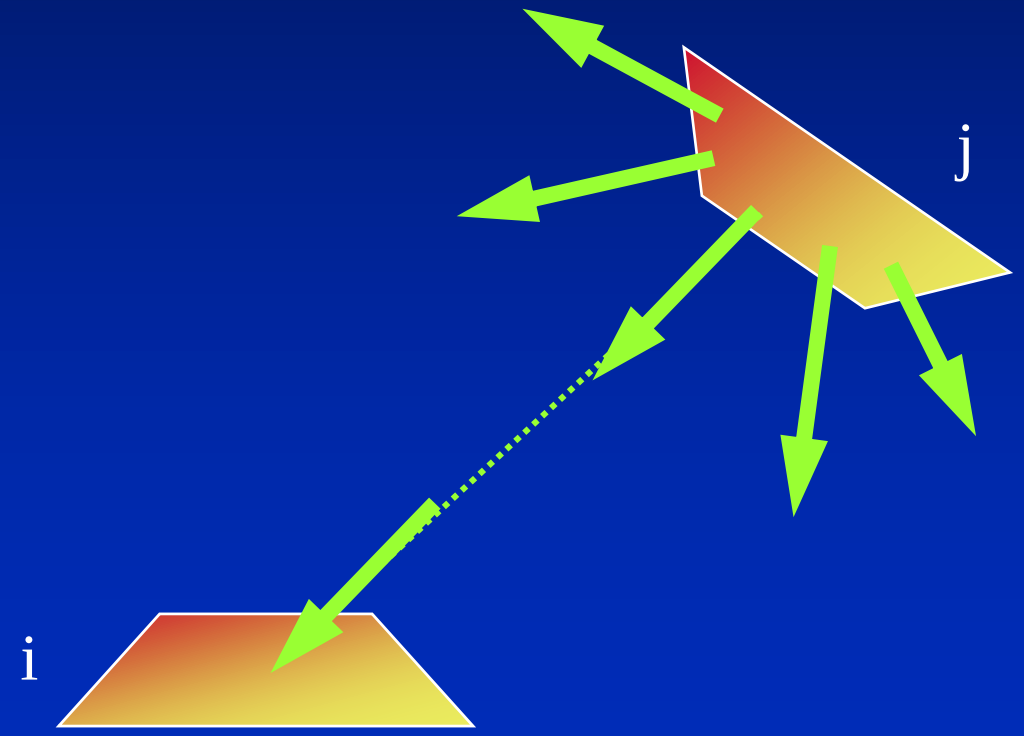
$\rho_i = \text{reflectivity of patch i}$

$F_{ij} = \text{form-factor from i to j}$

* assuming diffuse environments

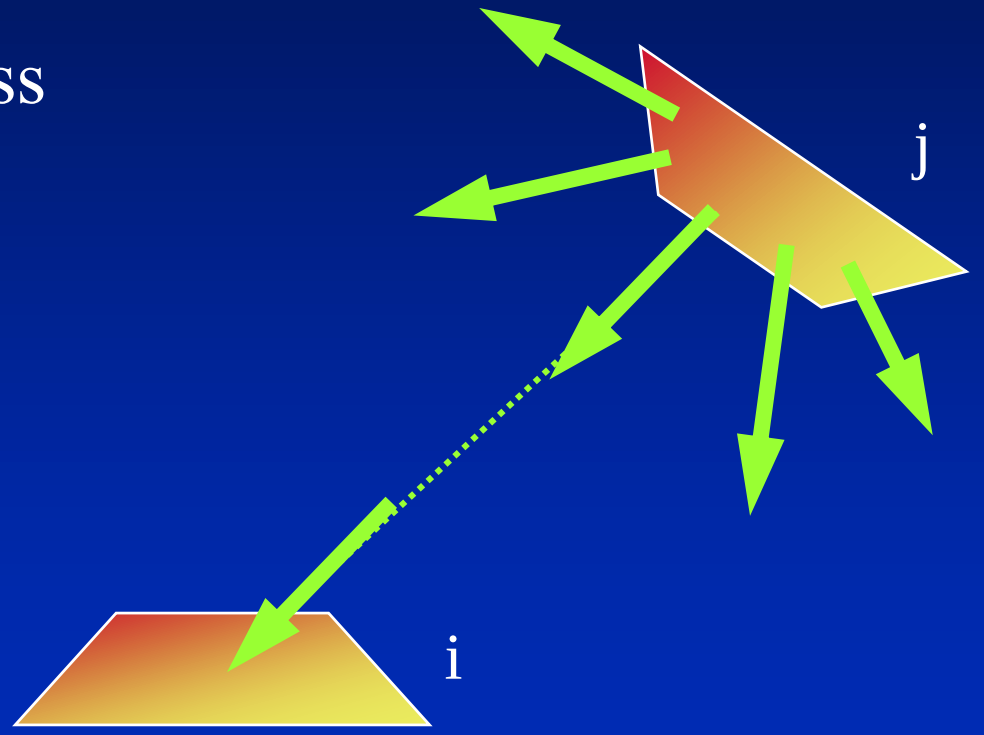
Form Factor

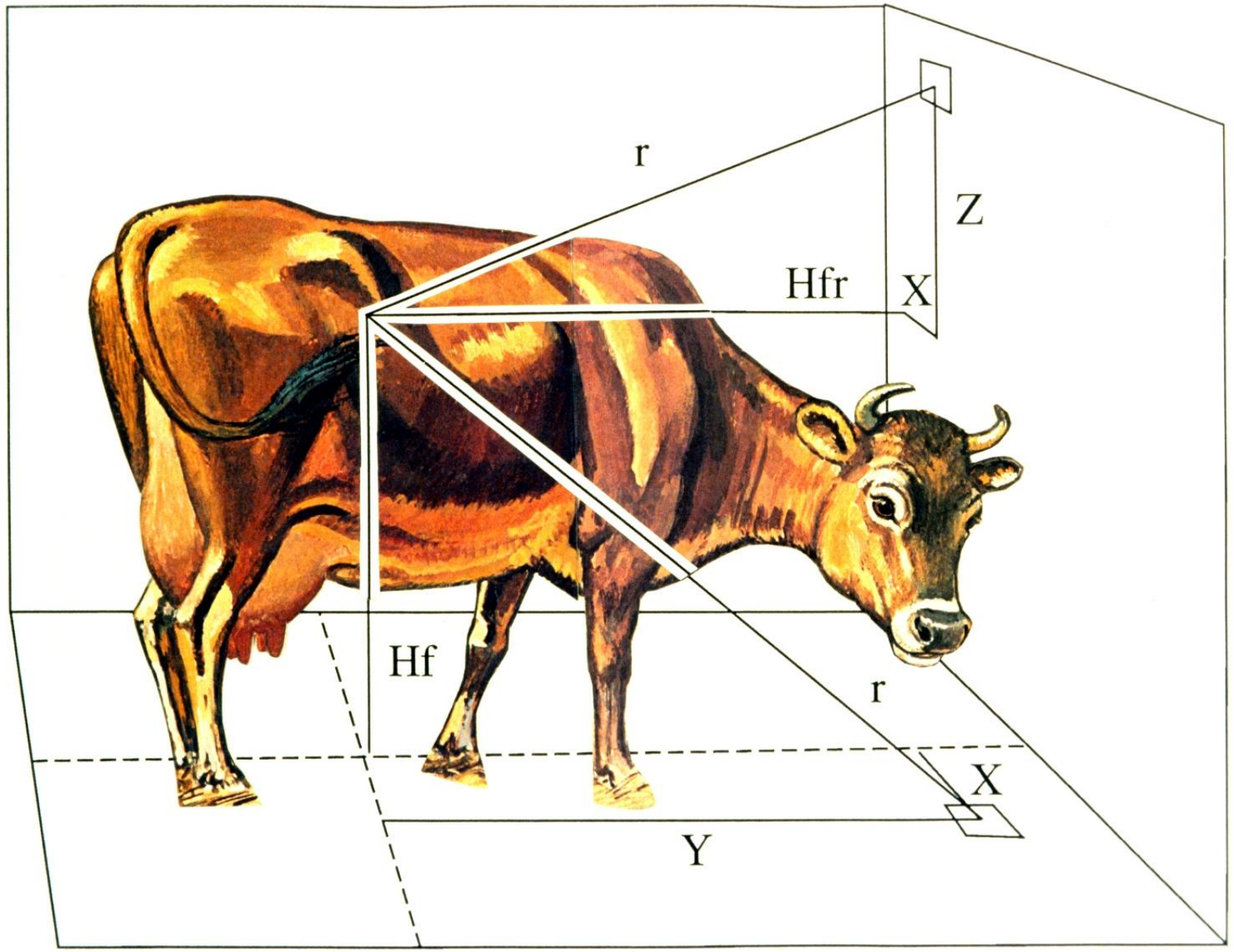
- $F_{i \leftarrow j}$ = the fraction of power emitted by j, which is received by i



Form Factor

- Area
  - if i is smaller, it receives less power
- Orientation
  - if i faces j, it receives more power
- Distance
  - if i is further away, it receives less power




r
Z
Hfr
X
Hf
r
X
Y

The Radiosity Method

$$B_i = E_i + \rho_i \sum_{j=1}^{n} B_j F_{ij}$$

B_i = radiosity of patch i

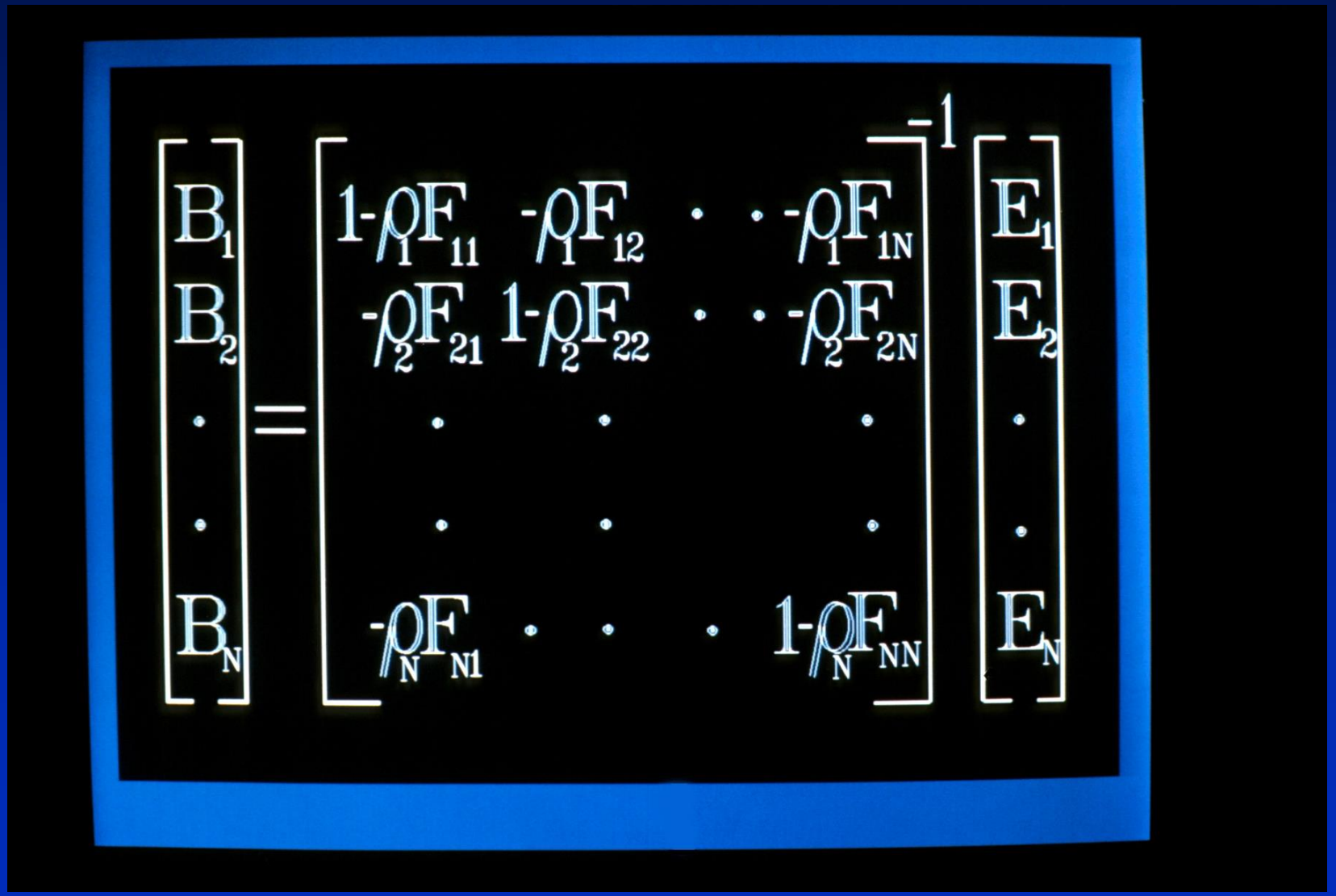
E_i = emission of patch i

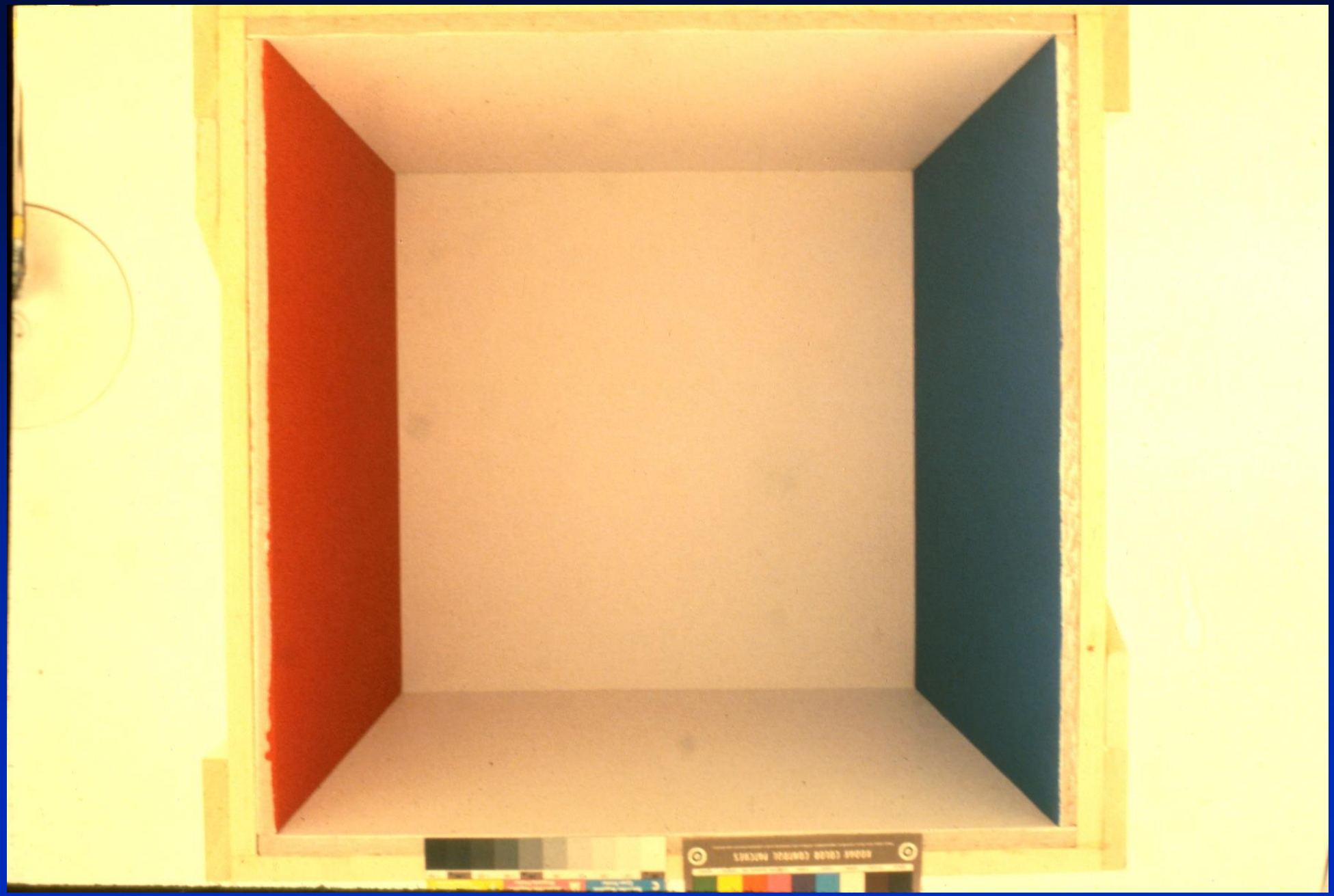
ρ_i = reflectivity of patch i

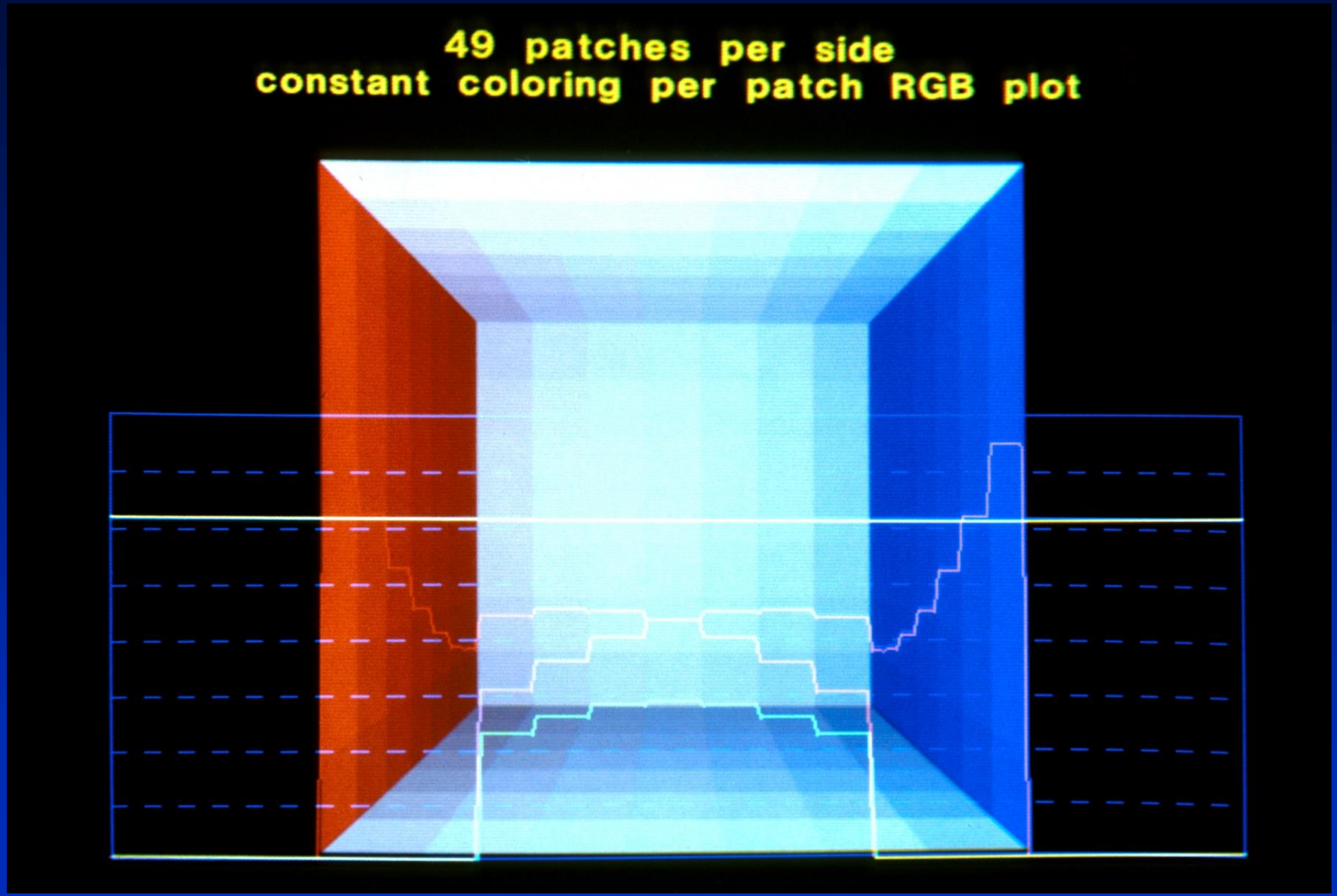
F_{ij} = form-factor from i to j

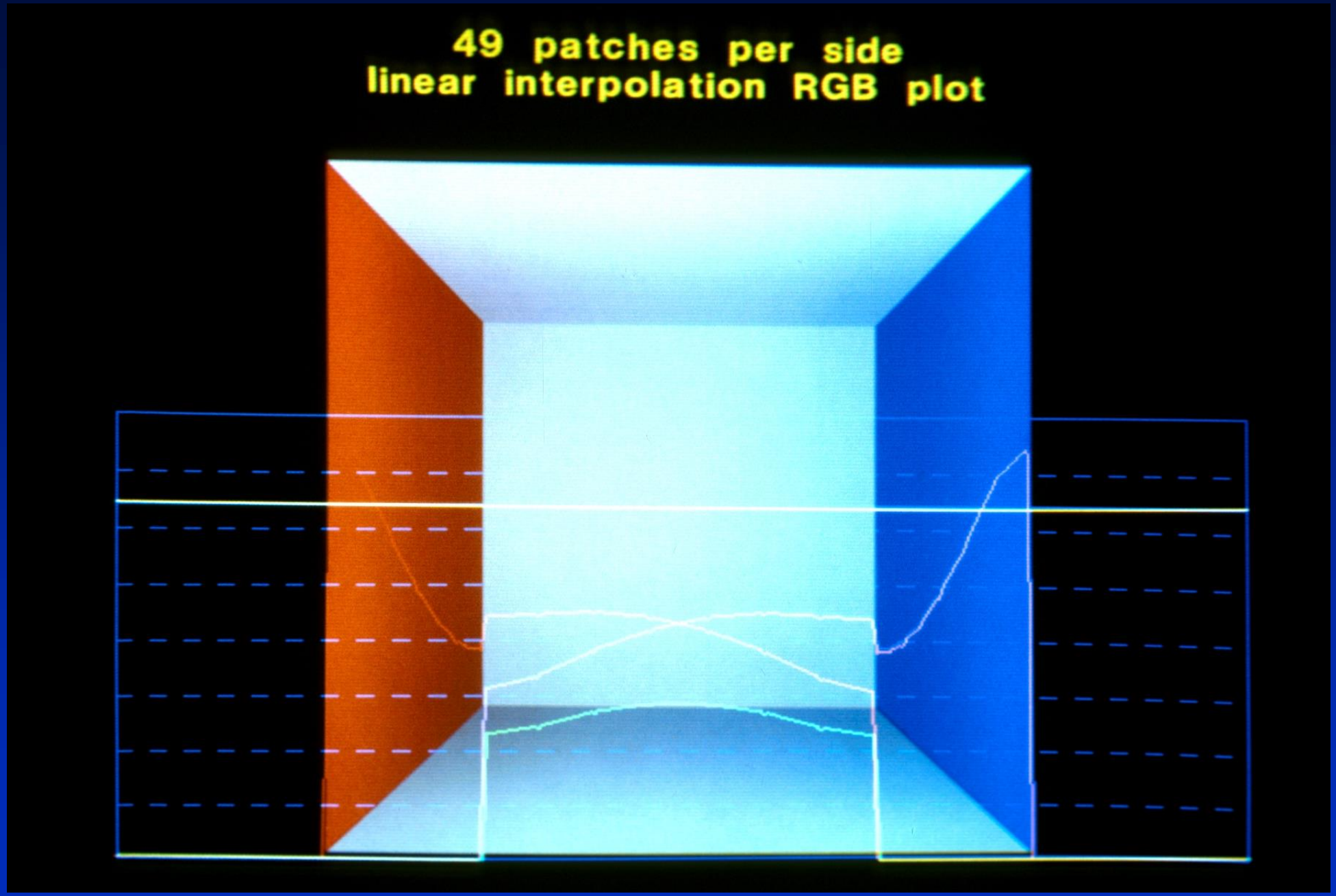
* assuming diffuse environments

Simultaneous Radiosity Equations

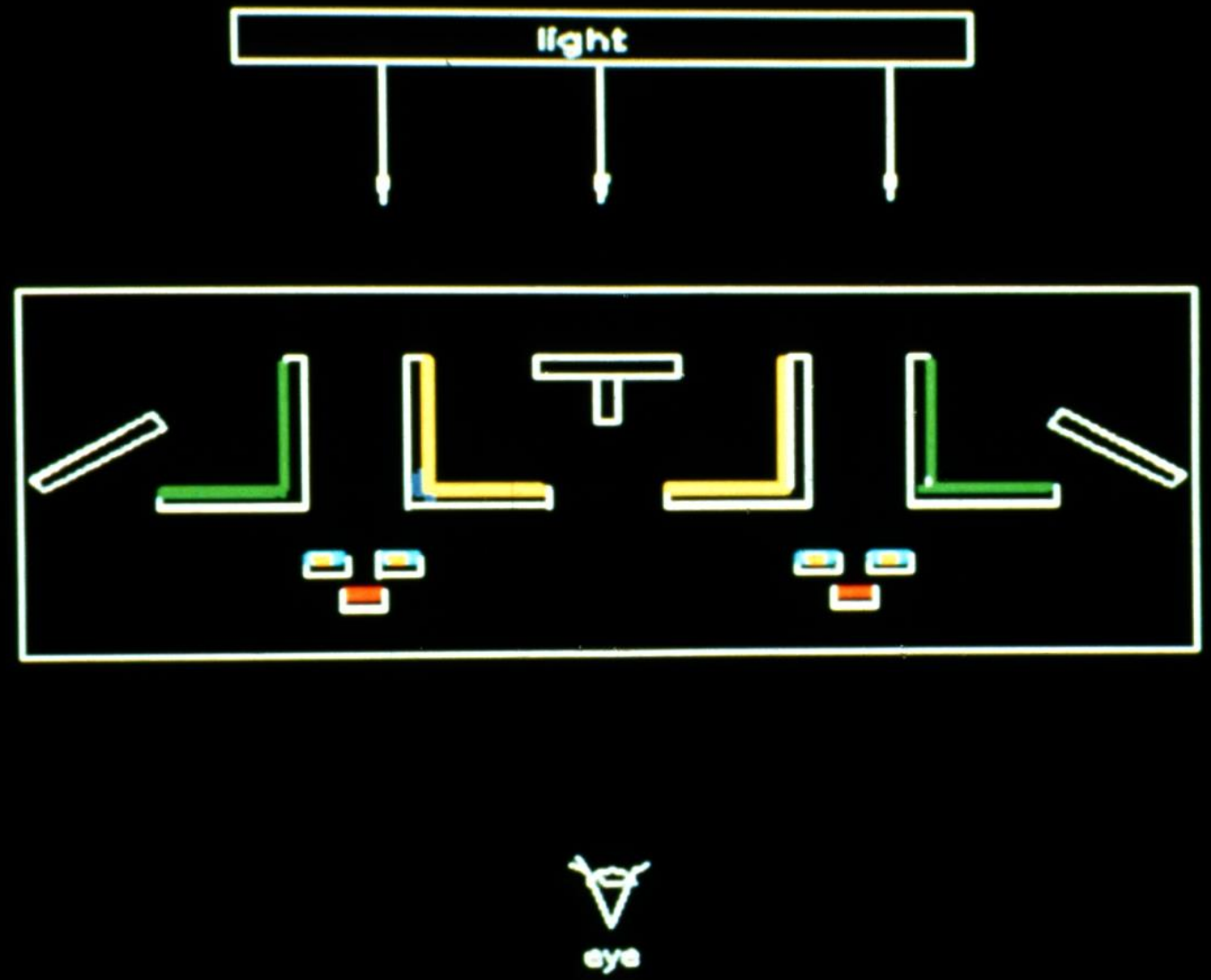




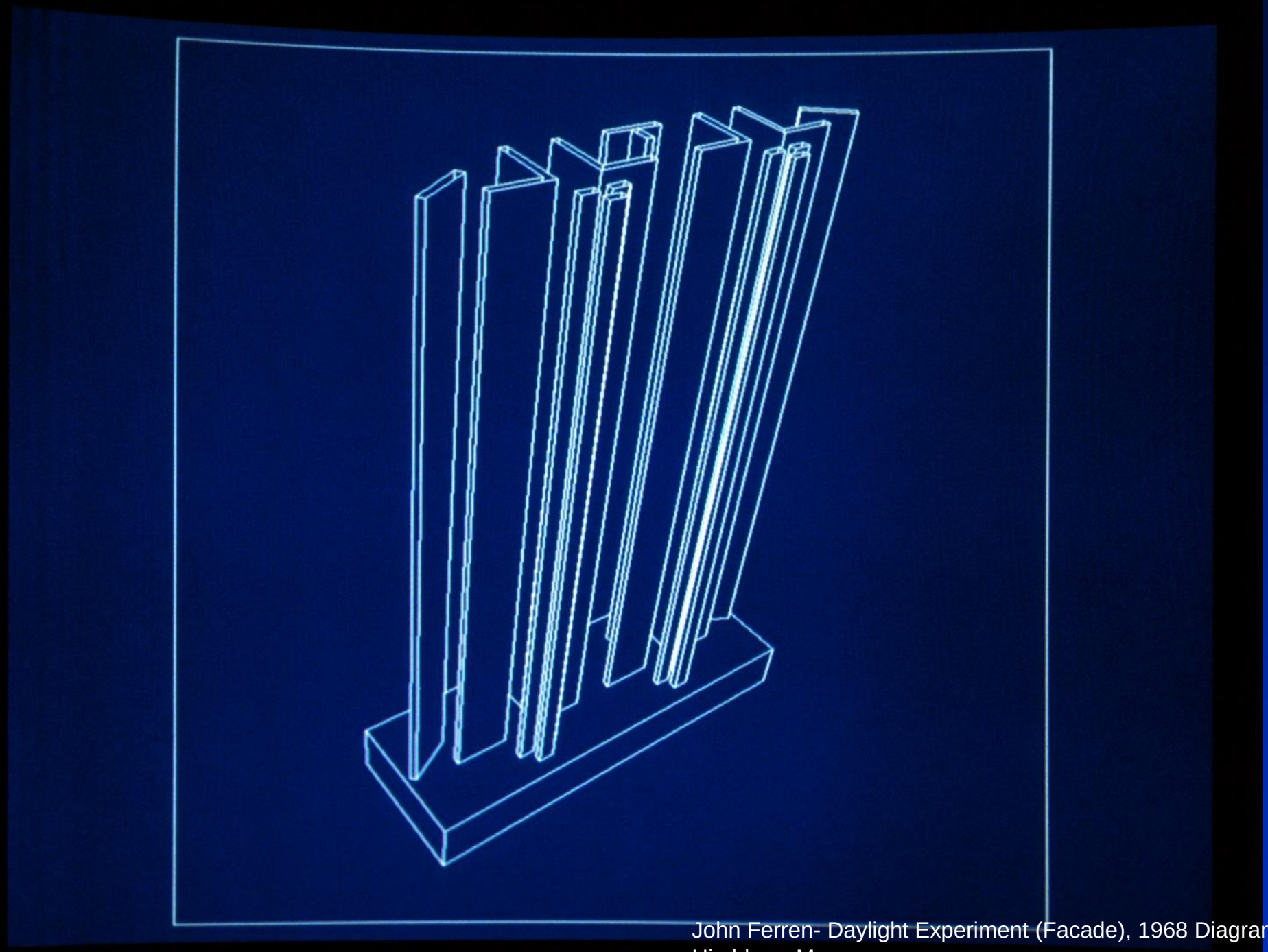

49 patches per side
constant coloring per patch RGB plot


49 patches per side
linear interpolation RGB plot

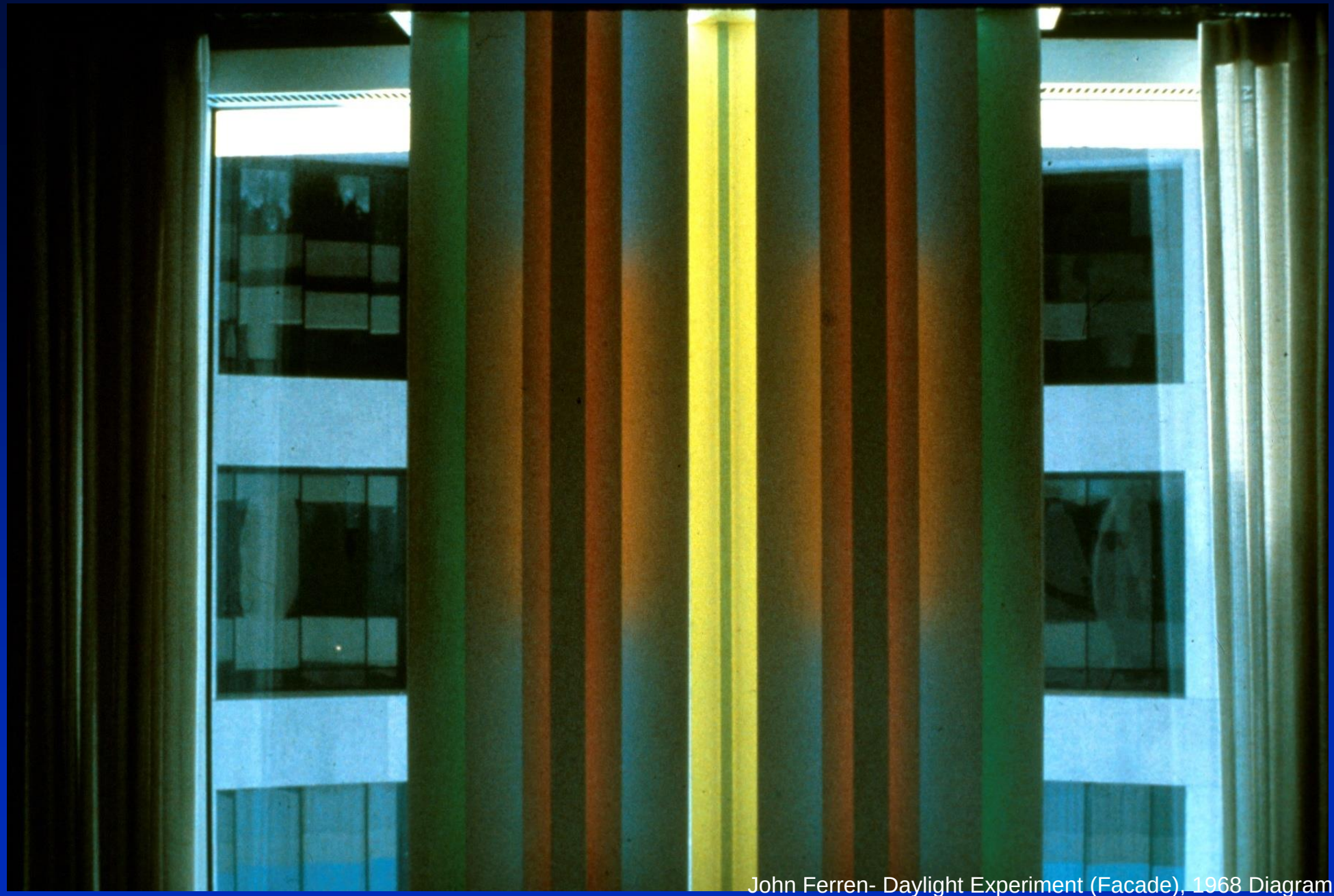
Cornell Box with Cameras



John Ferren- Daylight Experiment (Facade), 1968 Diagram
Hirshhorn Museum

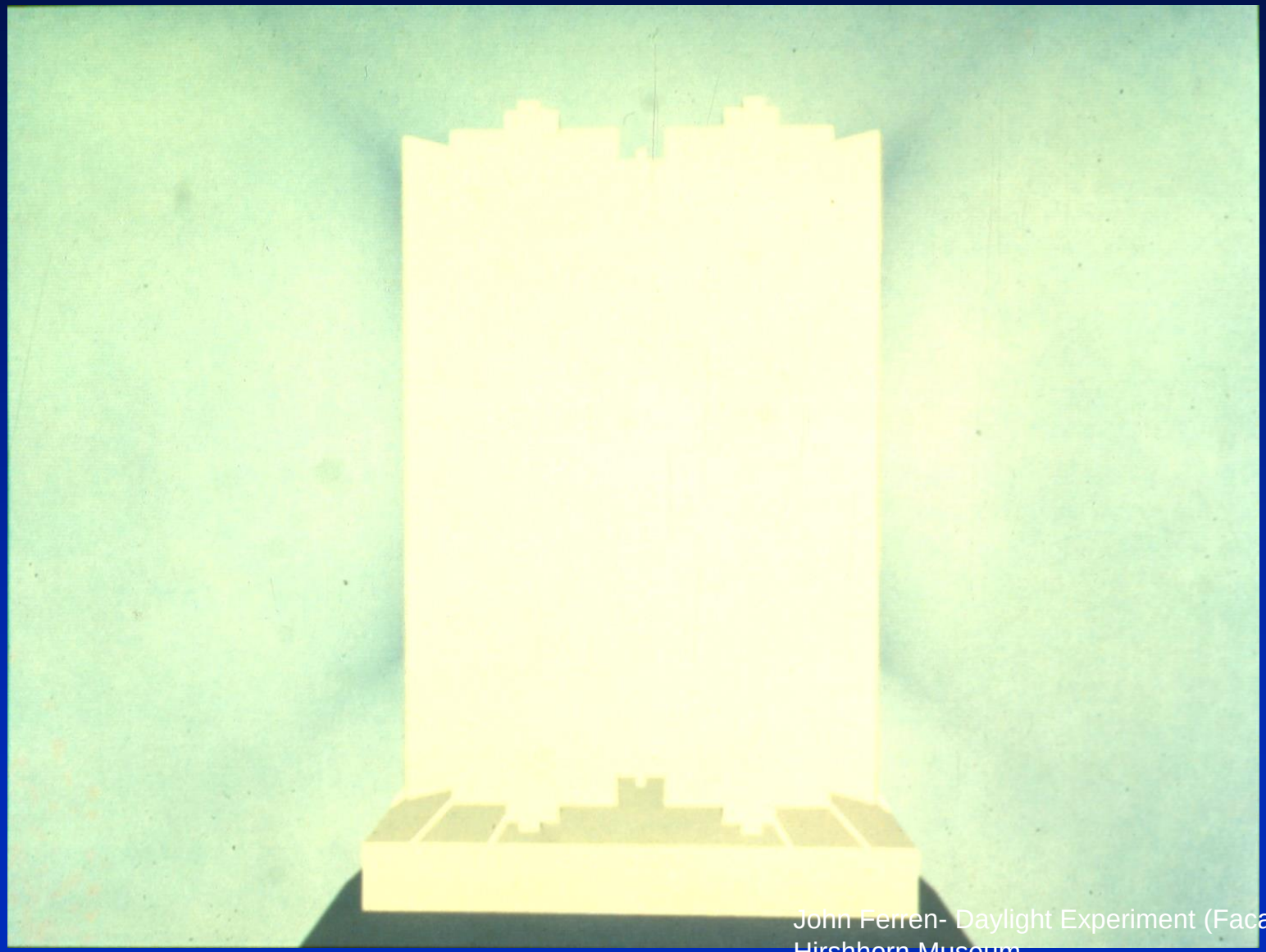


John Ferren- Daylight Experiment (Facade), 1968 Diagram
Hirshhorn Museum



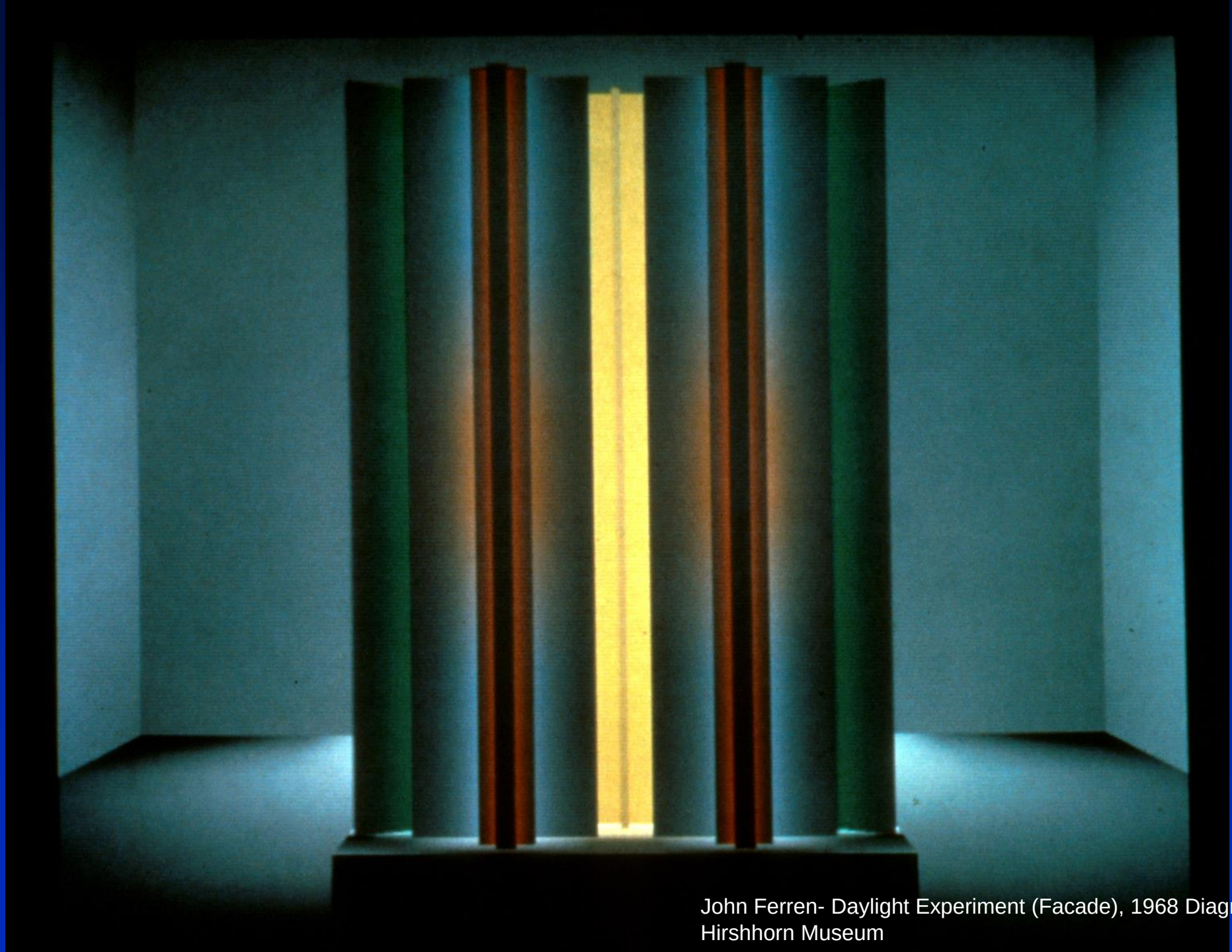
John Ferren- Daylight Experiment (Facade), 1968 Diagram
Hirshhorn Museum

Ray Traced Model



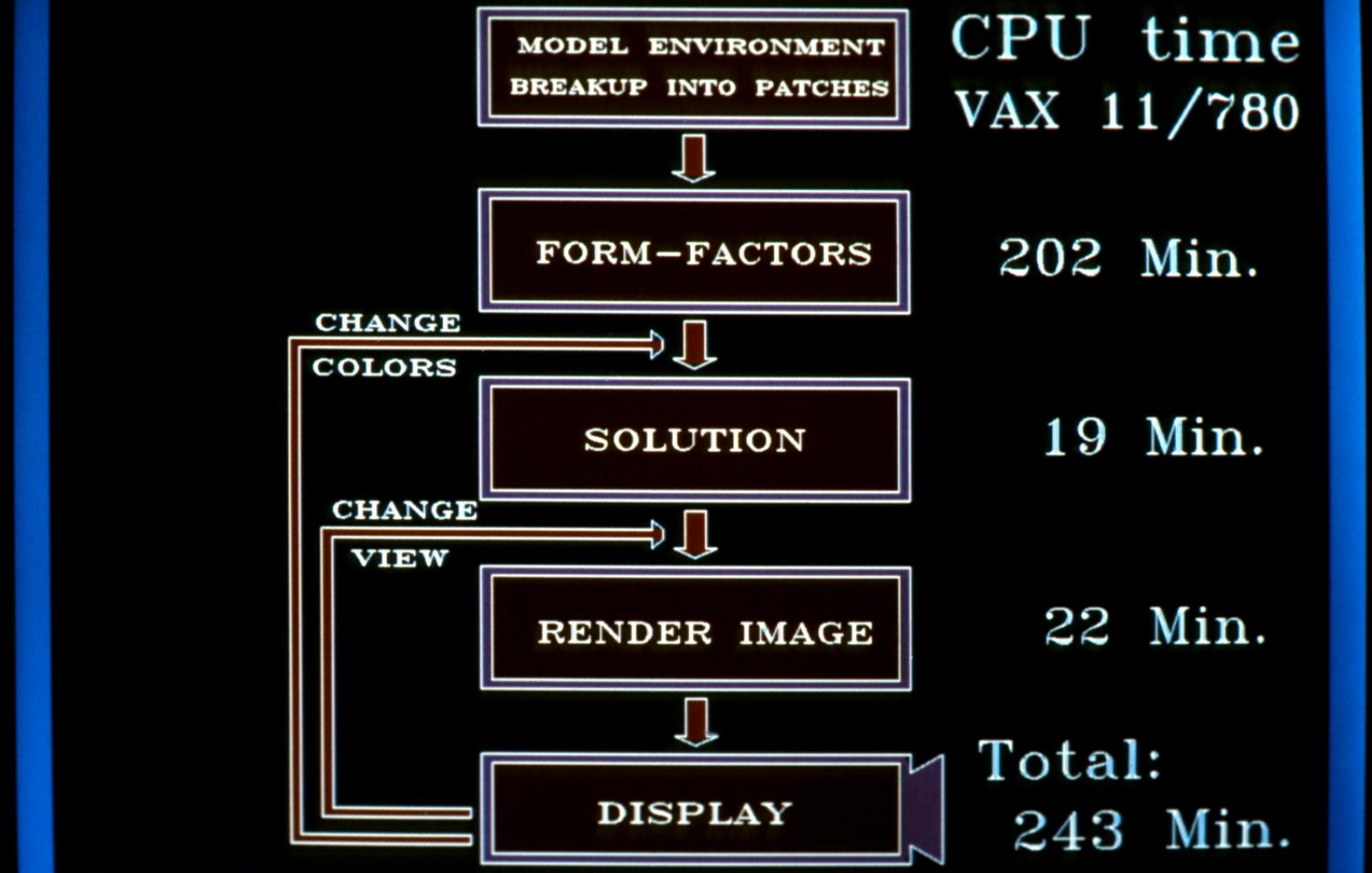
John Ferren- Daylight Experiment (Facade), 1968 Diagram
Hirshhorn Museum

Experiment and Photograph



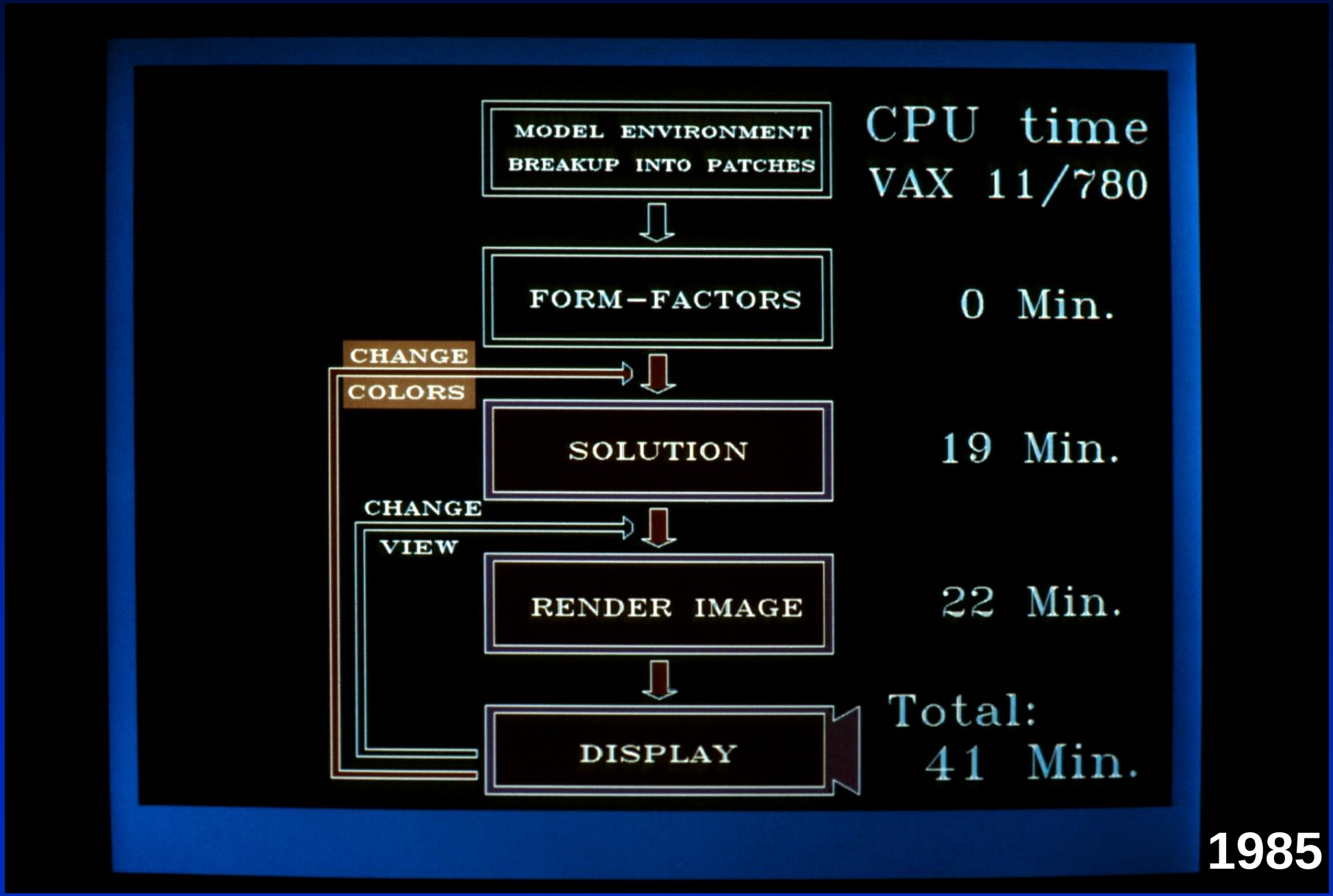
John Ferren- Daylight Experiment (Facade), 1968 Diagram
Hirshhorn Museum

Michael Cohen


MODEL ENVIRONMENT
BREAKUP INTO PATCHES
CPU time
VAX 11/780
FORM-FACTORS
202 Min.
CHANGE
COLORS
SOLUTION
19 Min.
CHANGE
VIEW
RENDER IMAGE
22 Min.
DISPLAY
Total:
243 Min.

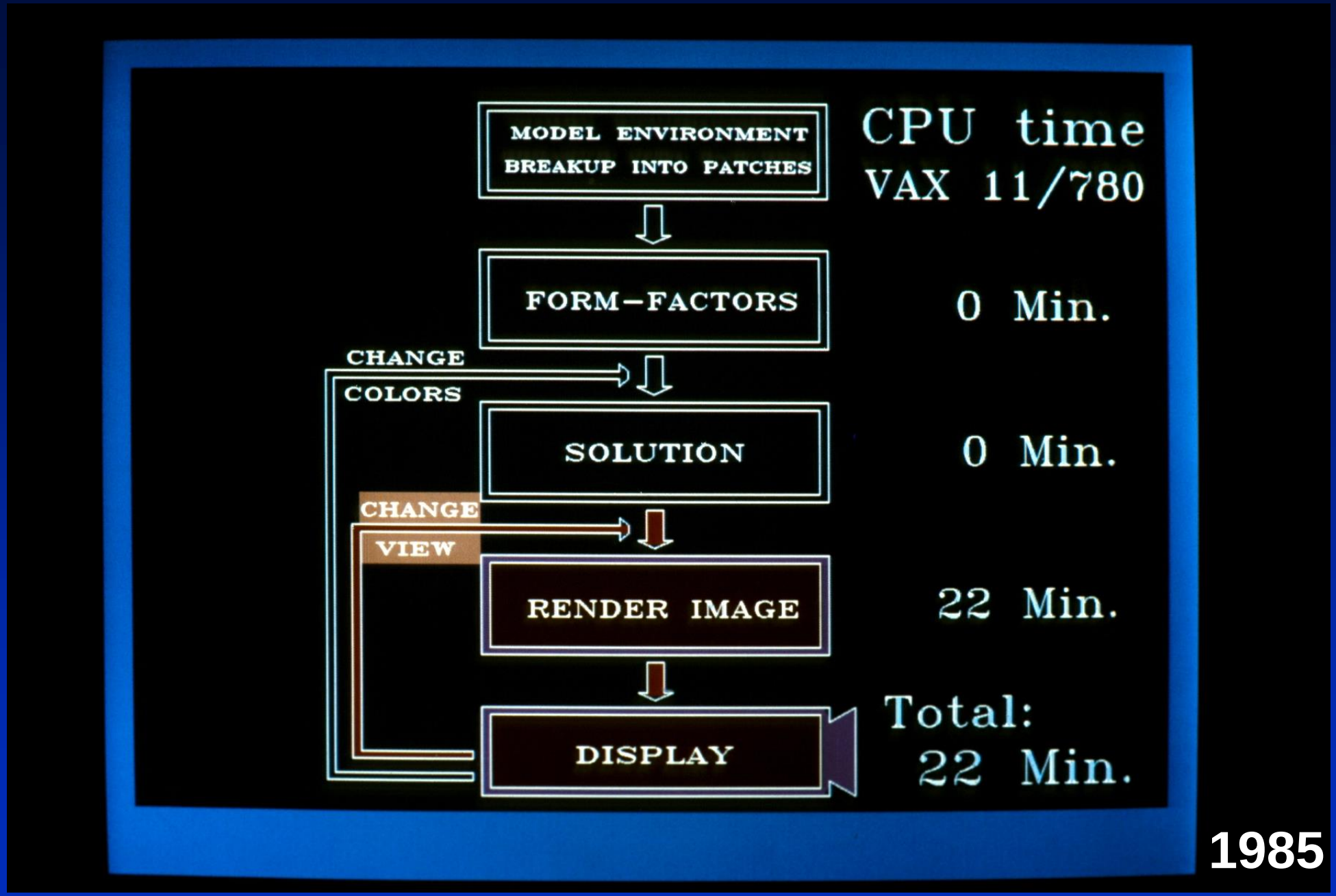
1985

Michael Cohen

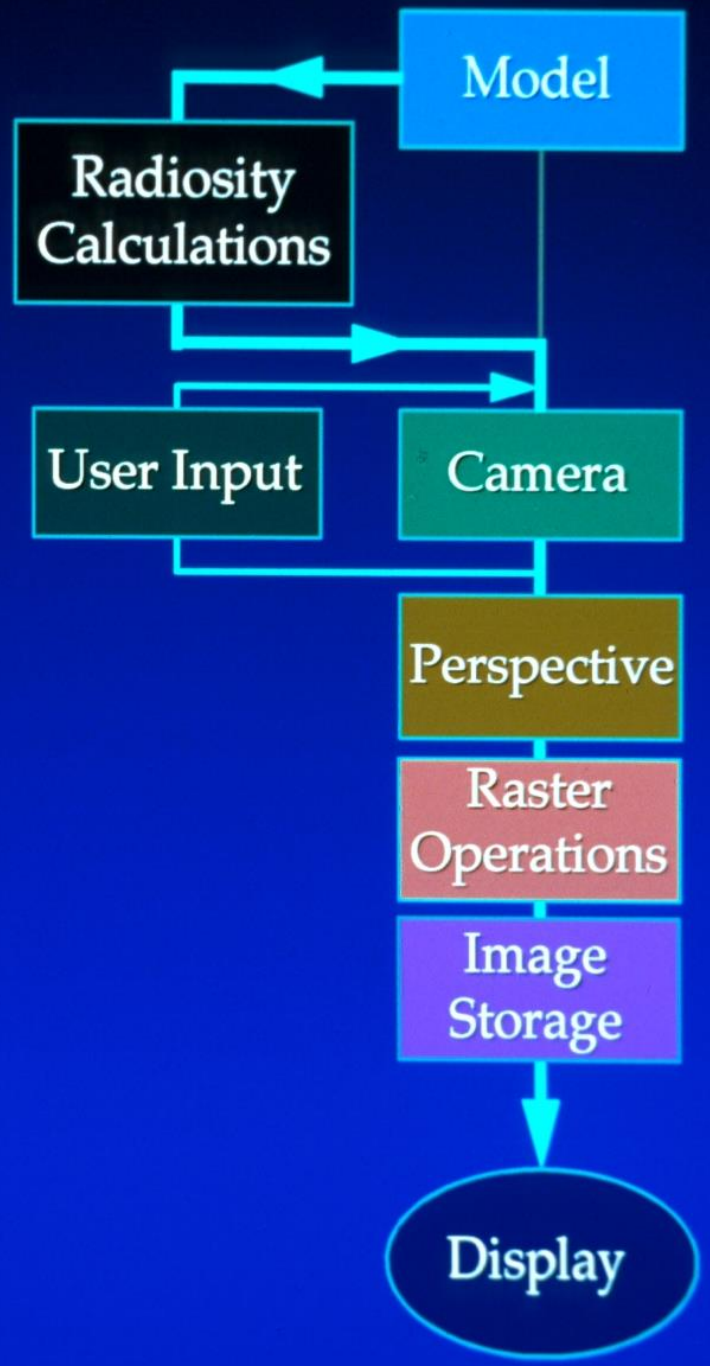

MODEL ENVIRONMENT
BREAKUP INTO PATCHES
CPU time
VAX 11/780
FORM-FACTORS
0 Min.
CHANGE
COLORS
SOLUTION
19 Min.
CHANGE
VIEW
RENDER IMAGE
22 Min.
DISPLAY
Total:
41 Min.

1985

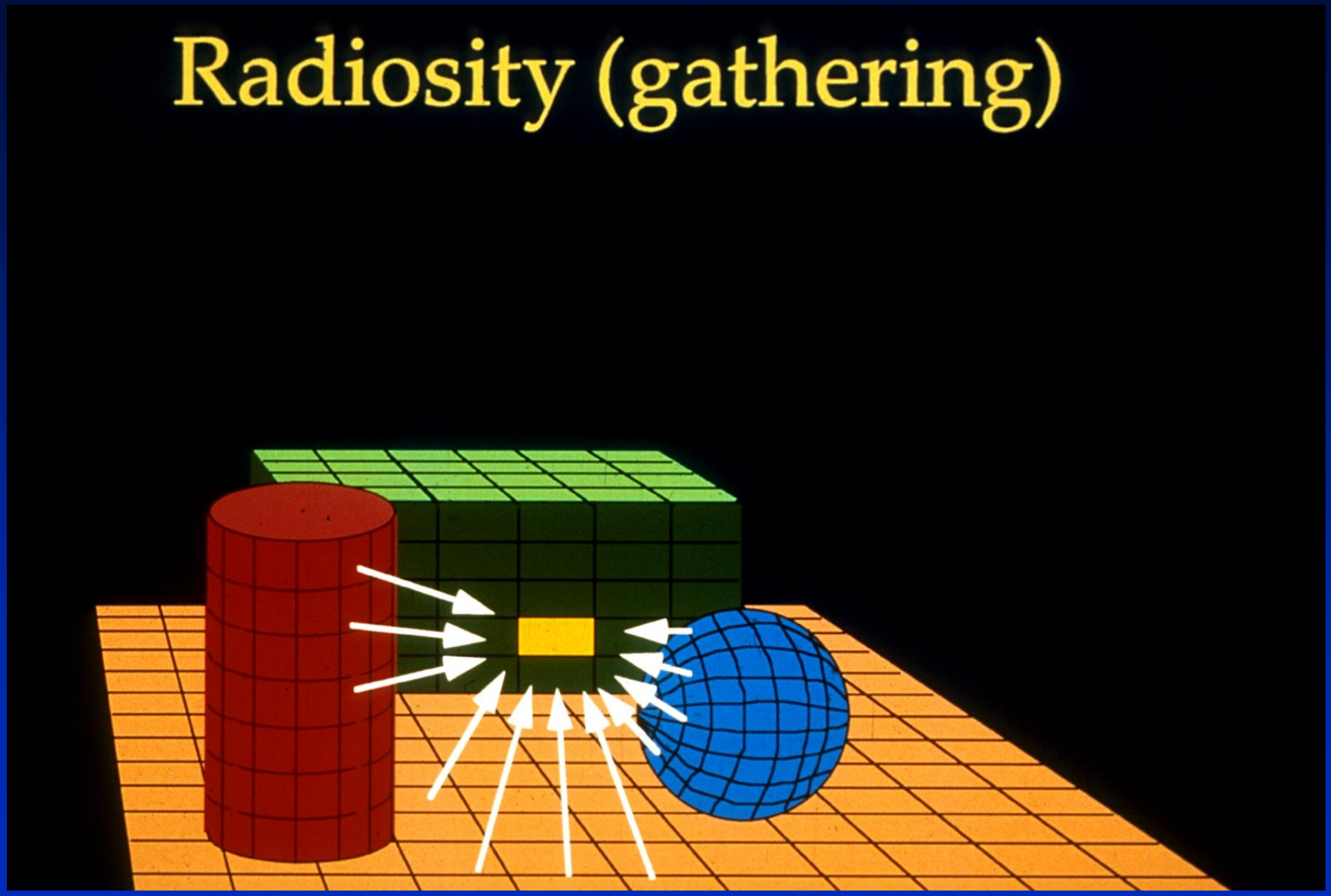
Michael Cohen


MODEL ENVIRONMENT
BREAKUP INTO PATCHES
CPU time
VAX 11/780
FORM-FACTORS
0 Min.
CHANGE
COLORS
SOLUTION
0 Min.
CHANGE
VIEW
RENDER IMAGE
22 Min.
DISPLAY
Total:
22 Min.
1985

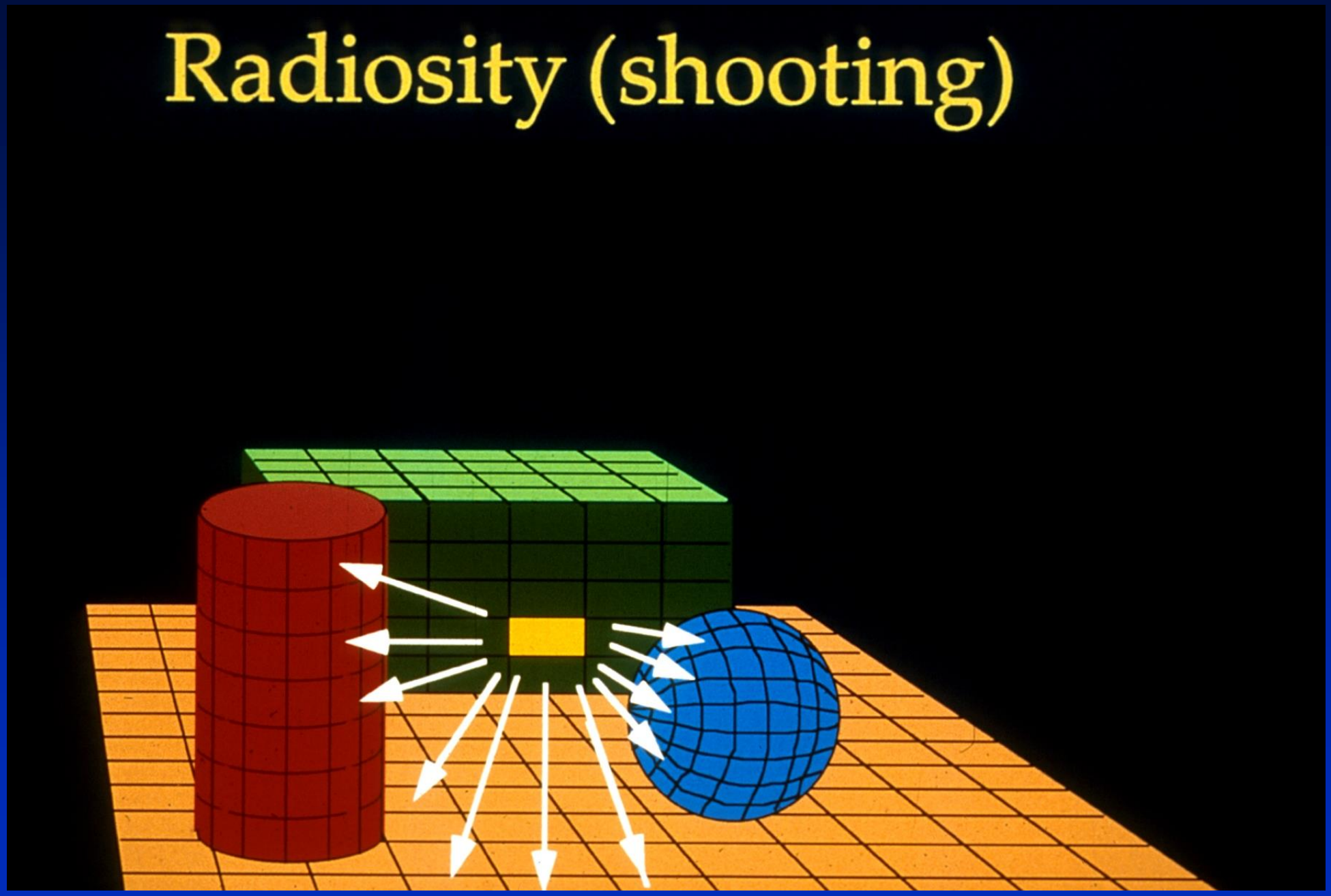
Radiosity

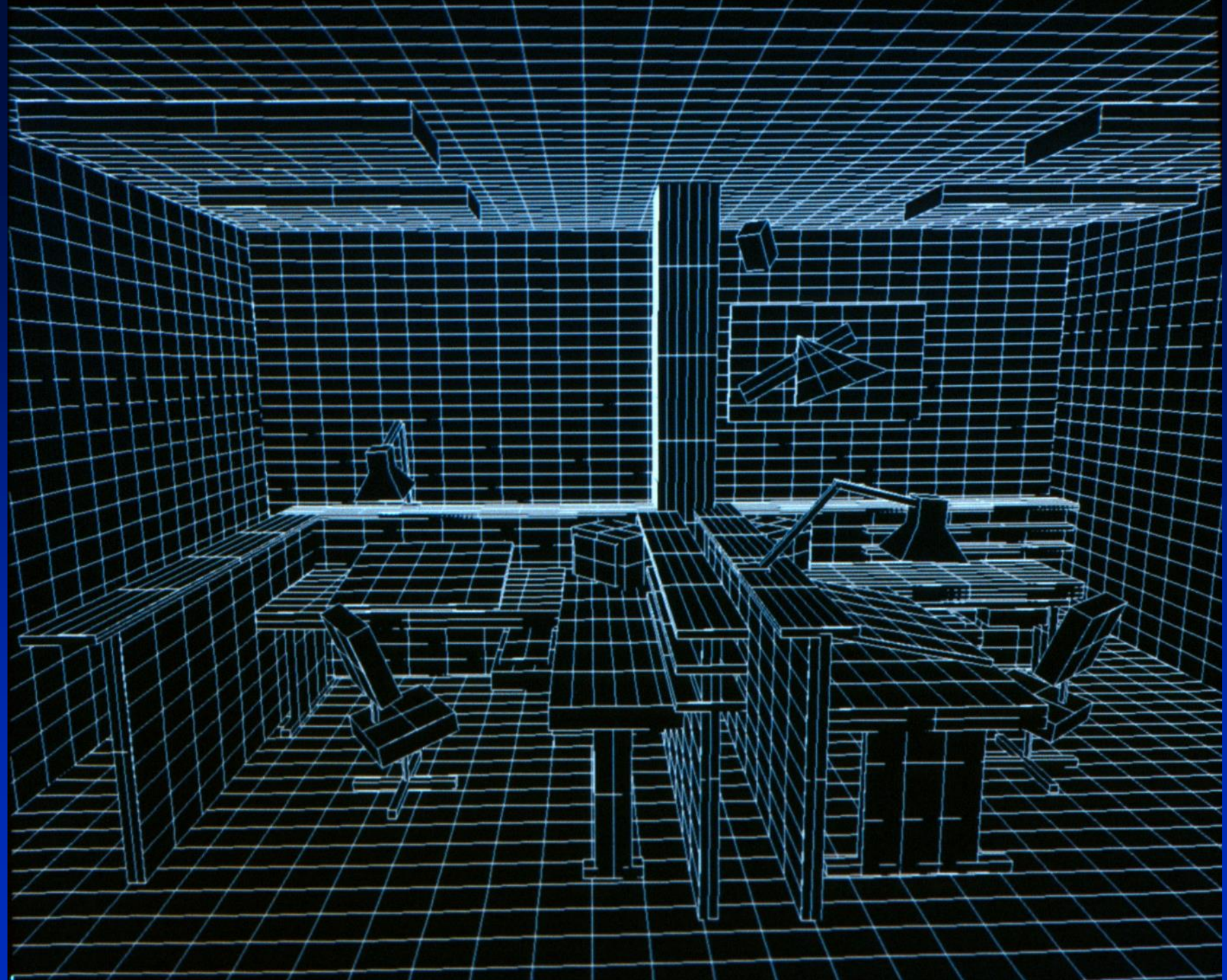

Model
Radiosity Calculations
User Input
Camera
Perspective
Raster Operations
Image Storage
Display

Radiosity (gathering)



Radiosity (shooting)






Ambient Only

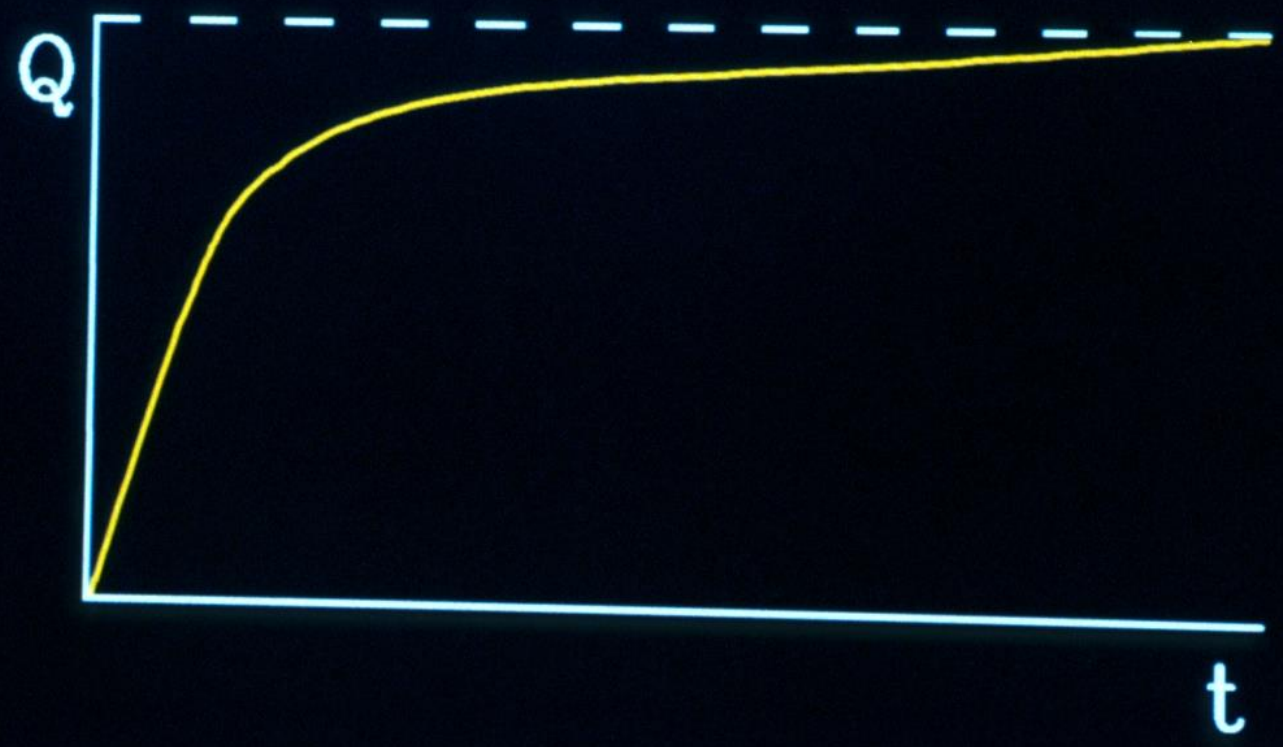

One Light Source


Two Light Sources


24 iterations

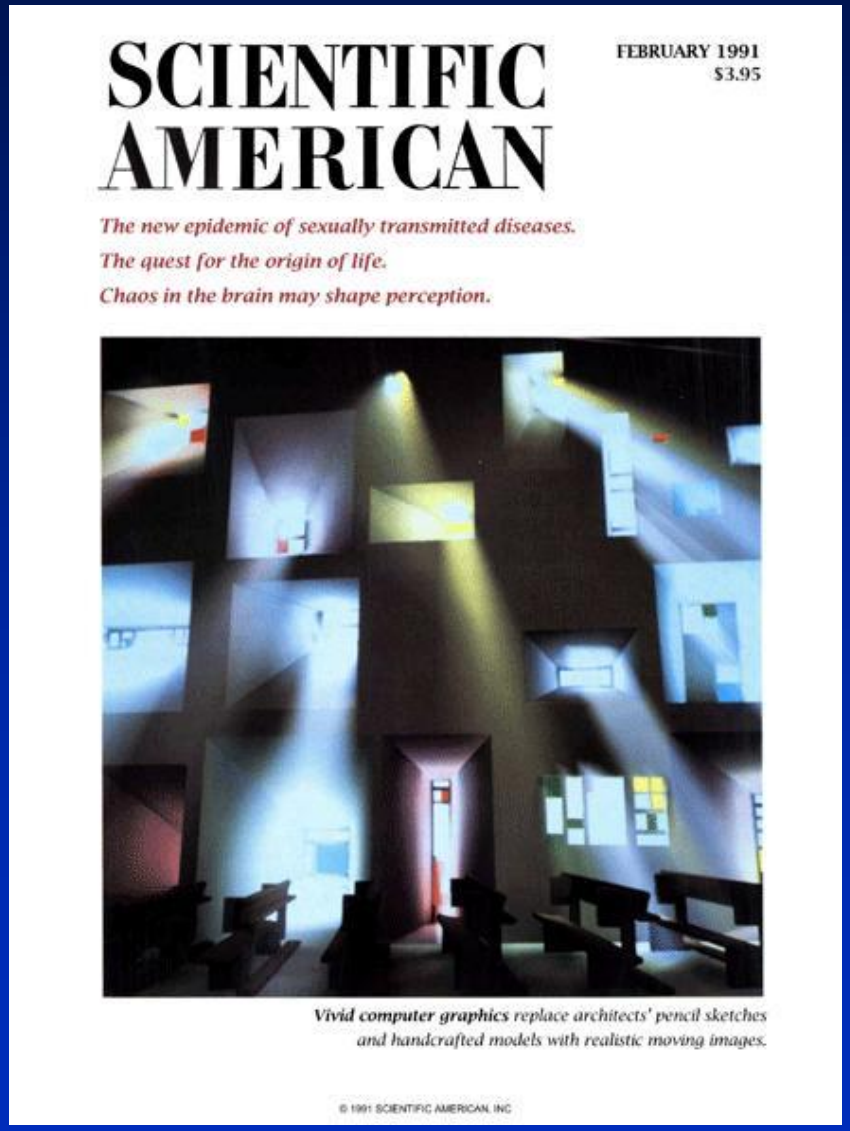

Full Solution

Progressive Refinement Radiosity

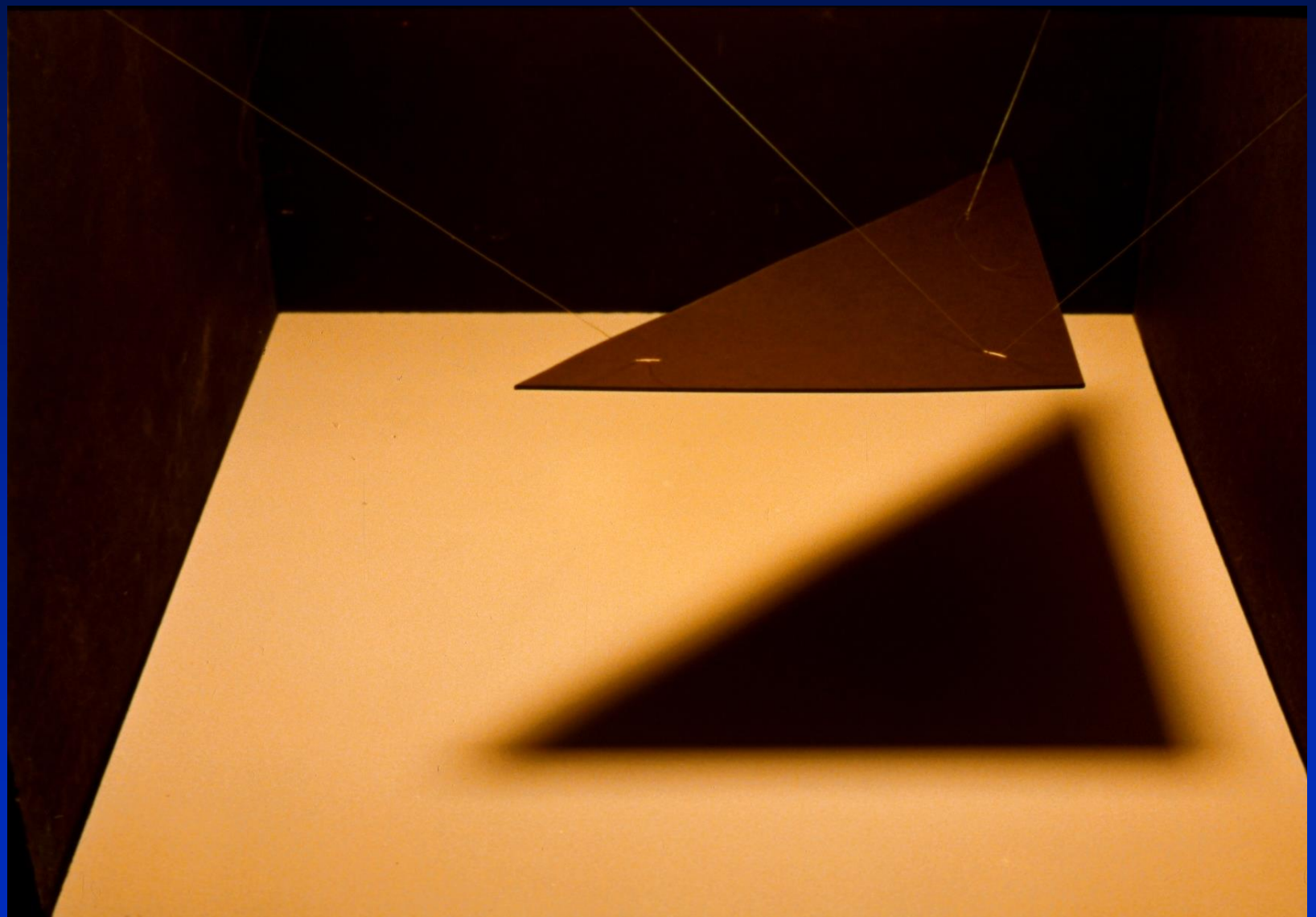


Simulated Steel Mill

Radiosity and Volume Rendering

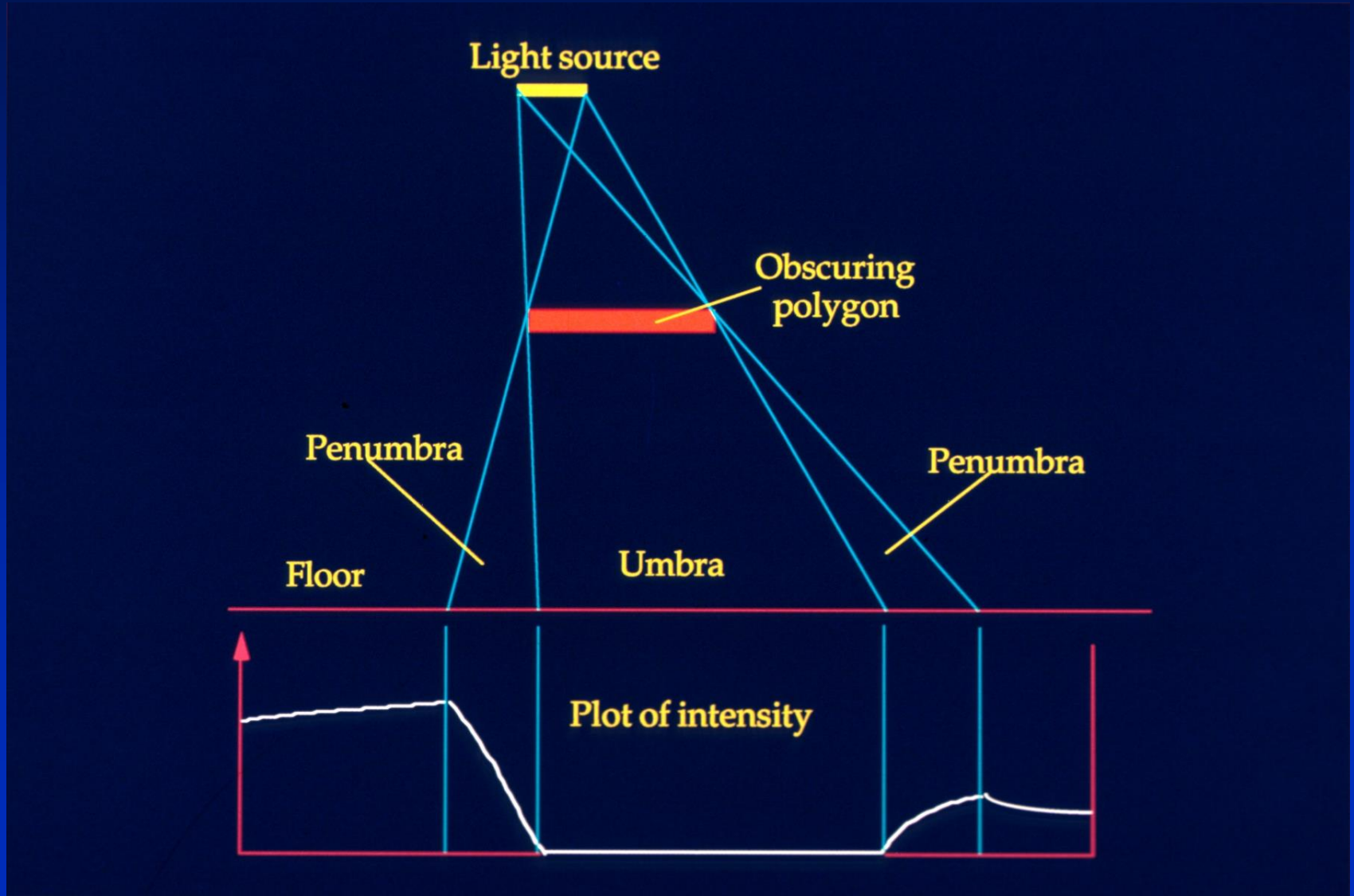


Discontinuity Meshing



Lischinski,Tampieri

Discontinuity Meshing

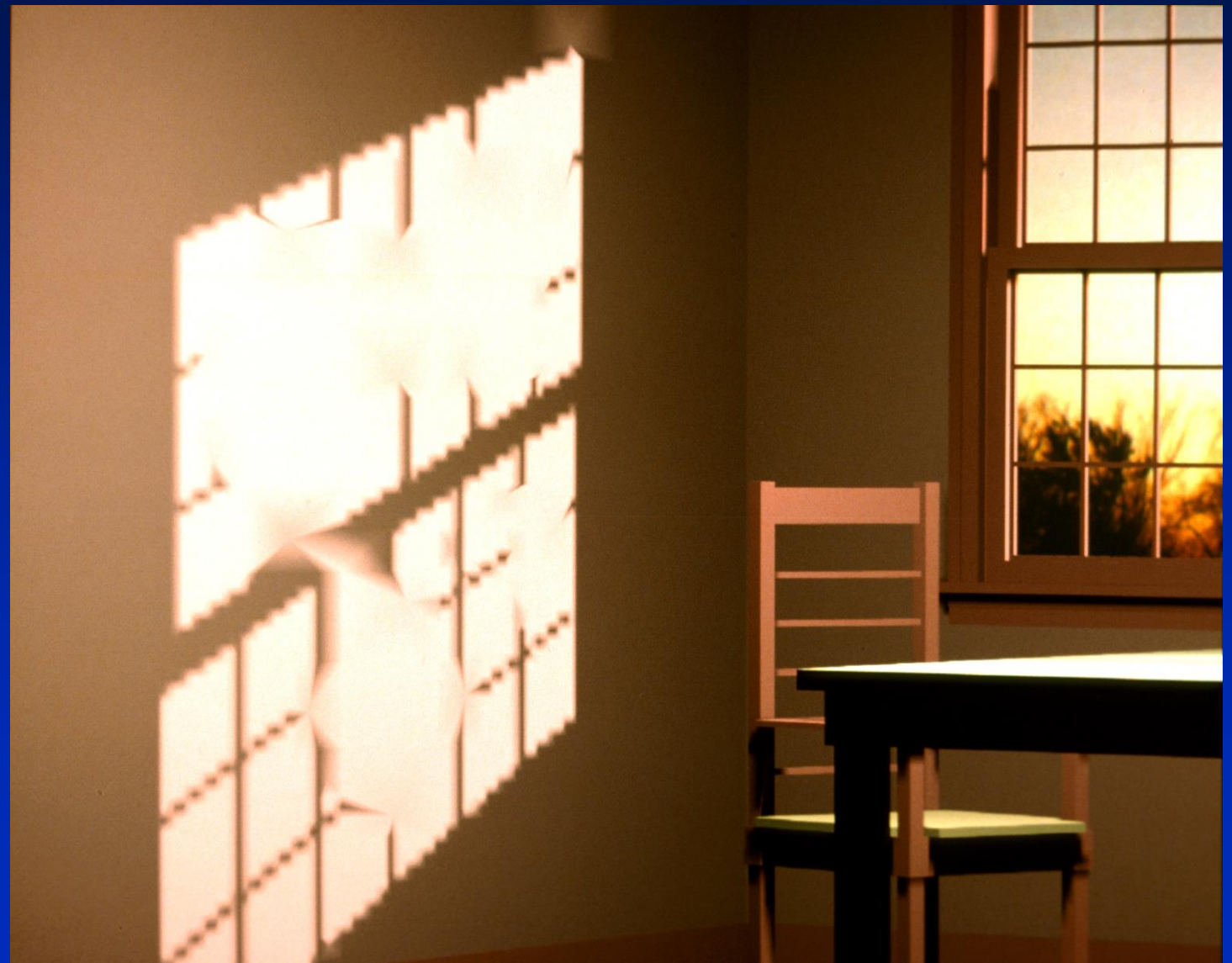


Lischinski,Tampieri

Discontinuity Meshing 1994

Lischinski,Tampieri

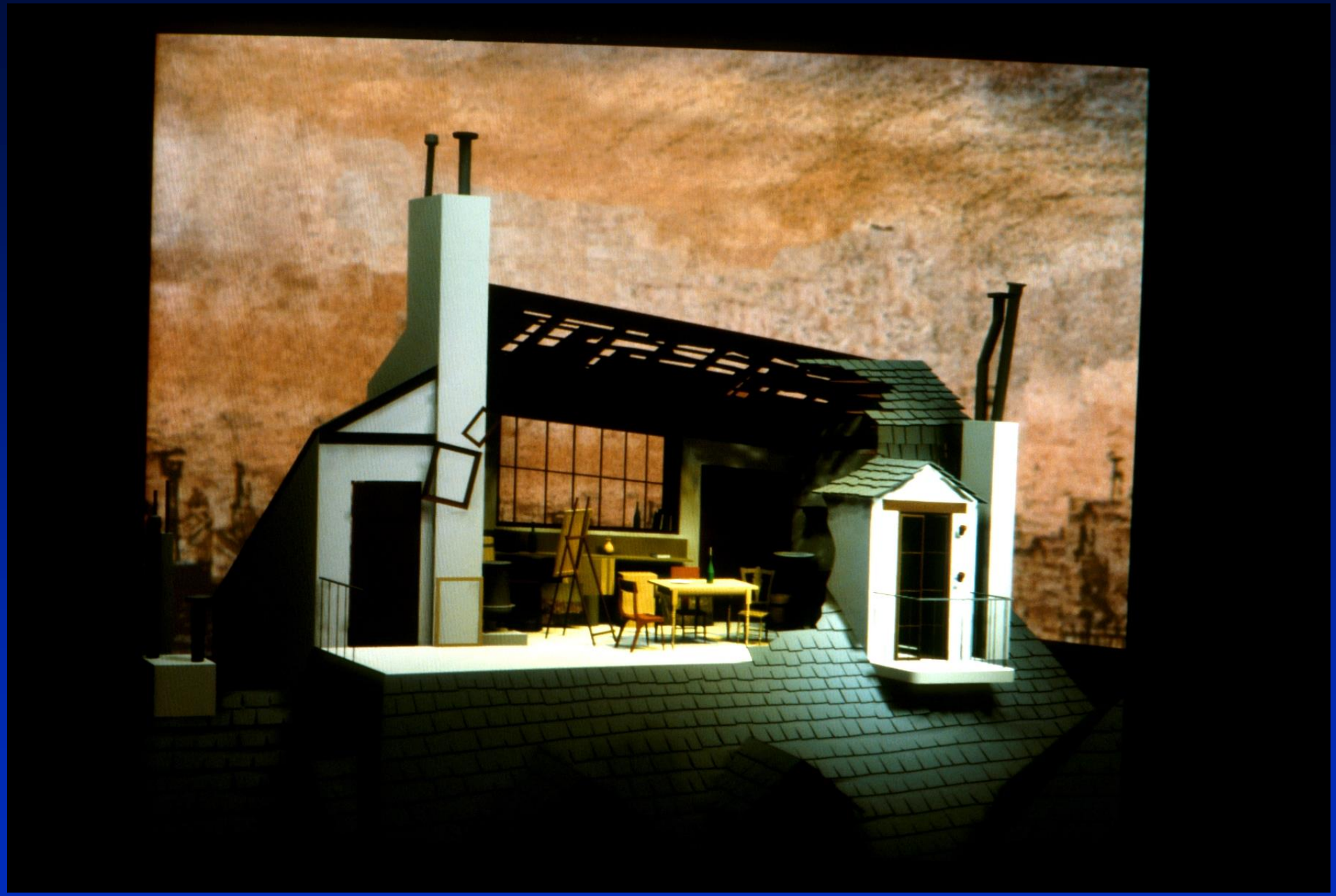
Standard Meshing



Discontinuity Meshing 1994

Lischinski,Tampieri


THANK YOU
FOR NOT SMOKING



2-Pass Radiosity

Vermeer

End. . .