

REPRESENTING LIGHT IN THE DIGITAL REALM

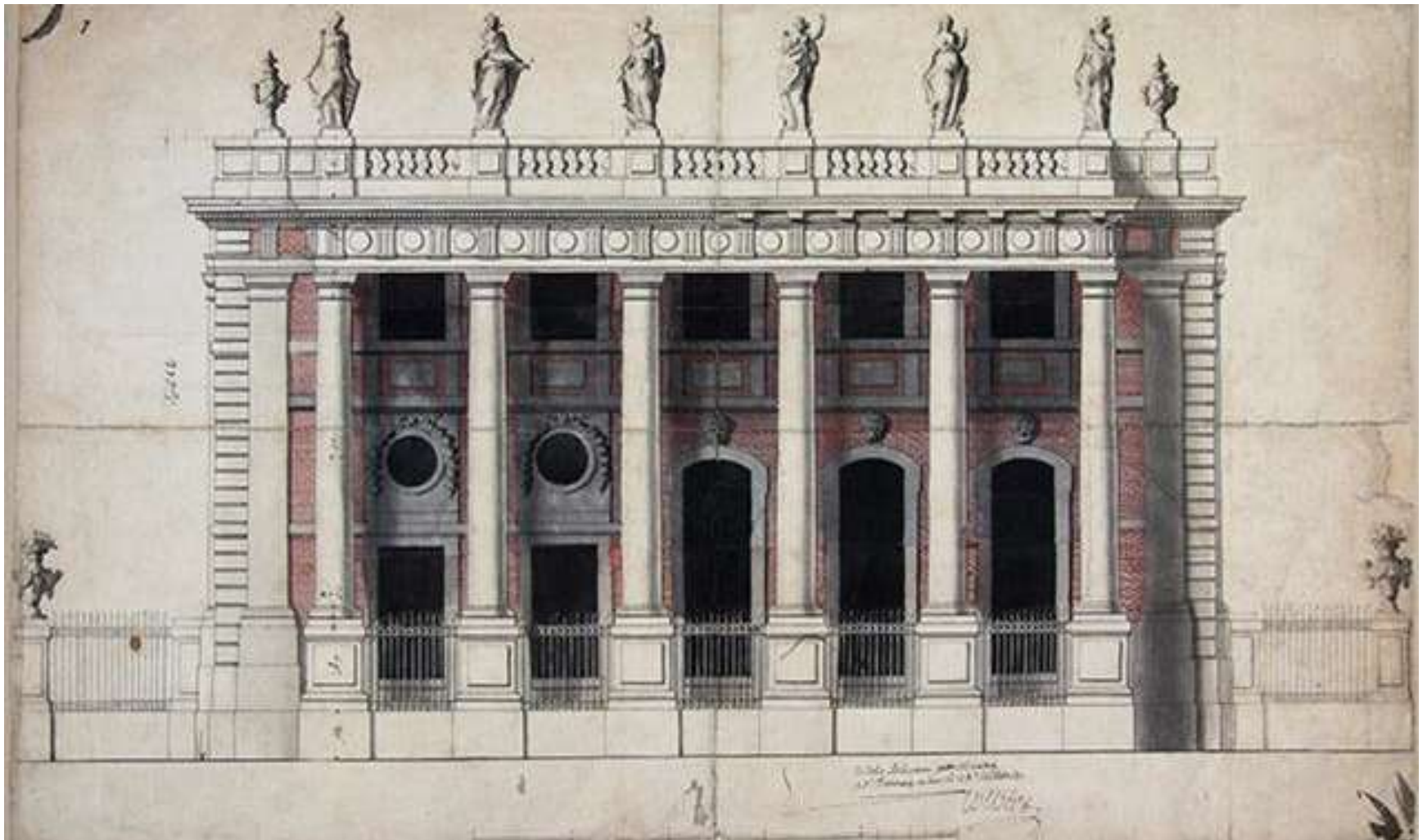
Stelios Zerefos, Architect

Associate Professor, Hellenic Open University

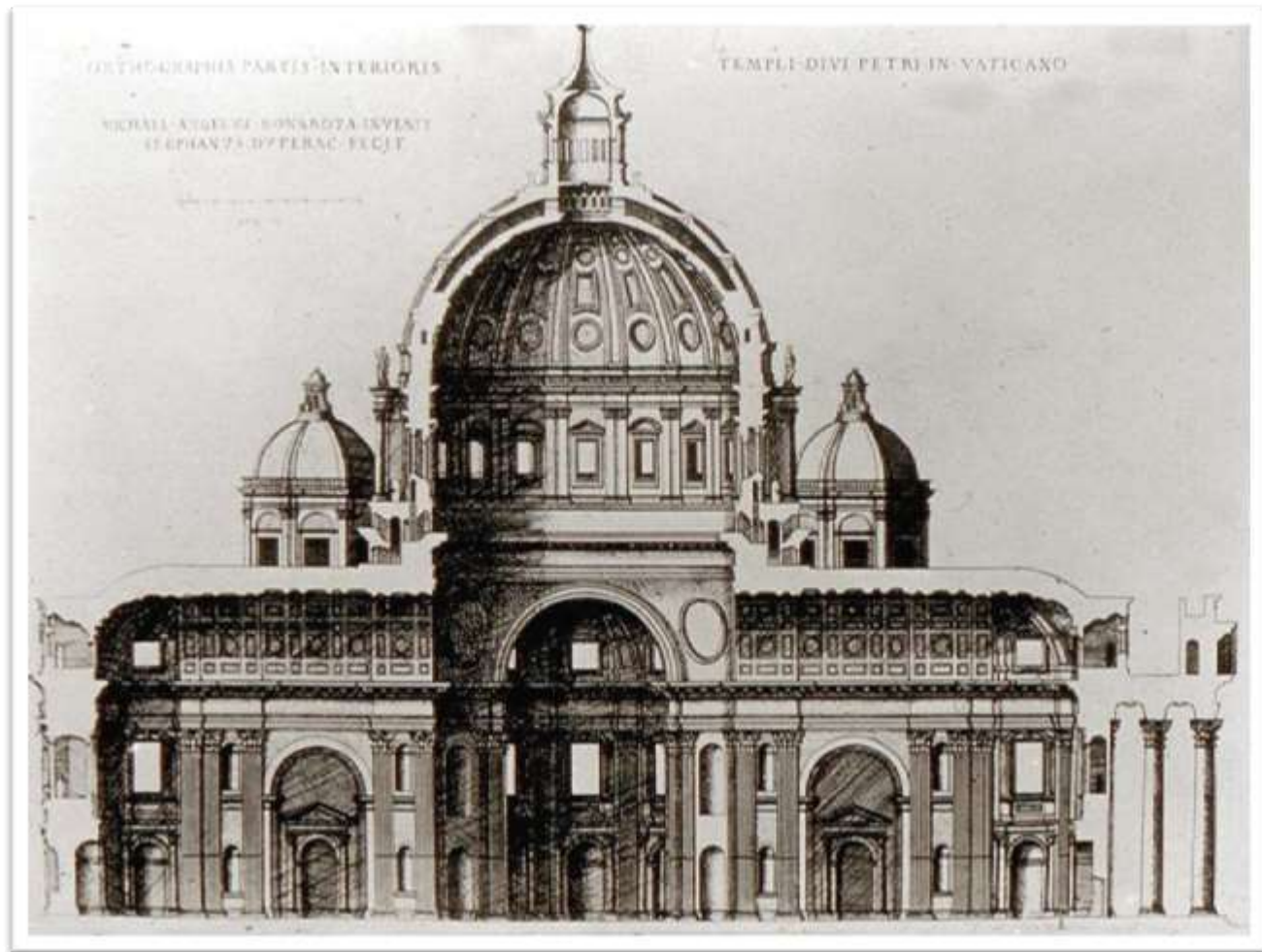
Use of light and shadow to communicate 3d space



Use of light and shadow to communicate 3d space



Use of light and shadow to communicate 3d space



The architectural drawing



?

The architectural drawing



The architectural drawing



Lighting design – thought of...



Lighting design – thought of...



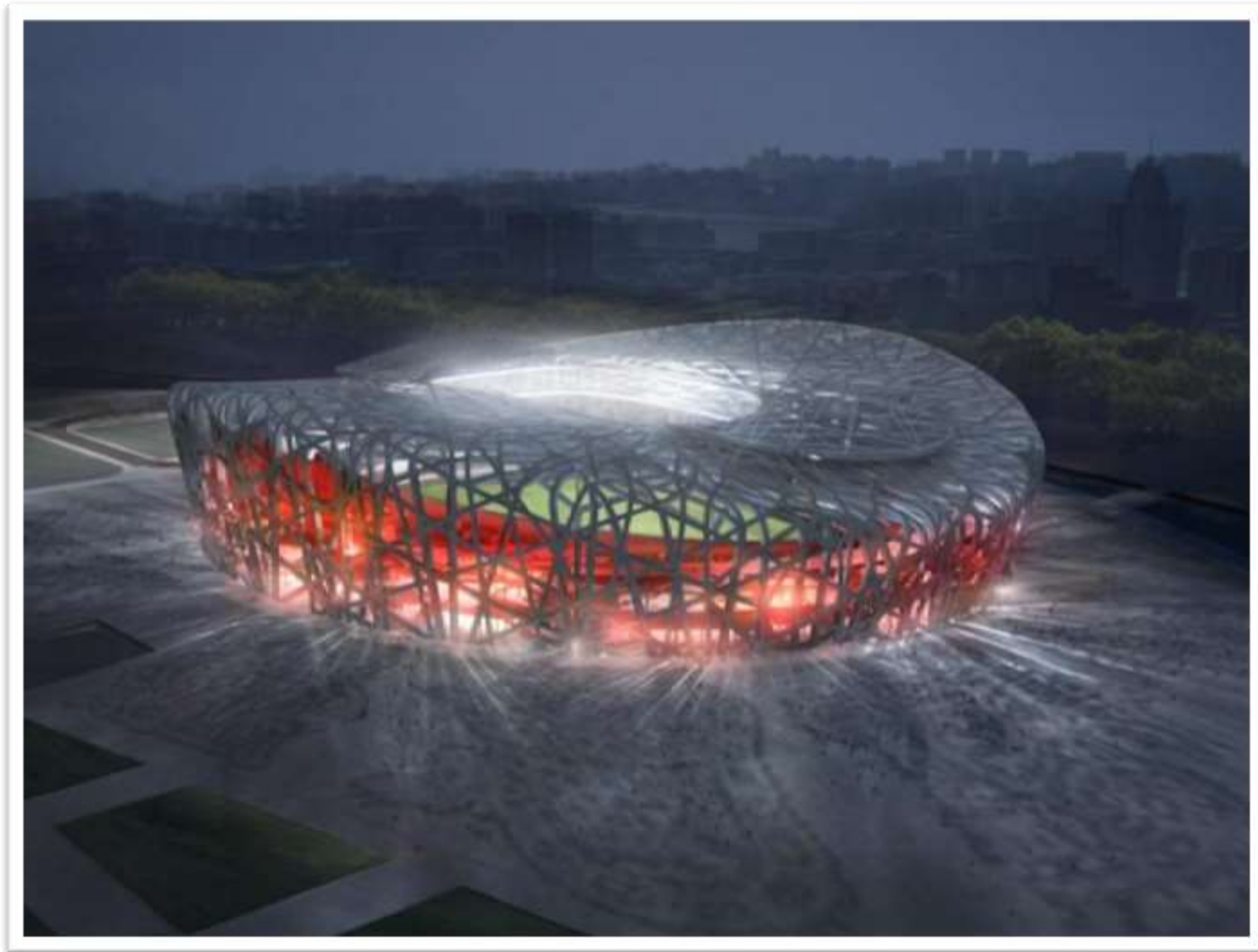
Post-war affluence



One Central Park – Jean Nouvel



Beijing Olympic Stadium – Herzog & de Meuron



Philharmonie d'Angers – Kengo Kuma



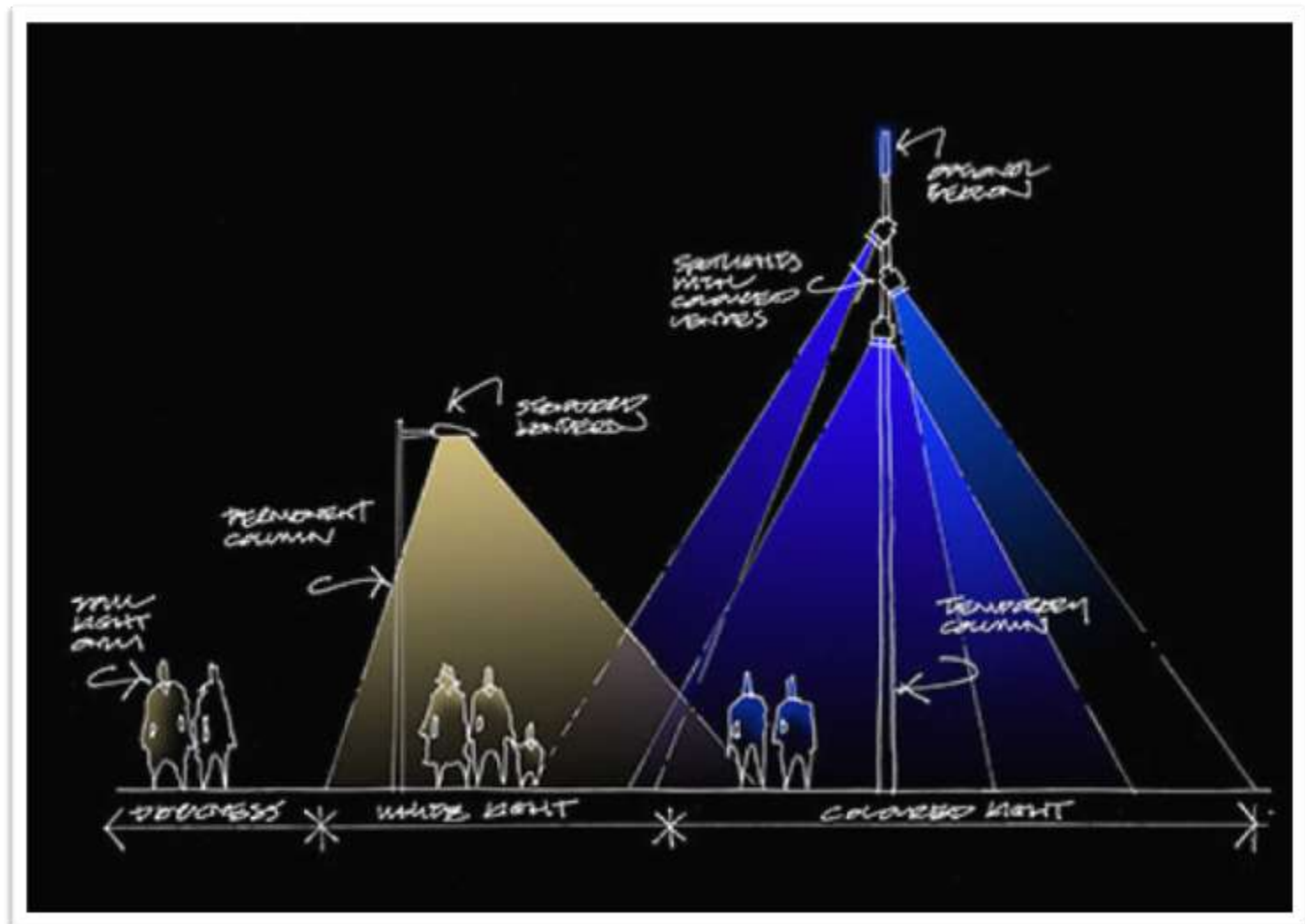
National Library and Opera House – Renzo Piano



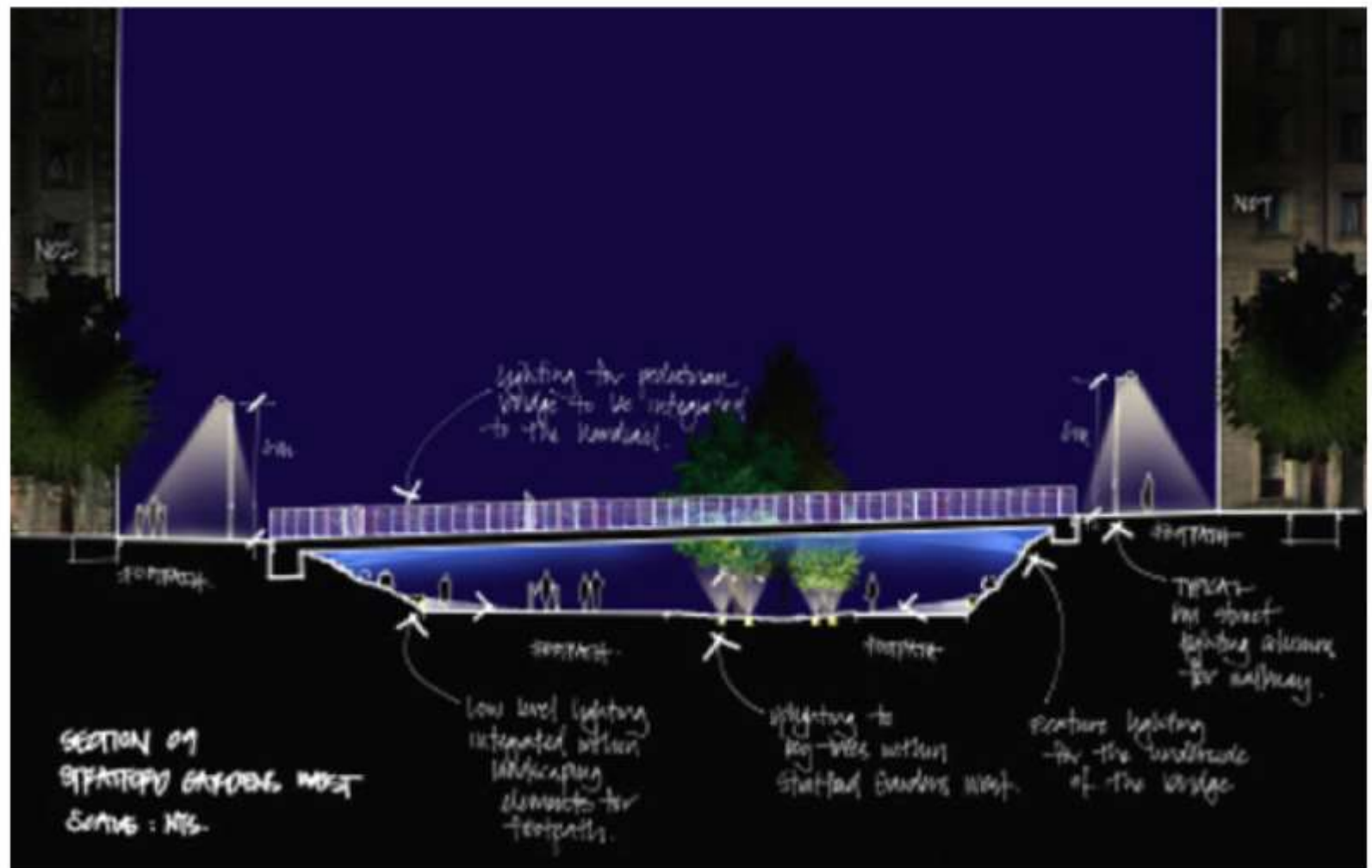
left: rendering — right: photograph



“back of house”



“back of house”



“back of house”



Representing lighting design

Lighting can be represented on a screen for conveying information on the:

quantitative characteristics of light

(intensity, energy, decay, multiple sources etc.)

qualitative characteristics of light

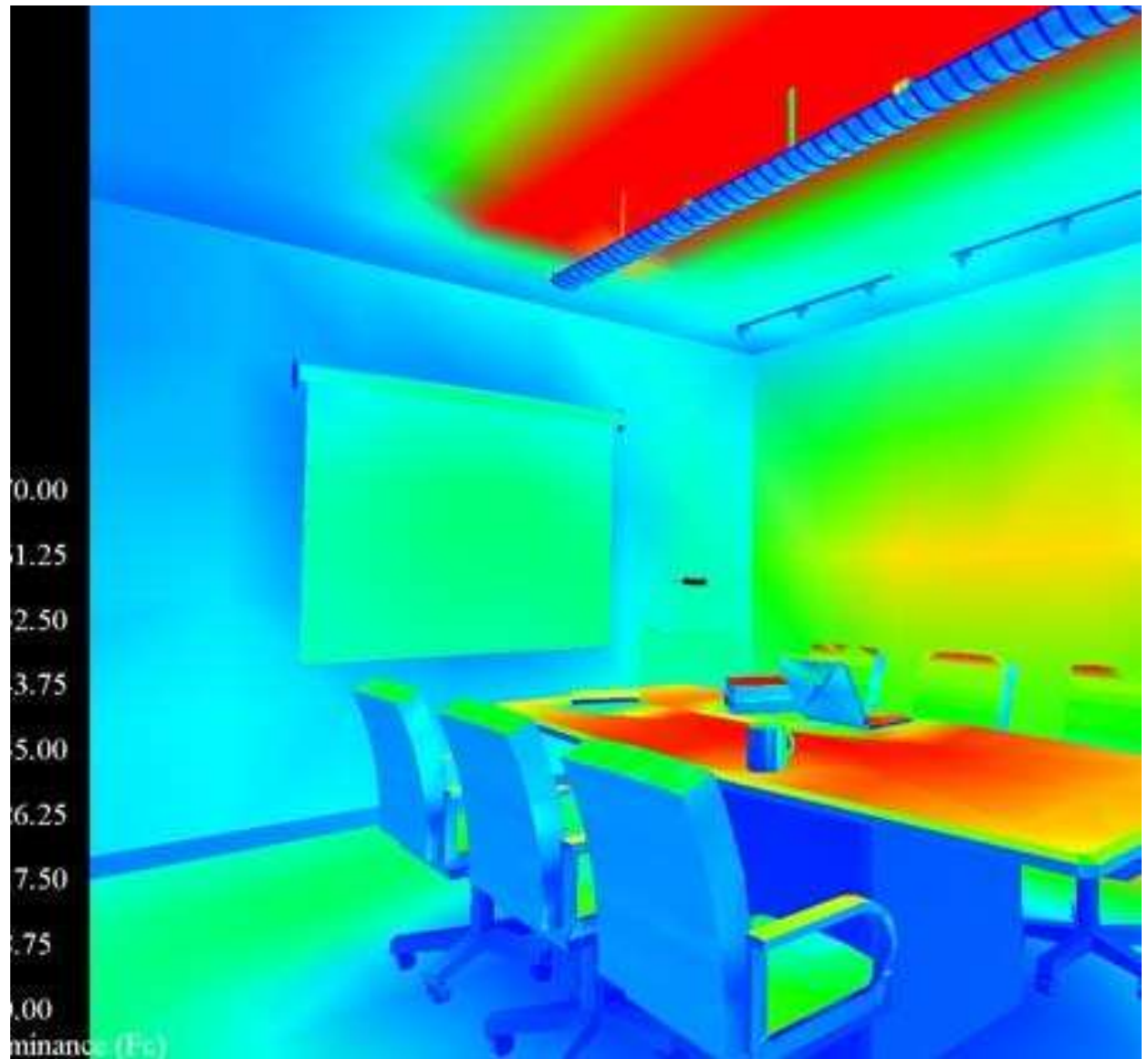
(position of source, shadows, color, projection)

quantitative

Help us to define numerical values on the effects of light on surfaces

Usually used to determine if lighting is appropriate for certain tasks

Can lead to optimizations for energy use and glare control



qualitative

Help us to define
the aesthetic
qualities of a space

Accurate projection
of shadows
provides more
contrast information

Depiction of
material textures
and translucency
inform us on the
absolute behaviour
of light on surfaces



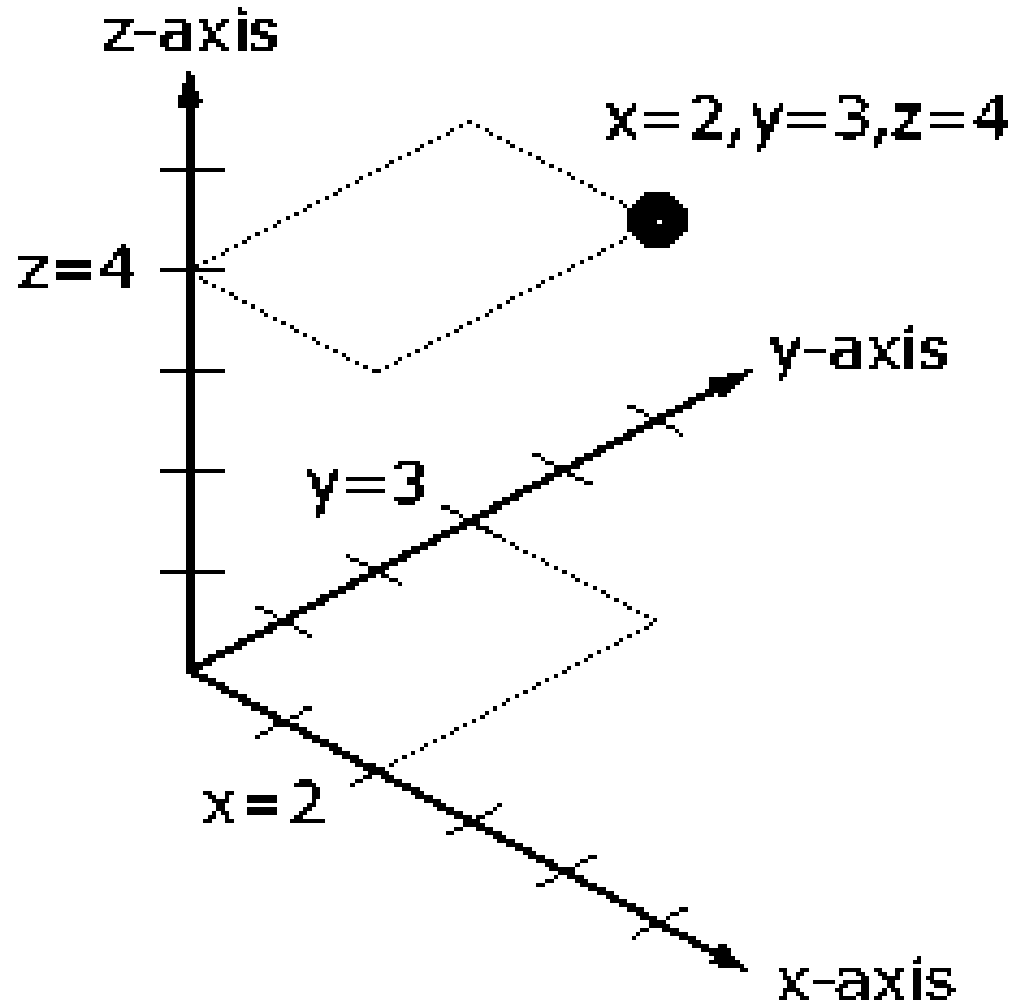
3d space

Cartesian coordinate system with three axes

The centre of the coordinate system is 0, 0, 0.

The position on each axis corresponds to 0

The position of any point is identified by three numbers (x, y, z) corresponding to the distance from each axis



topology

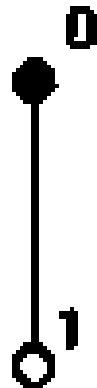
Main topological characteristic is the point

Two connected points create one line

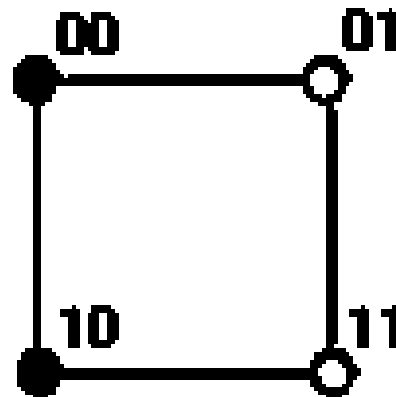
Three or more connected points form a surface

Five or more surfaces form an object

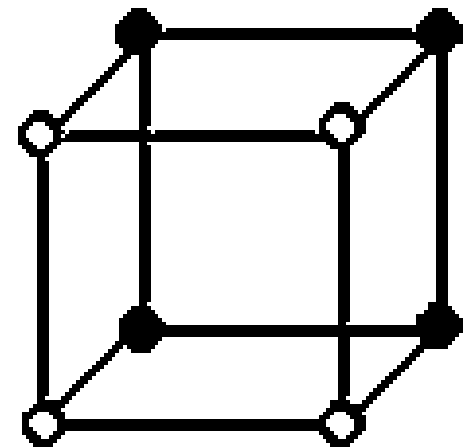
1D



2D



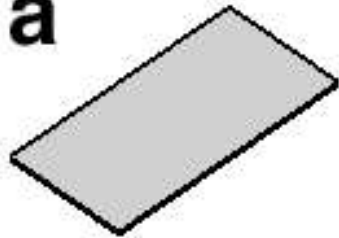
3D



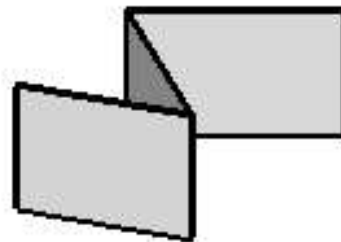
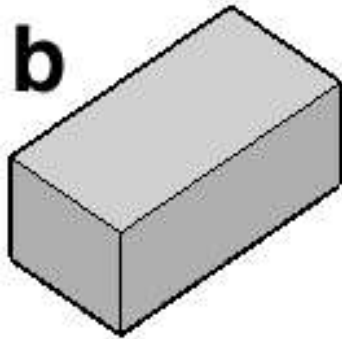
creation

Extrusion of a surface

a



b



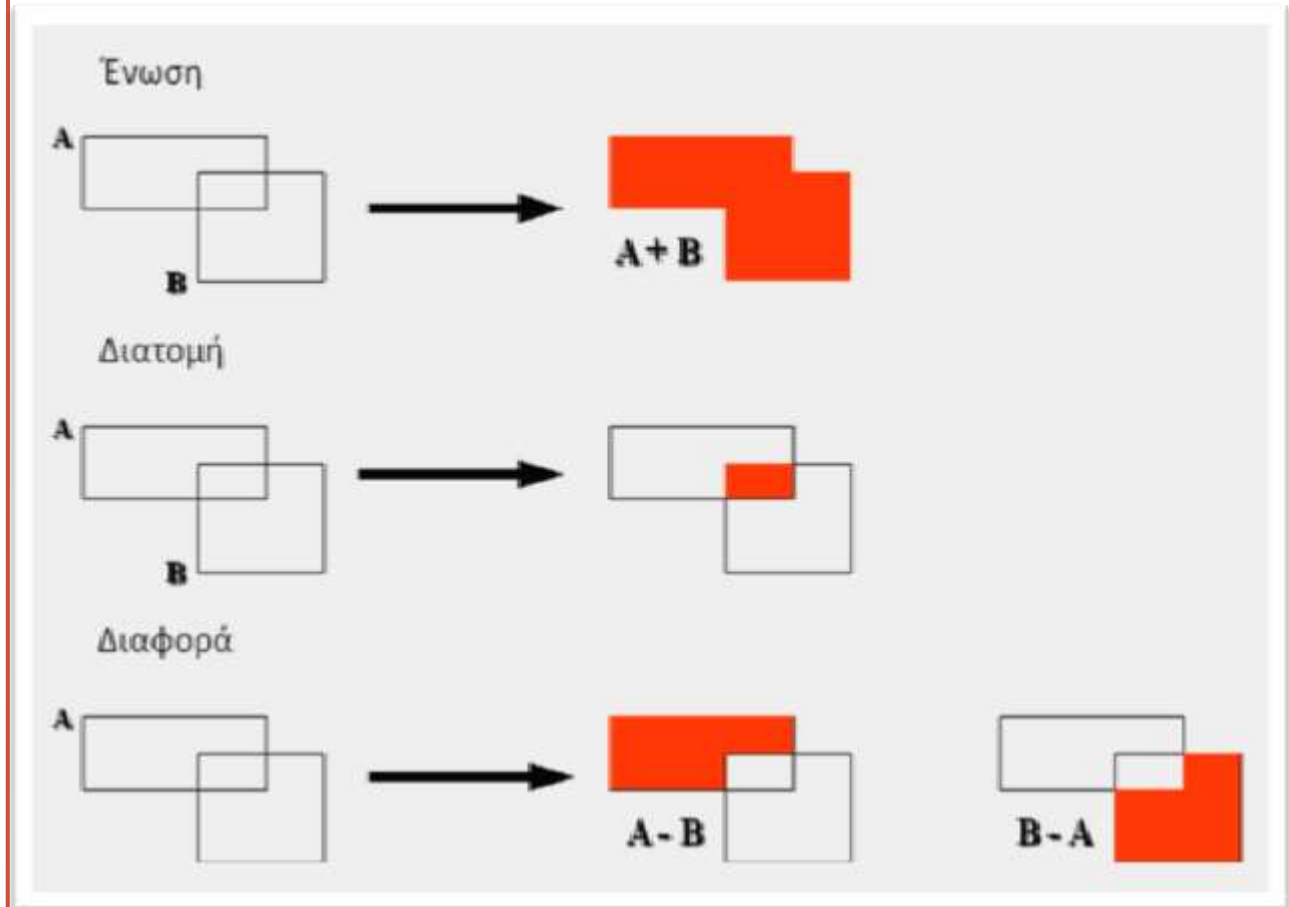
creation

Boolean functions:

Union

Intersection

Deifference



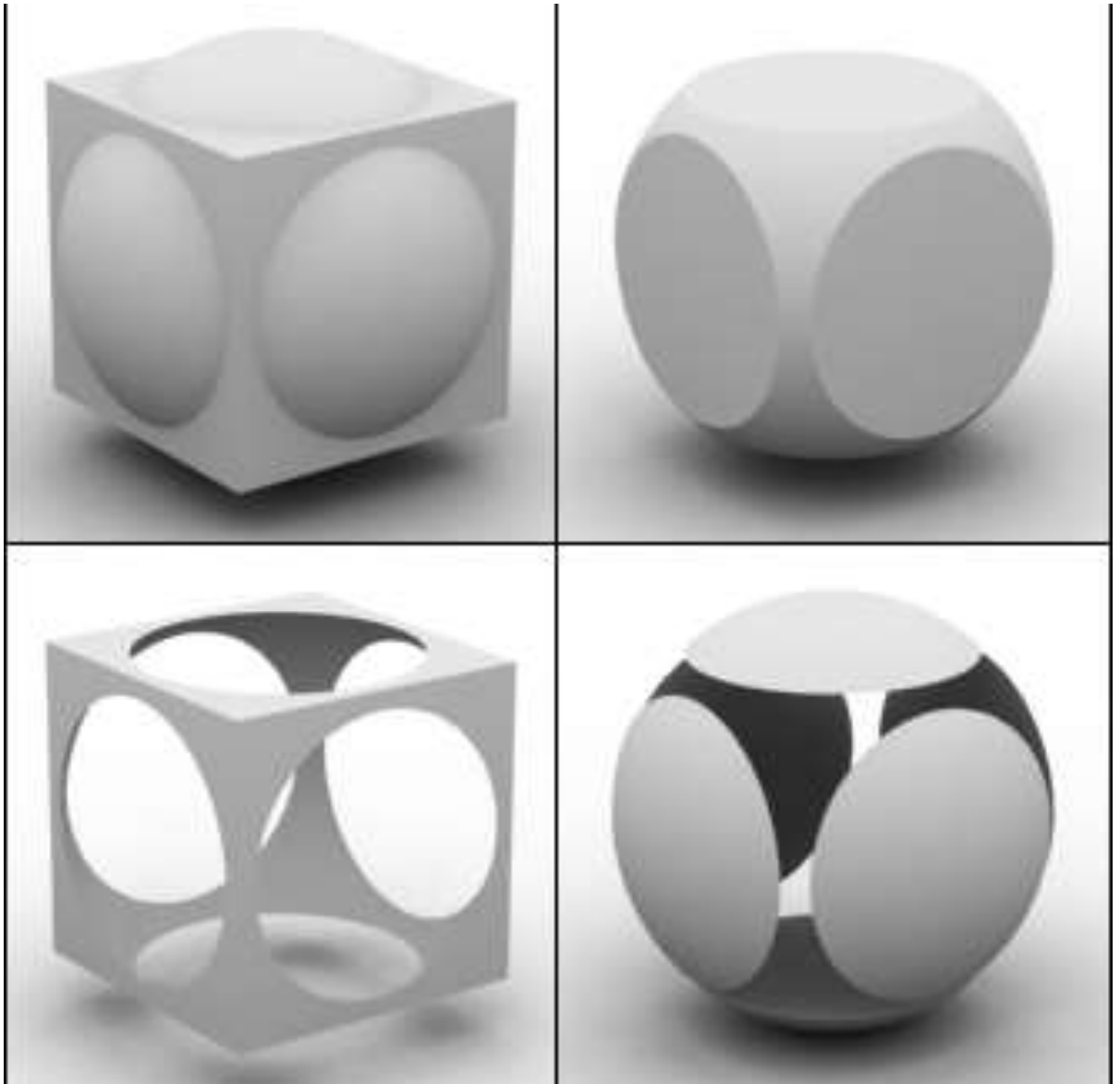
creation

Boolean functions:

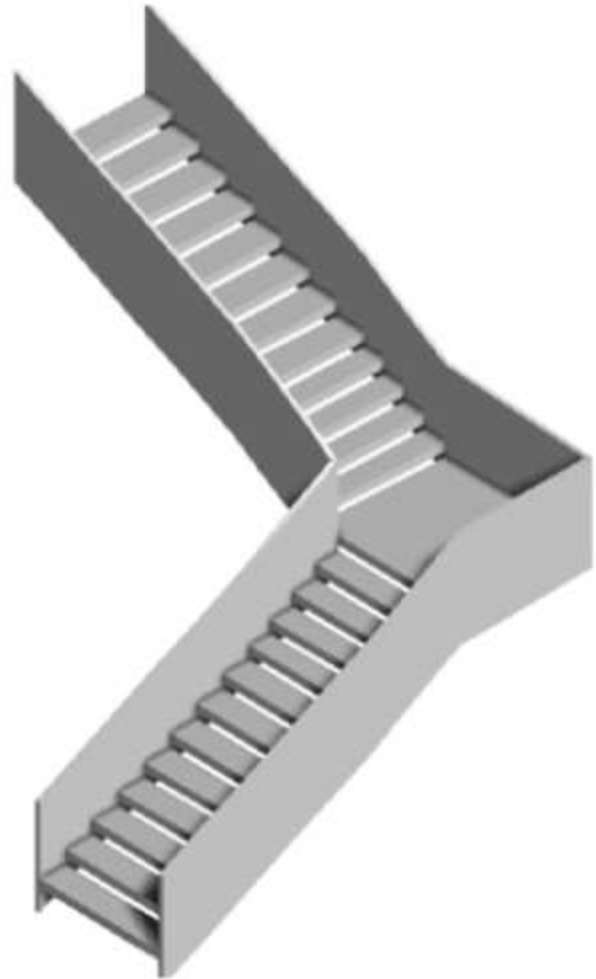
Union

Intersection

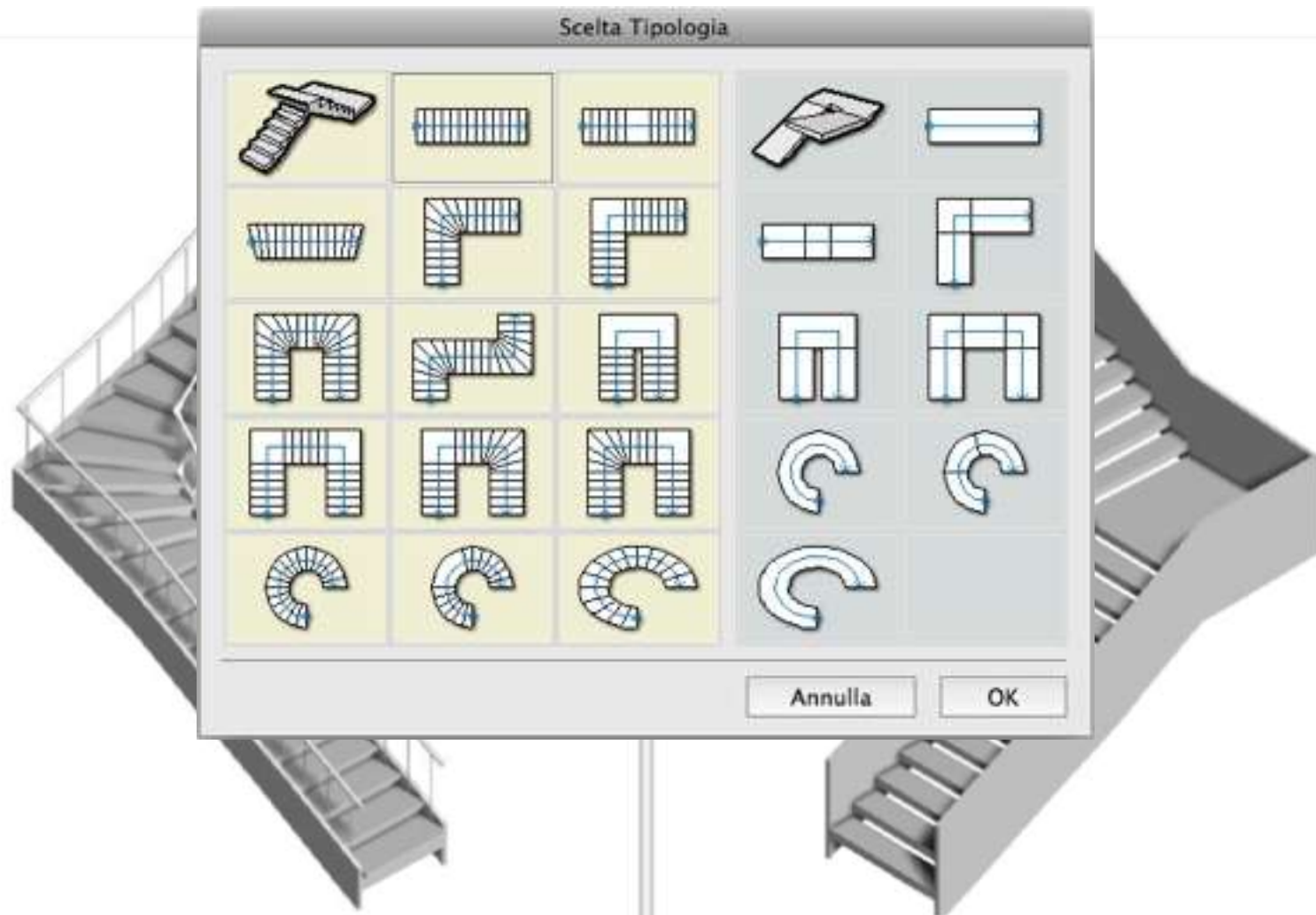
Deifference



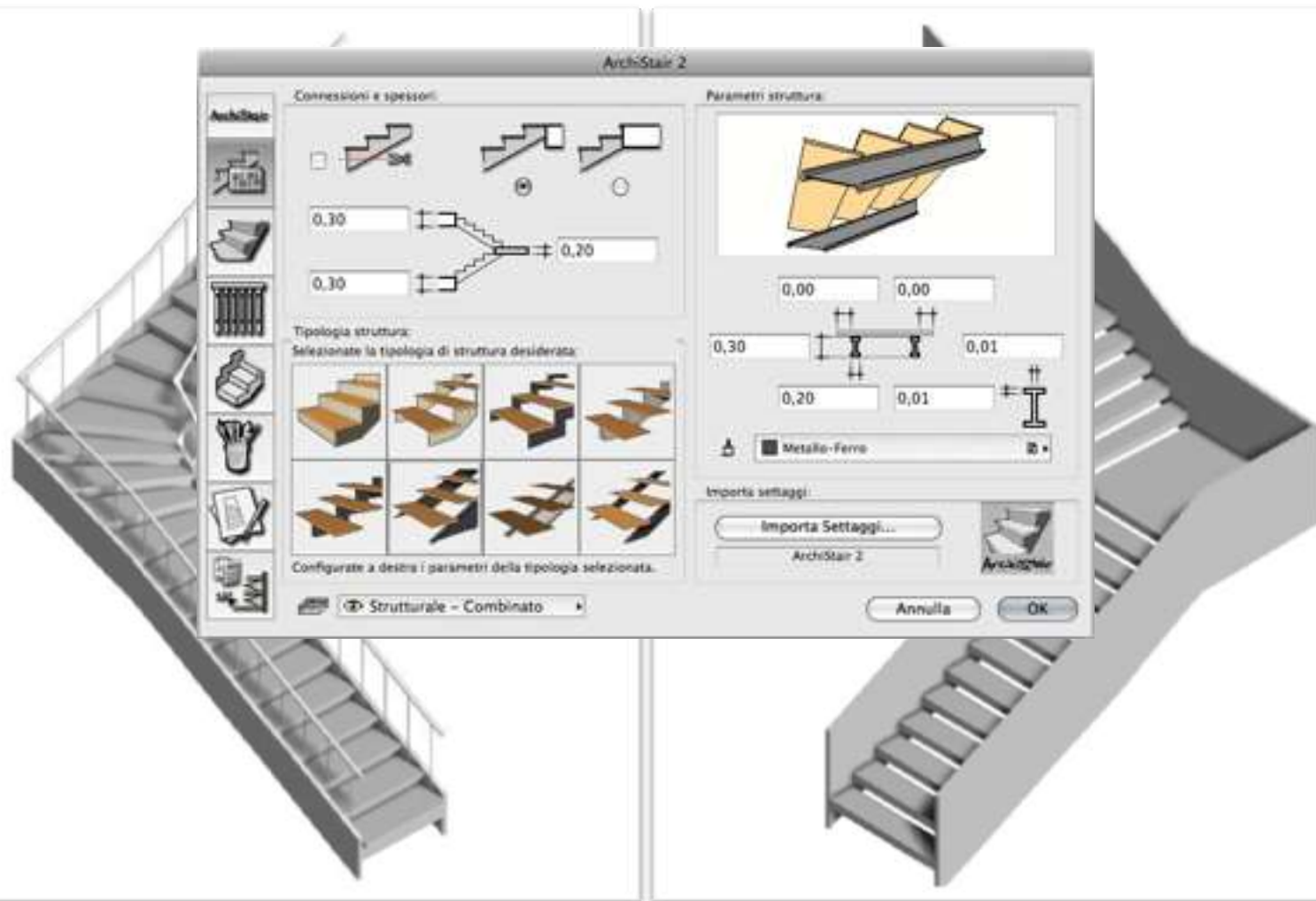
Parametric objects



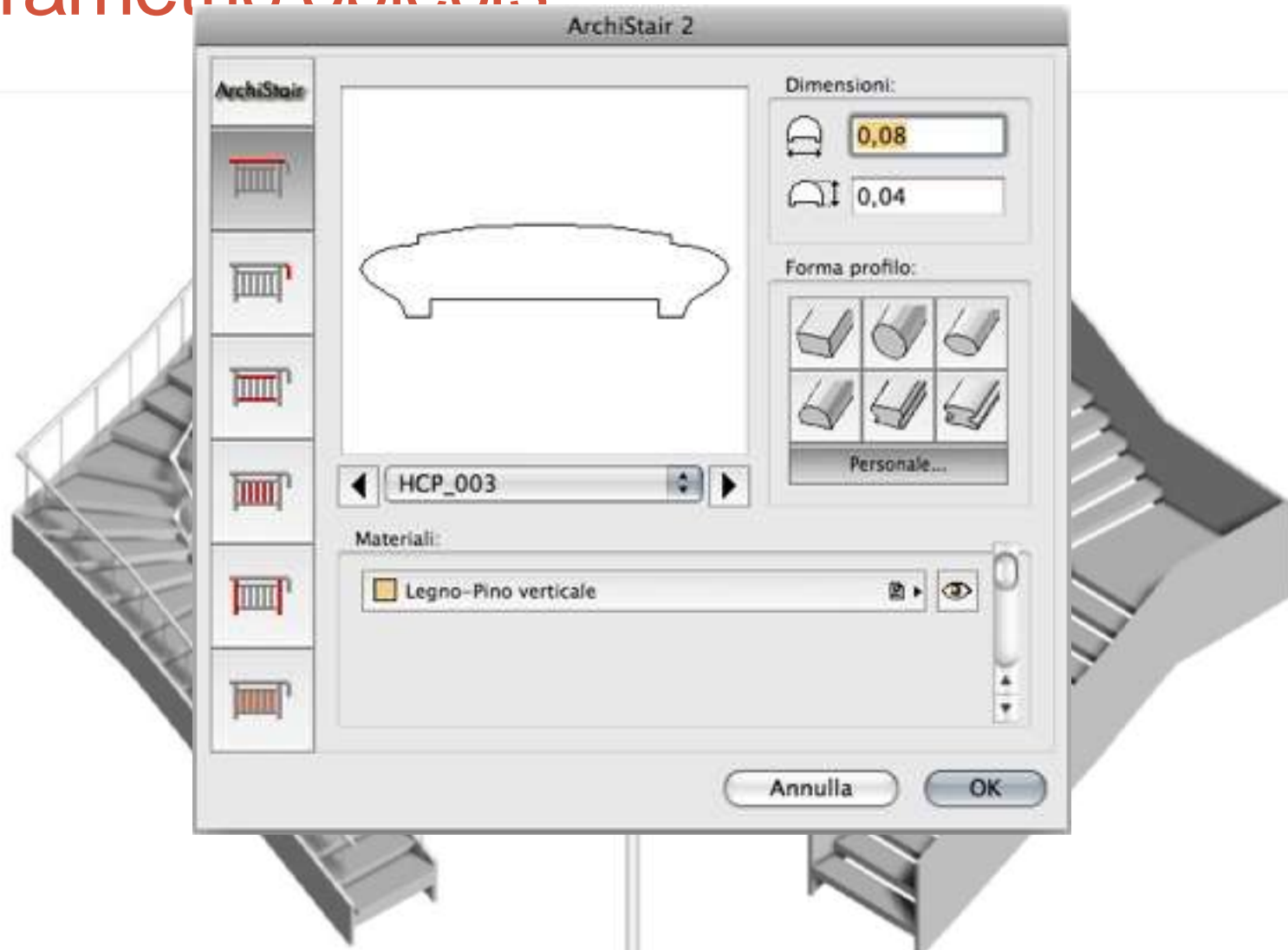
Parametric objects



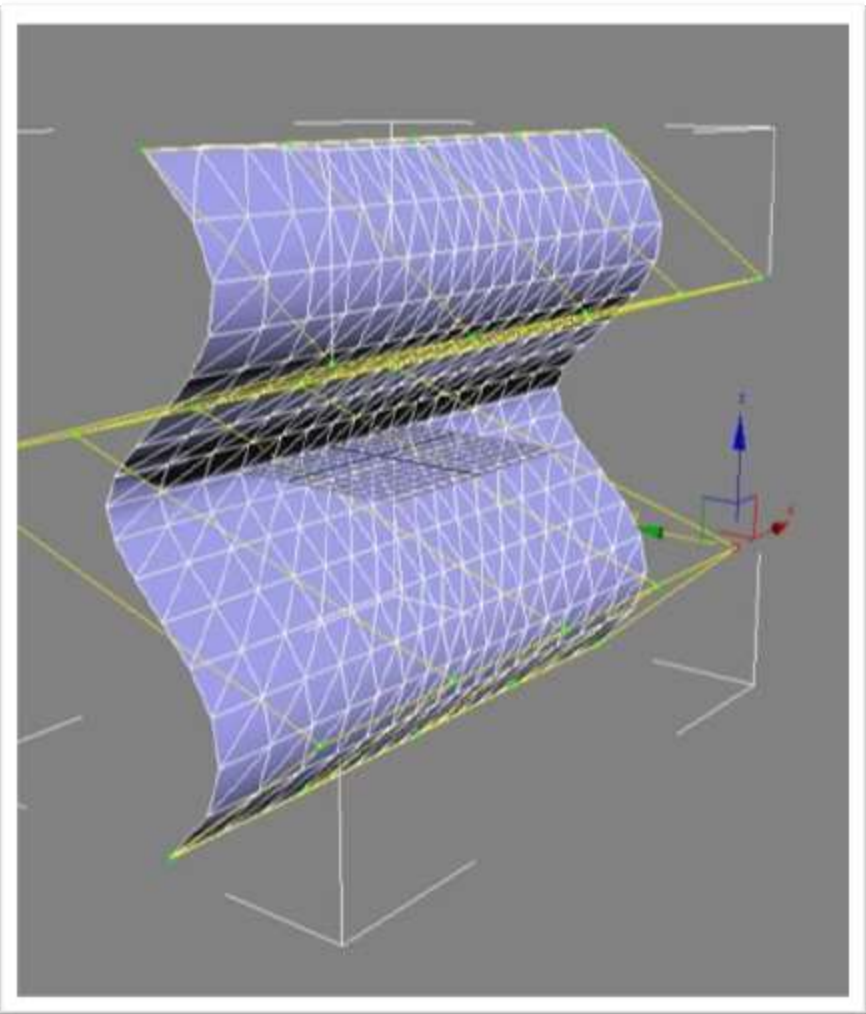
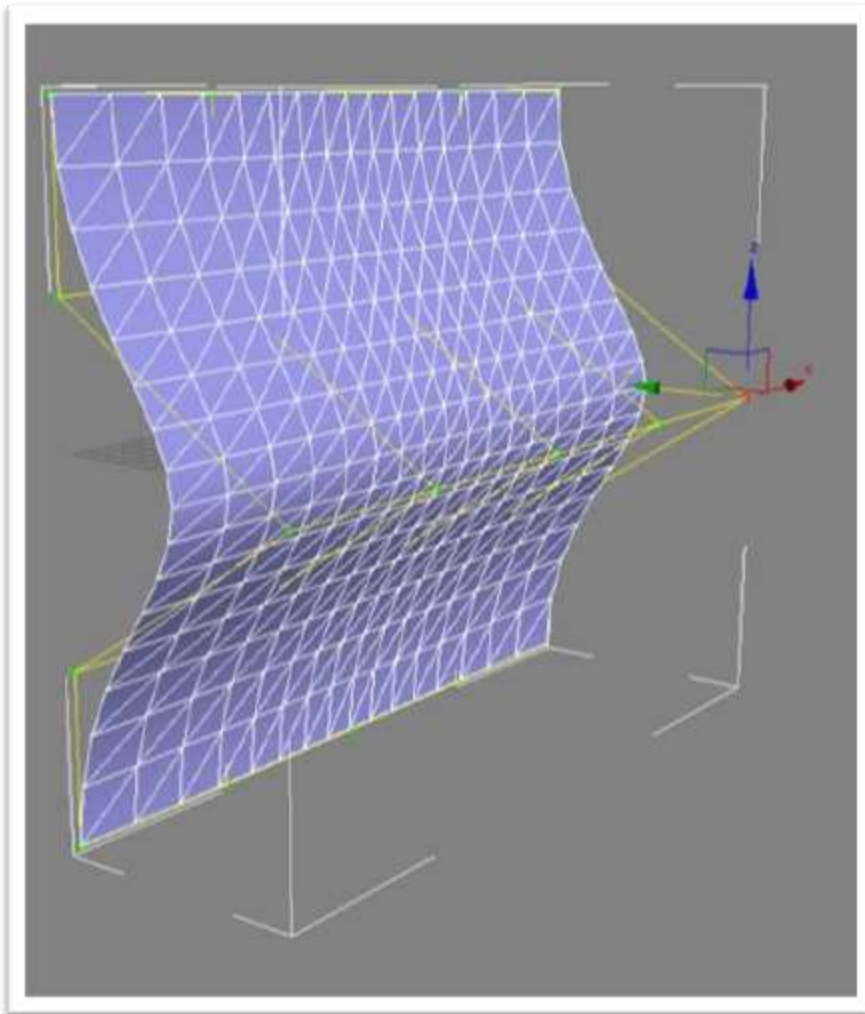
Parametric objects



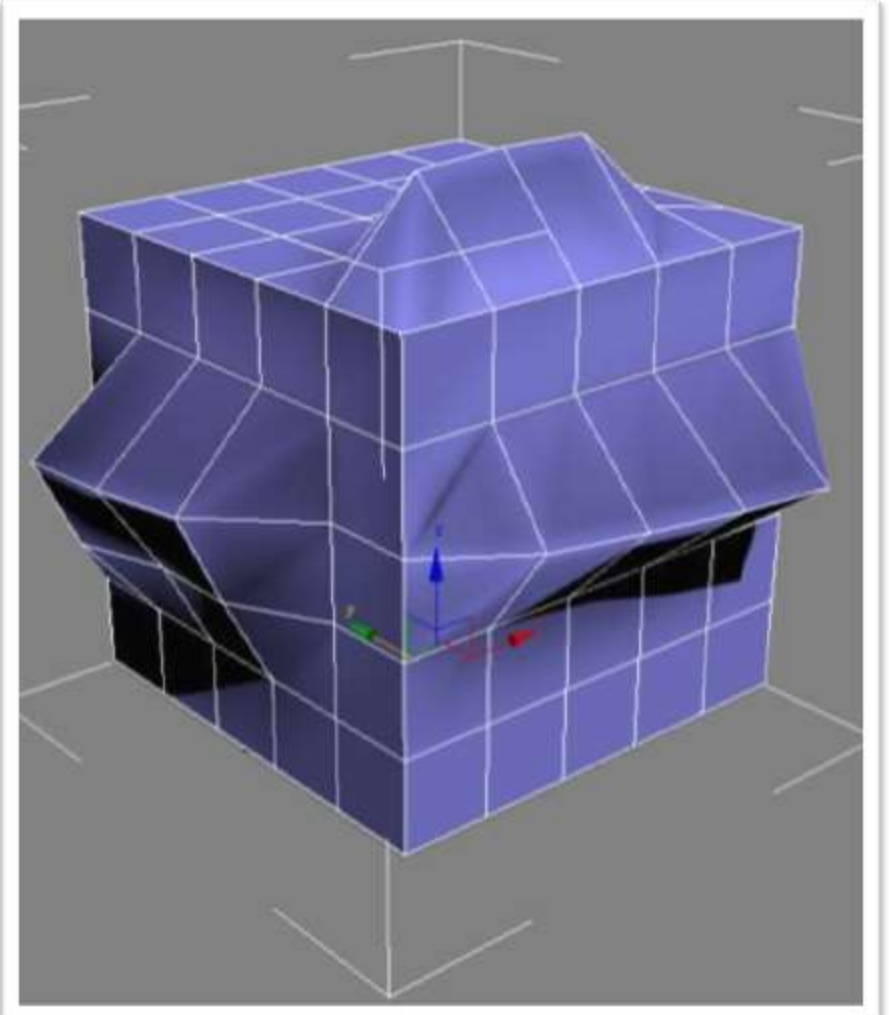
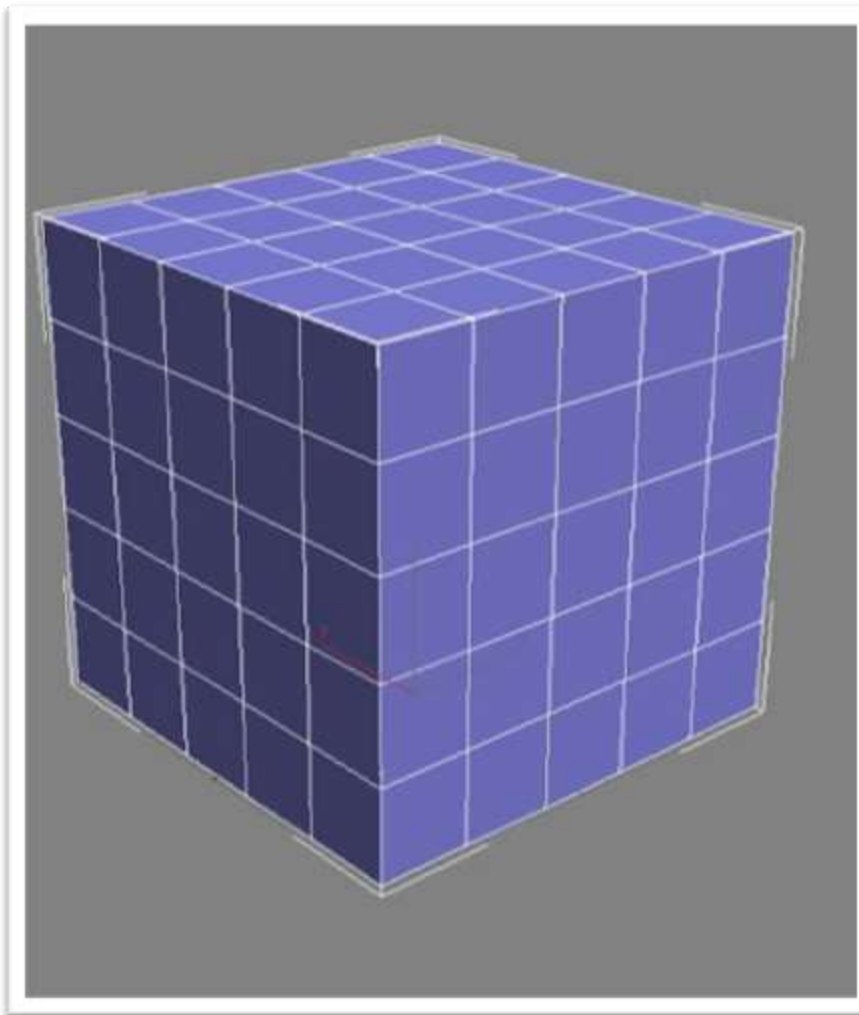
Parametric objects



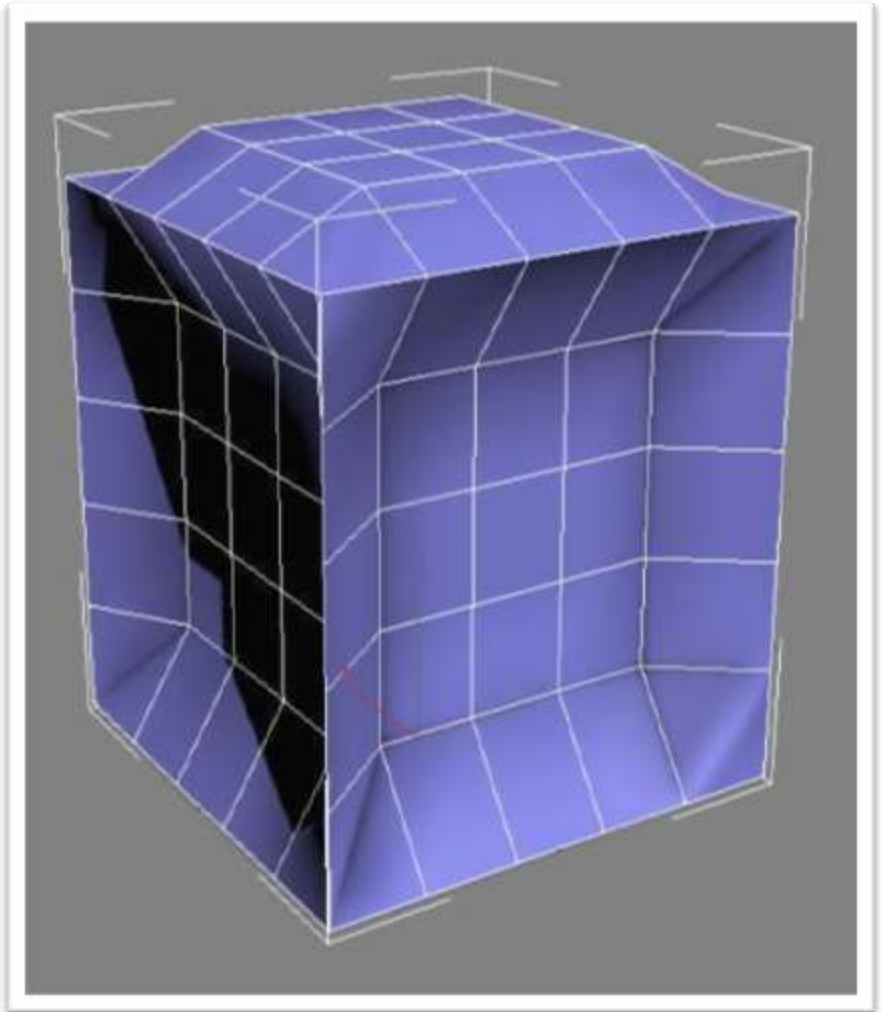
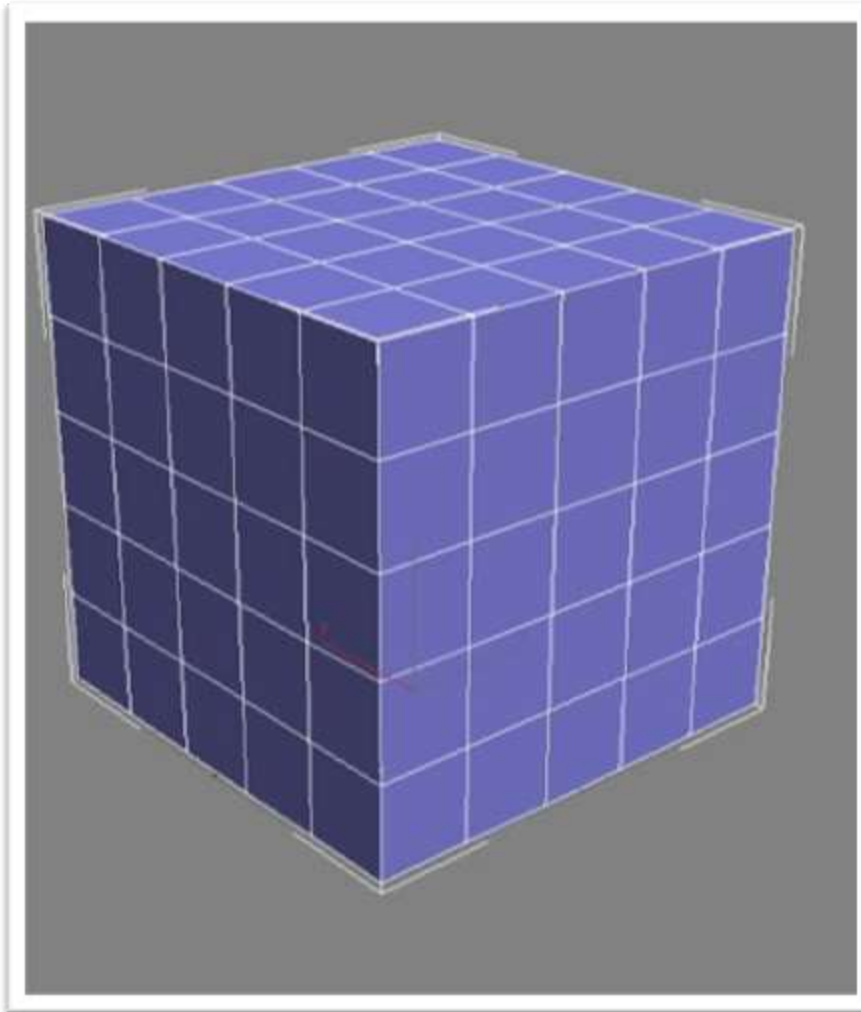
NURBS (Non Uniform Rational B-Spline)



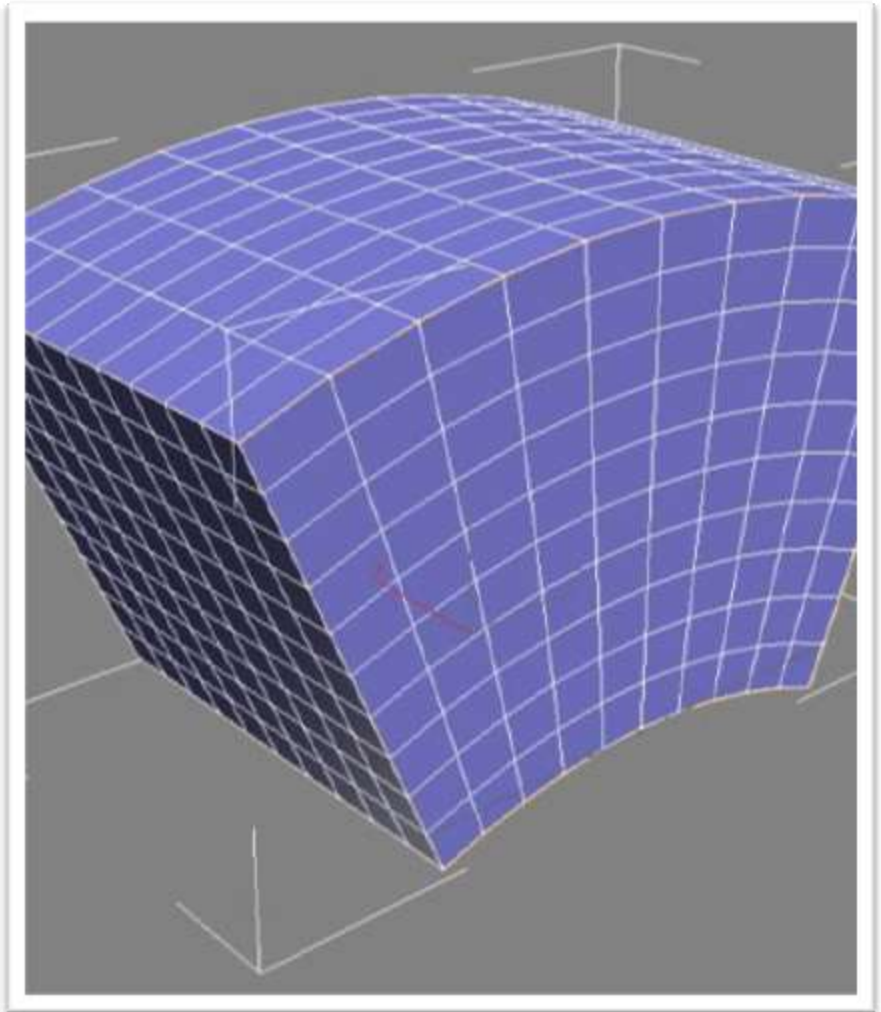
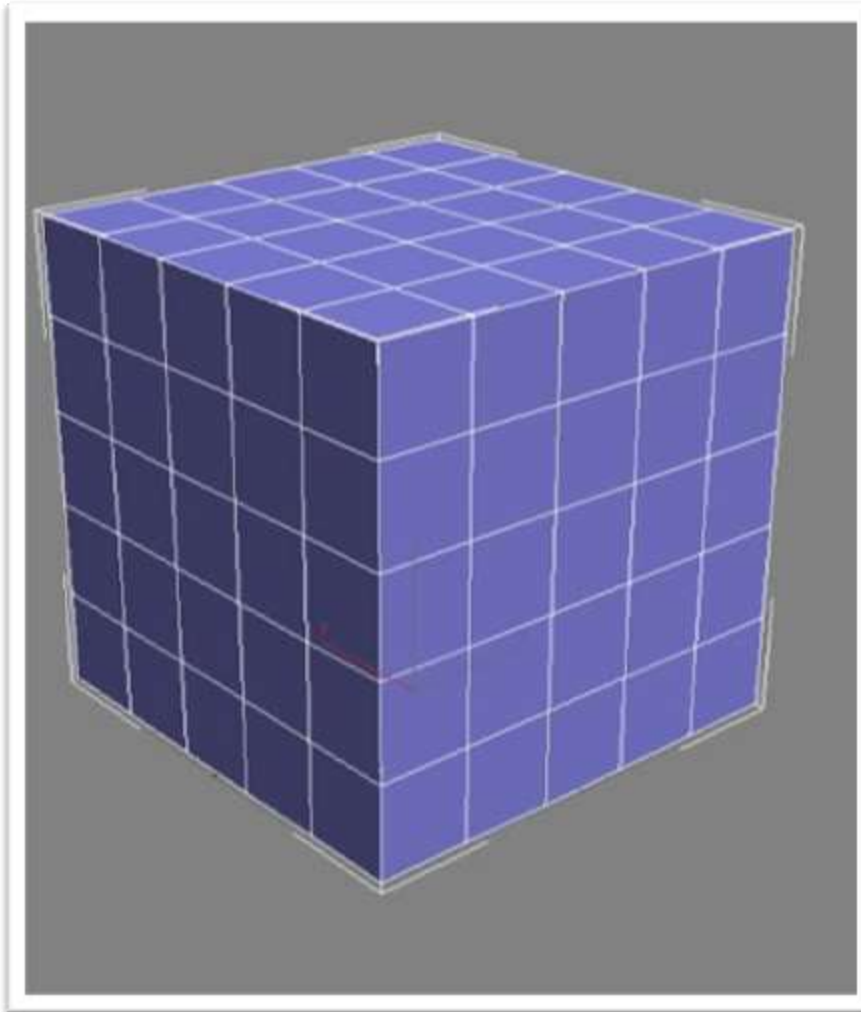
Transformation



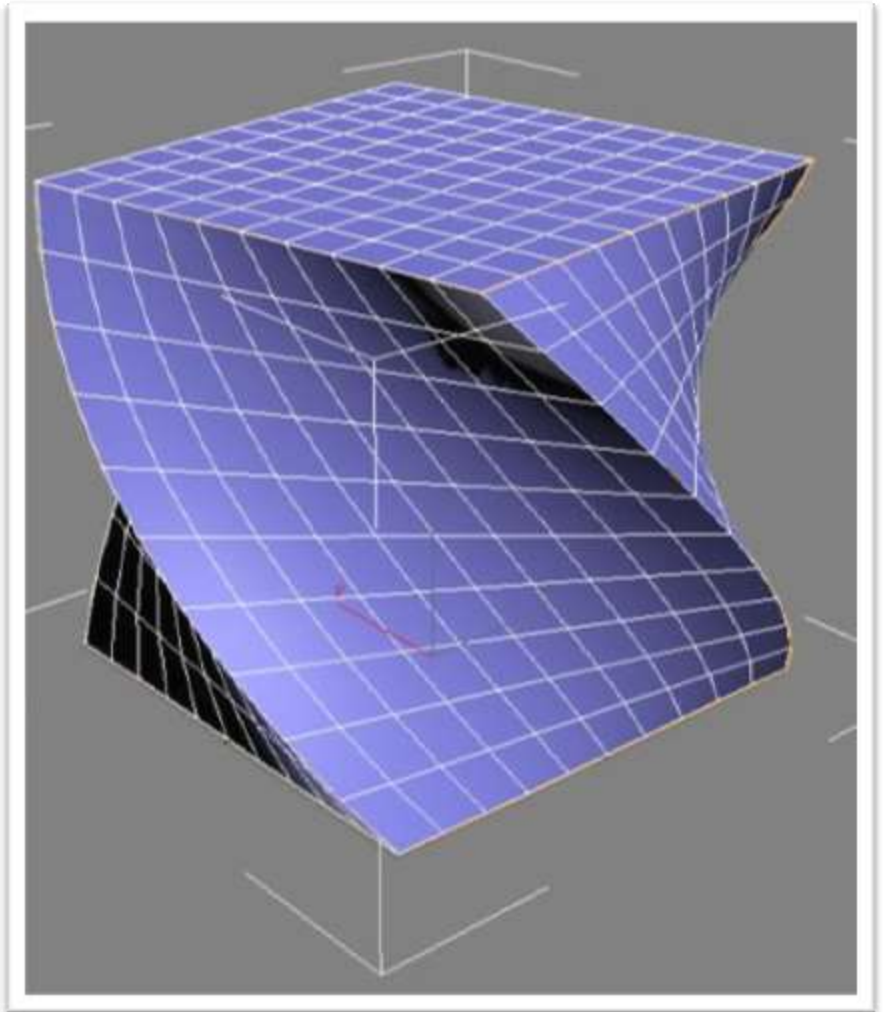
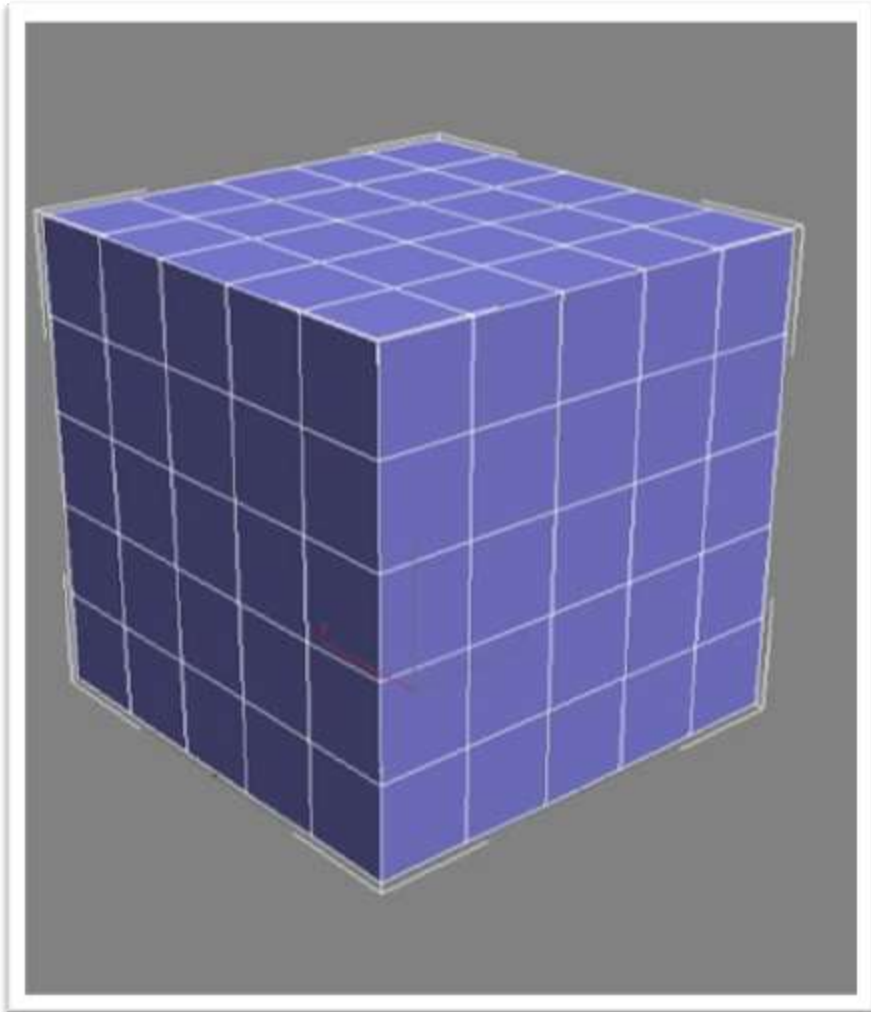
Transformation



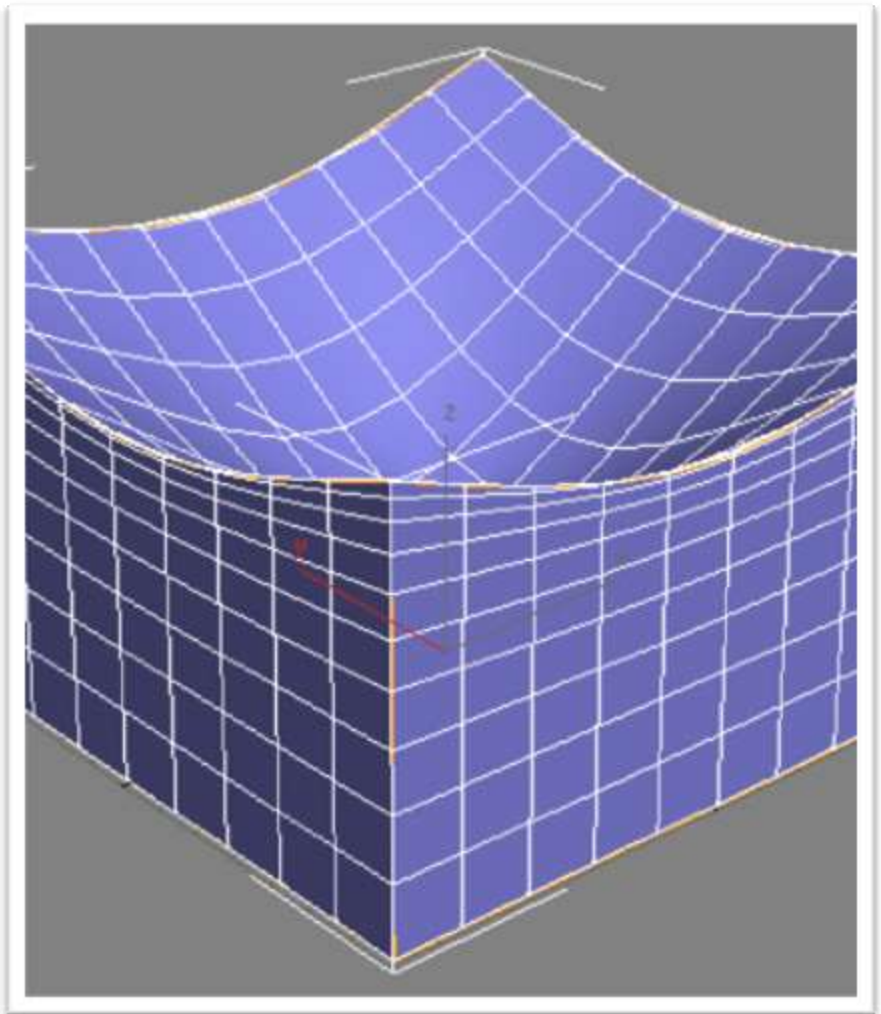
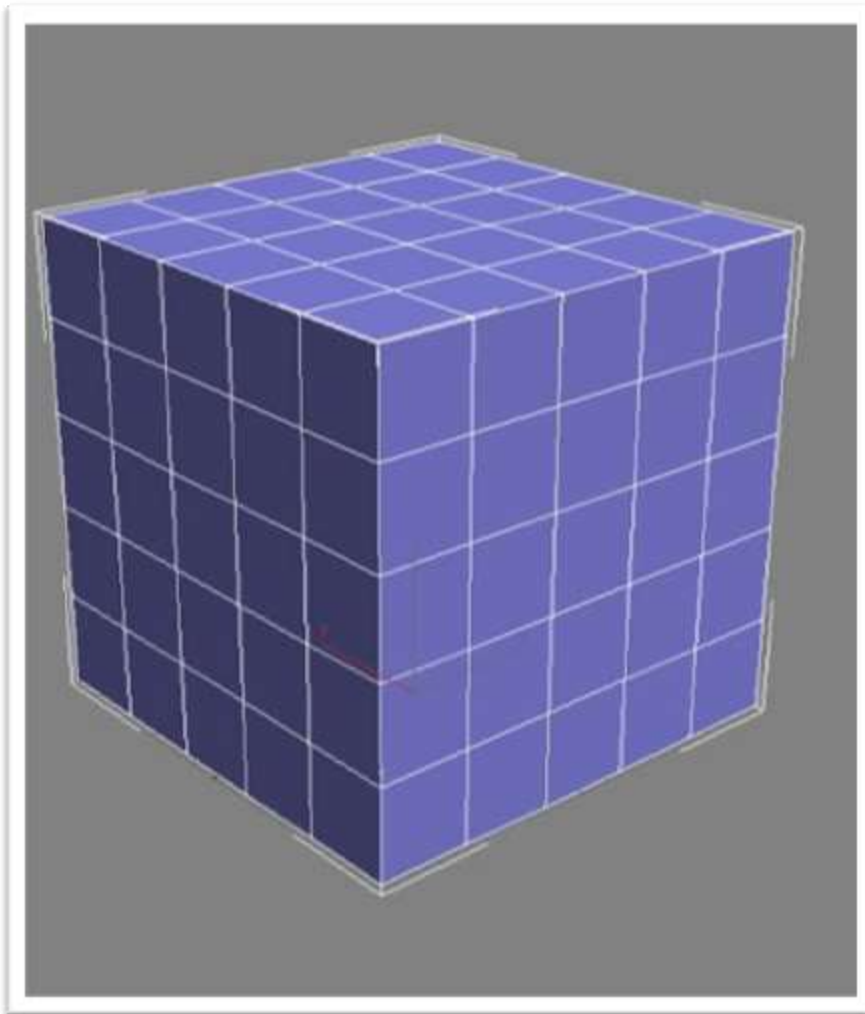
Parametric transformation (bend)



Parametric transformation (twist)



Parametric transformation (compress)



What are we looking (c)at?



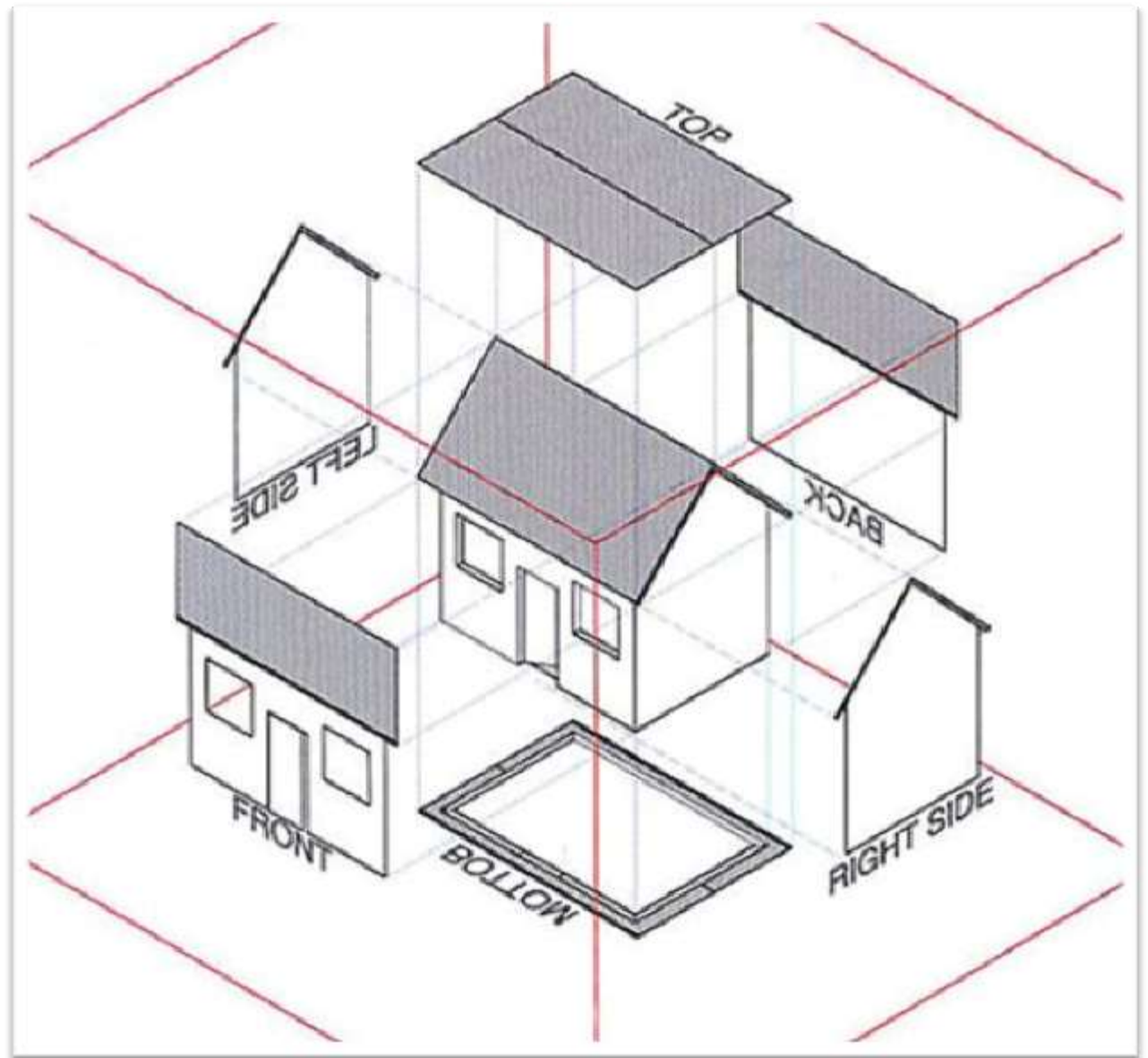
orthographic projection

Quick way of
understanding
shapes

Can be used for
measurements

Is not susceptible
to distortion

Can perceive
whole 3d objects



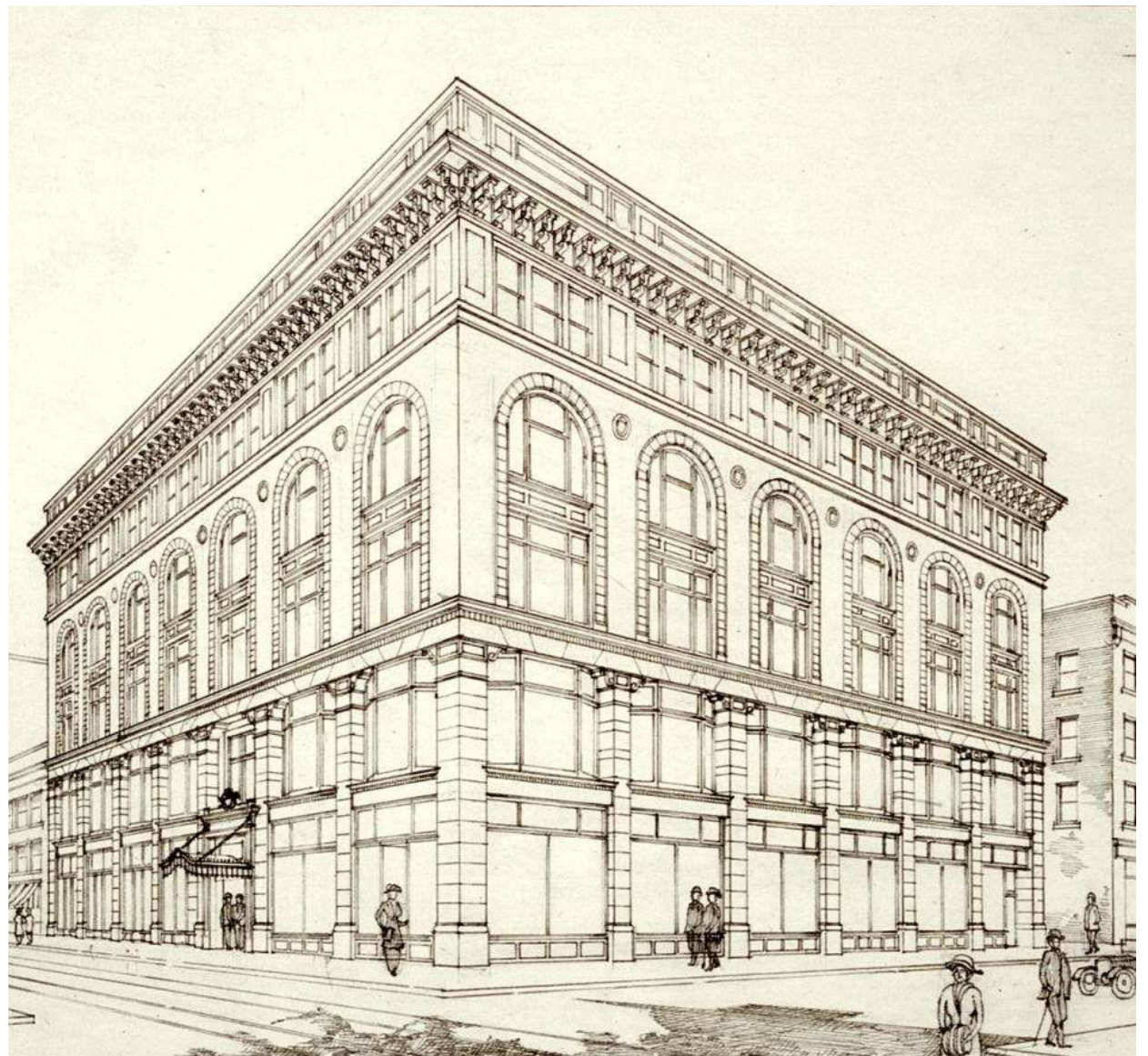
perspective projection

Simulation of
human vision

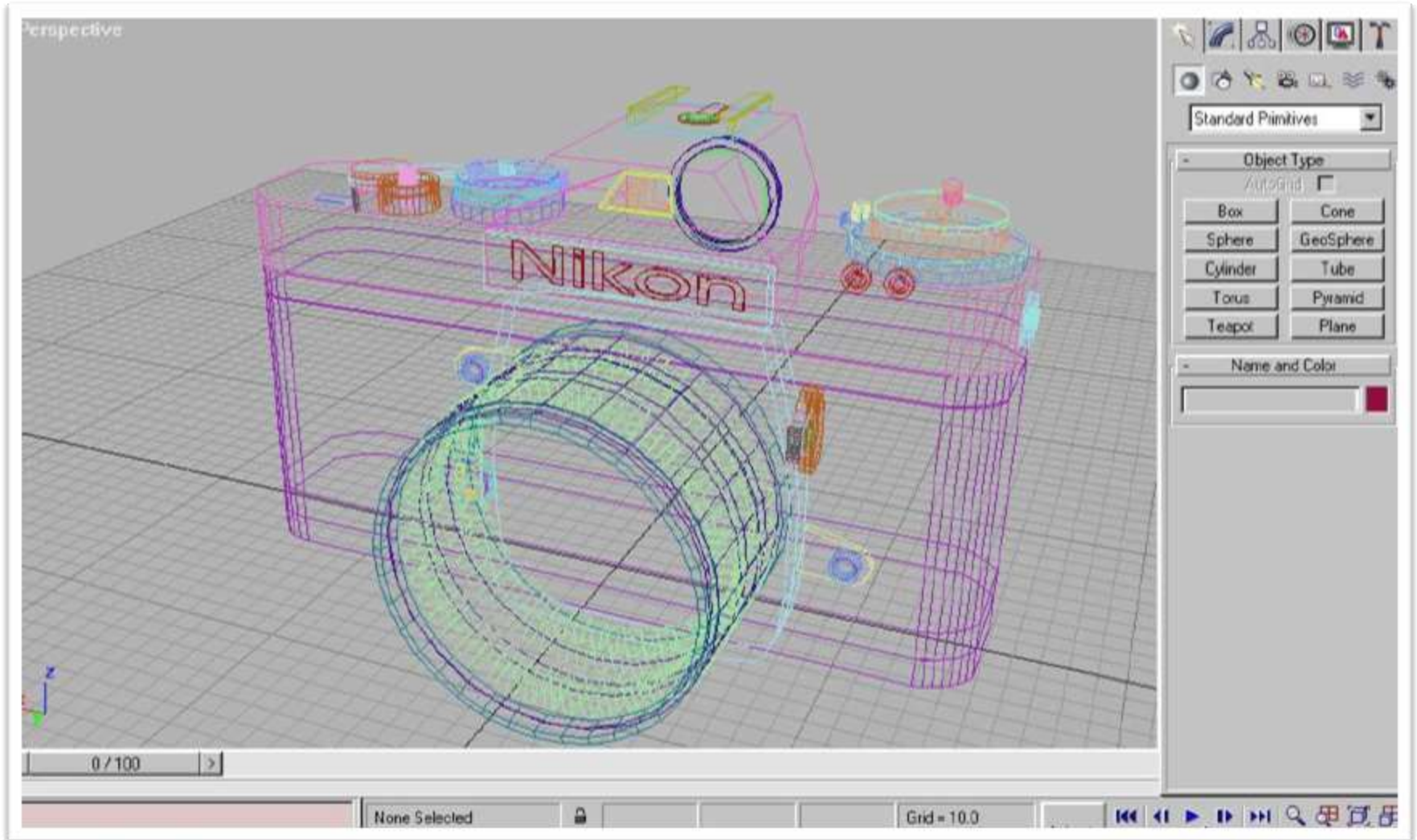
Cannot be used for
measurements

Is susceptible to
distortion

Can relate to
human perception



camera



lens

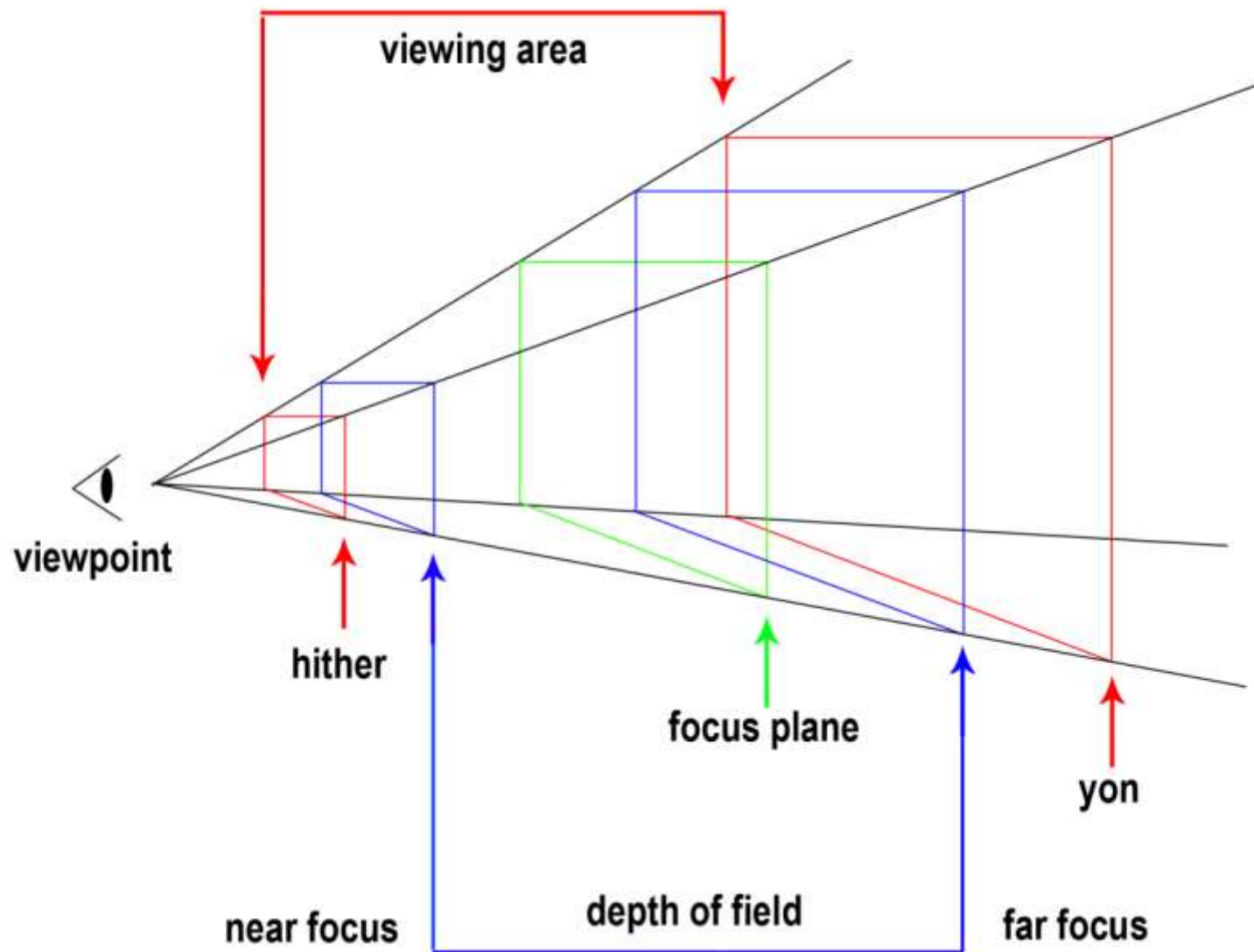


24mm, 35mm and 85mm

lens



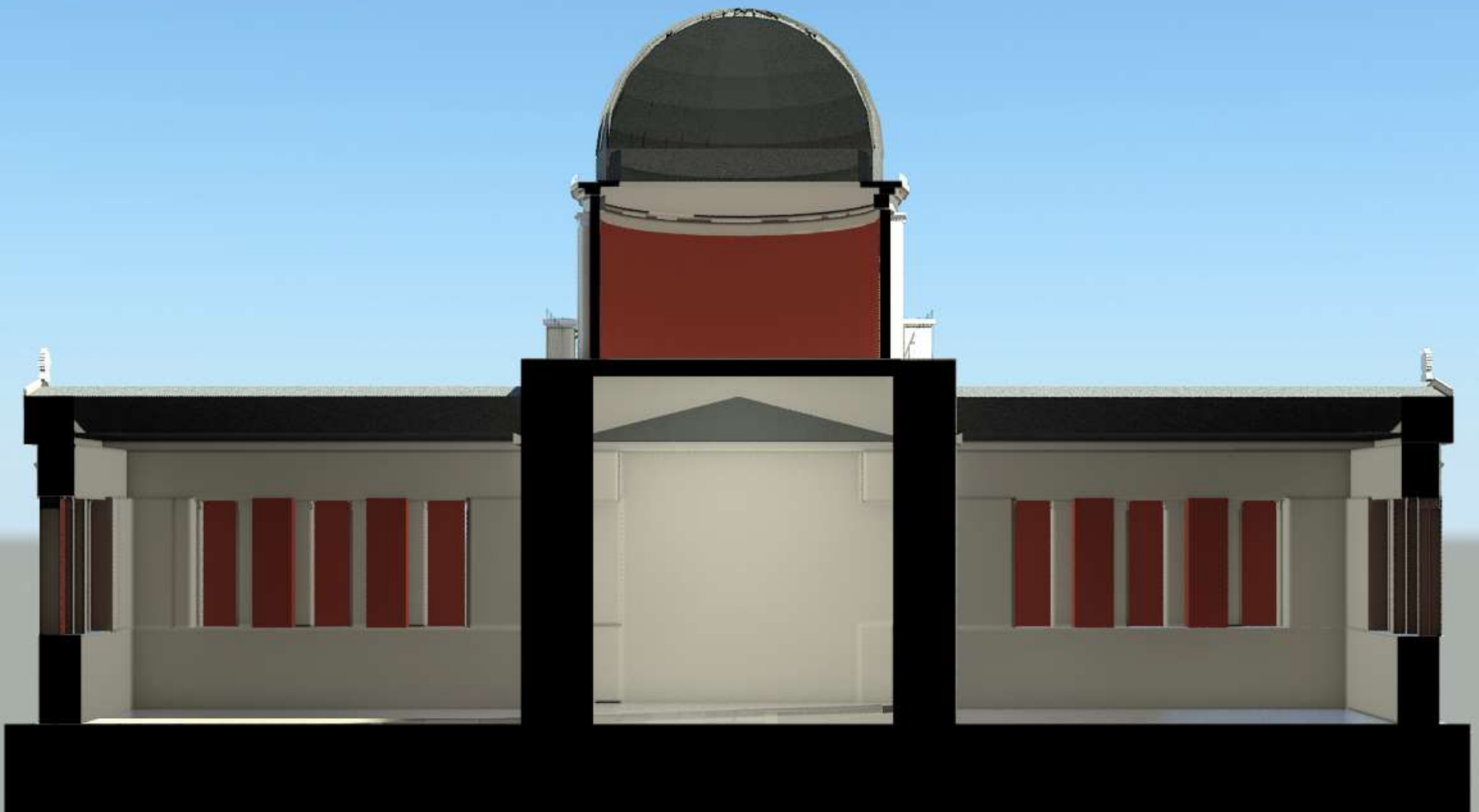
cone of vision



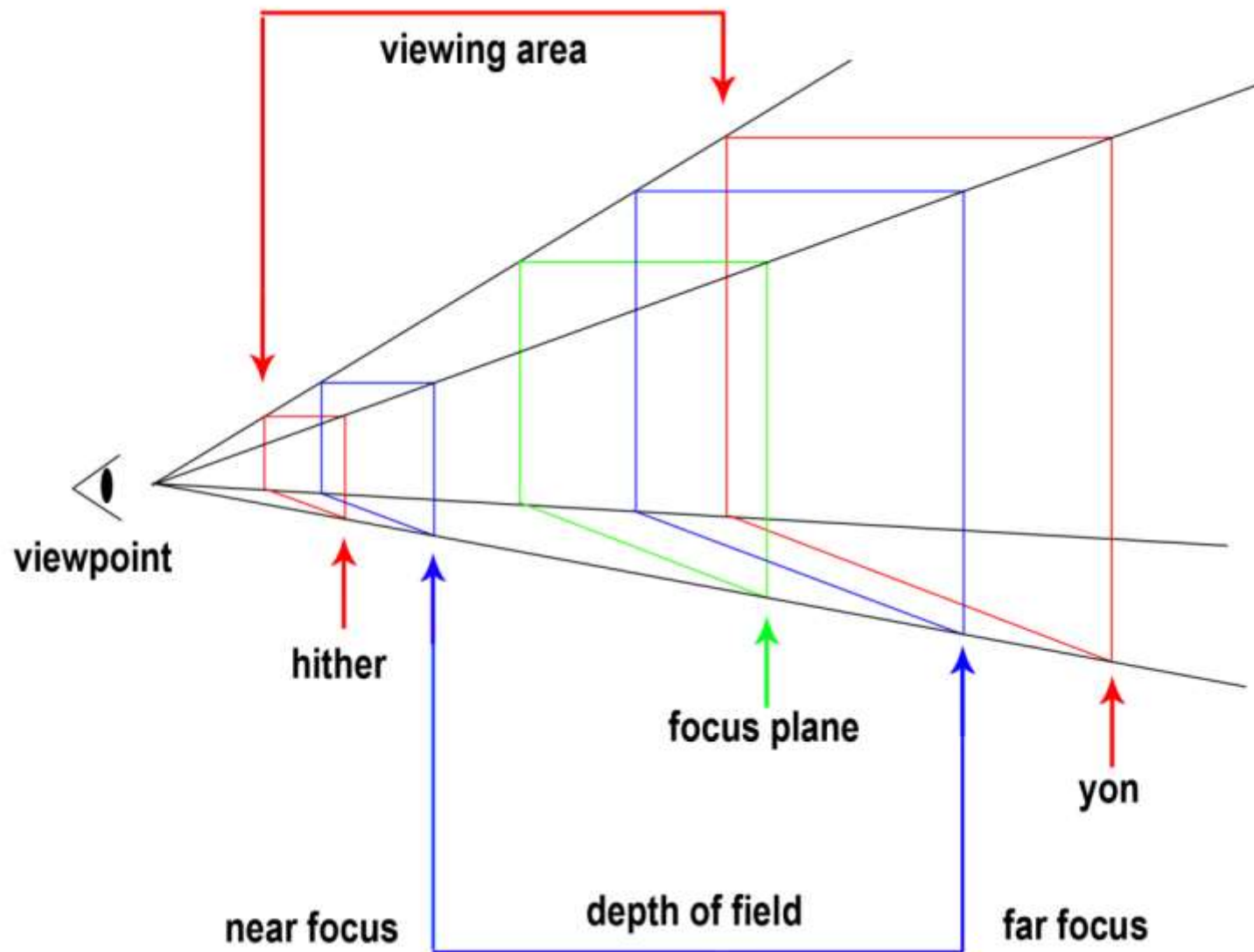
hither



hither



cone of vision



depth of field

Far focus



Near focus



exposure

F STOP 2.8



F STOP 5.6



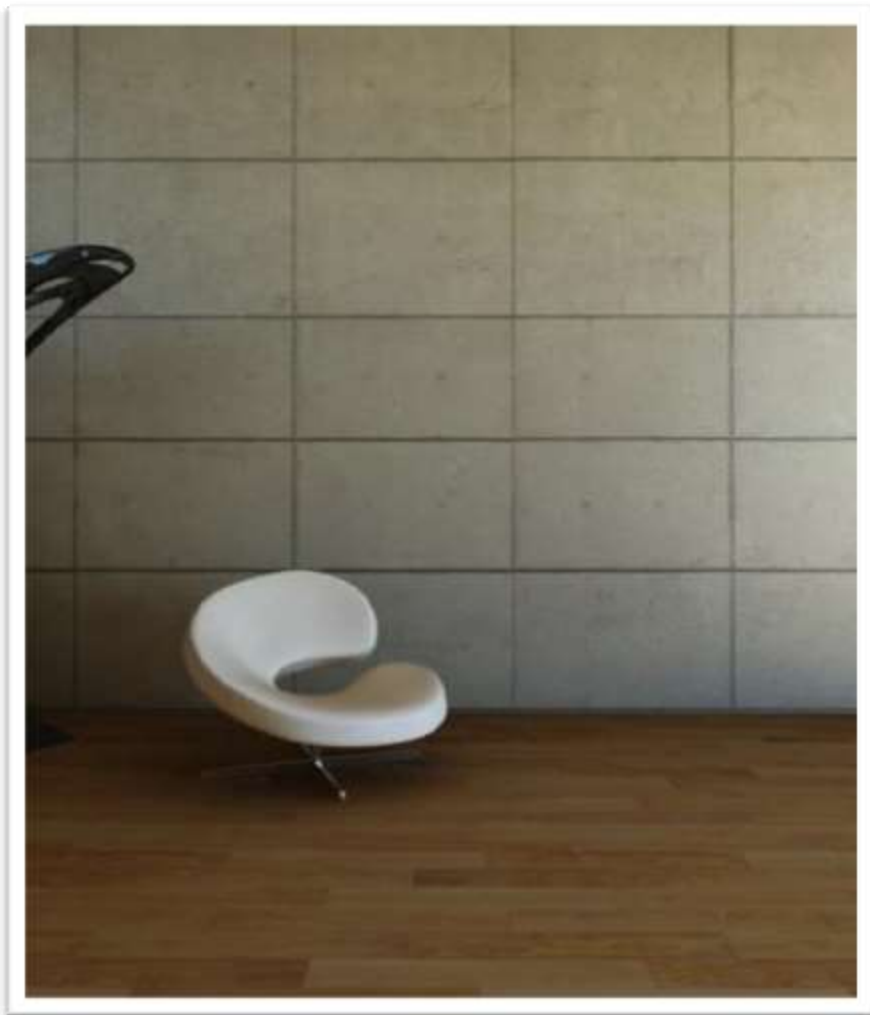
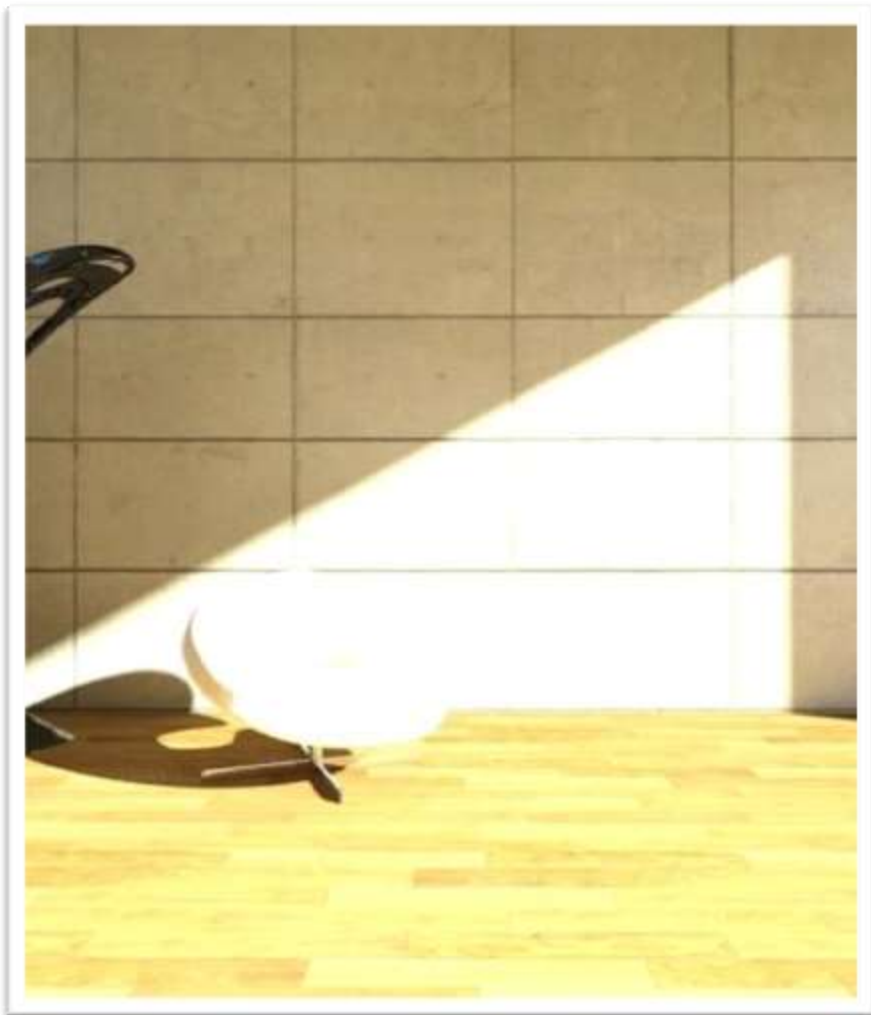
qualities of light



intensity



smoothness



colour



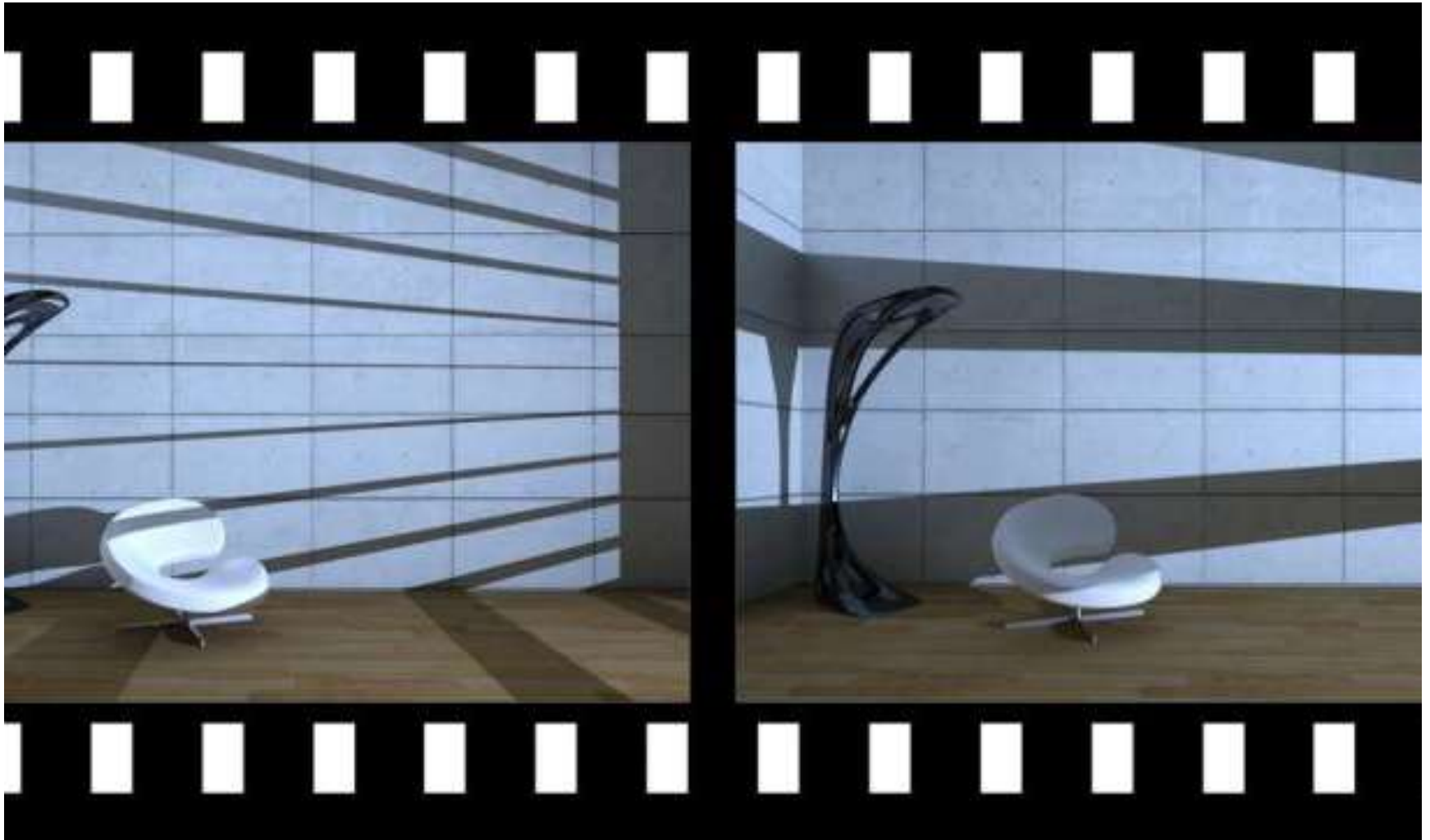
projection



projection



movement



BREAK!

sources of light



directional

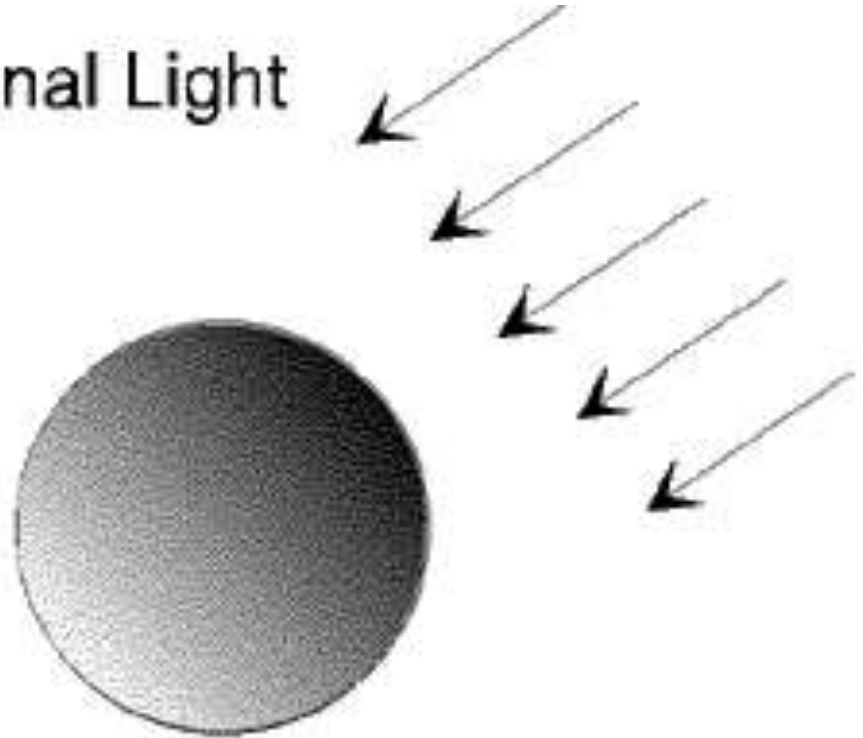
Targeted light
source

Simulation of the
Sun rays

Even distribution

Predictable
shadows

Directional Light



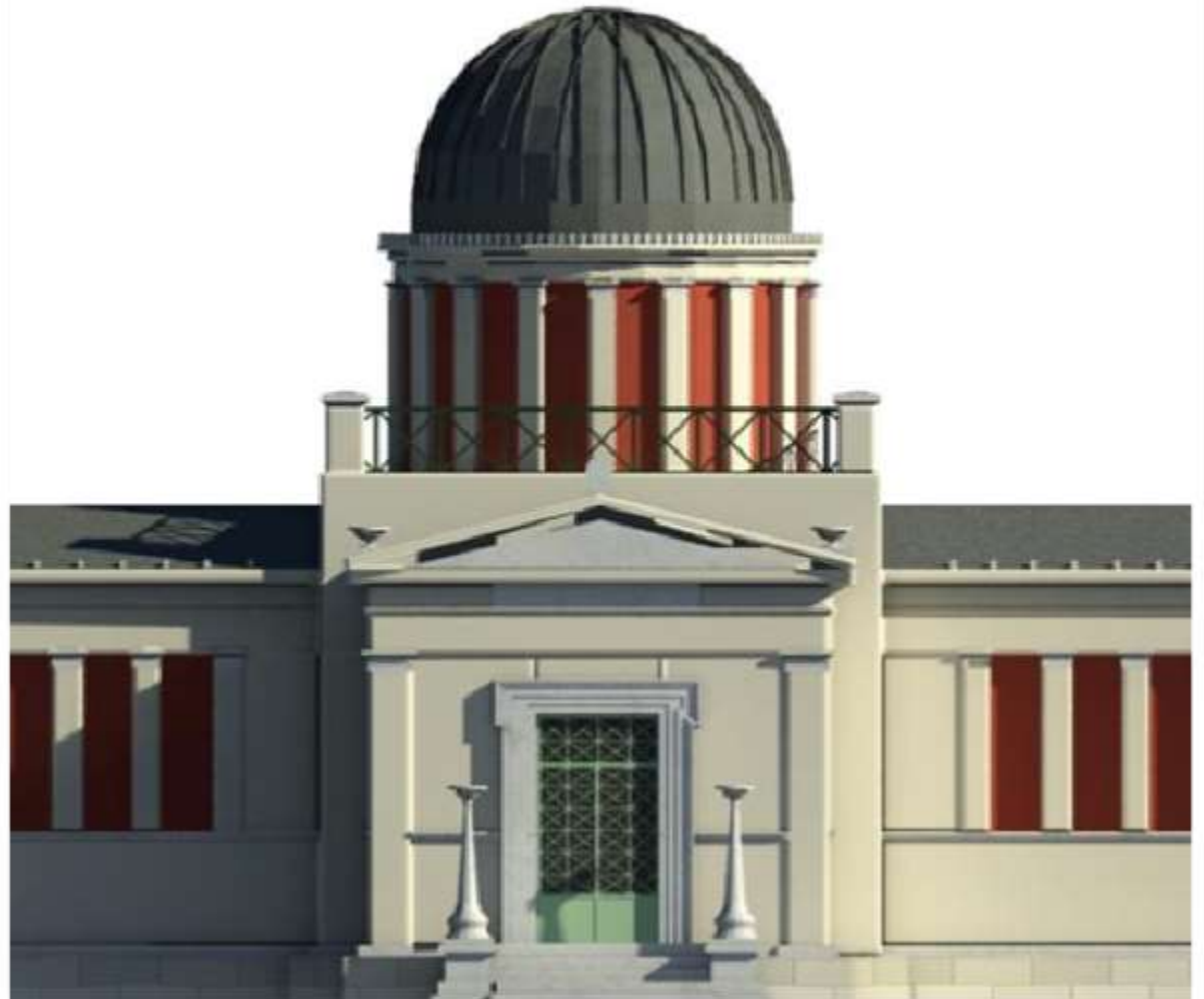
directional

Targeted light
source

Simulation of the
Sun rays

Even distribution

Predictable
shadows



omnidirectional

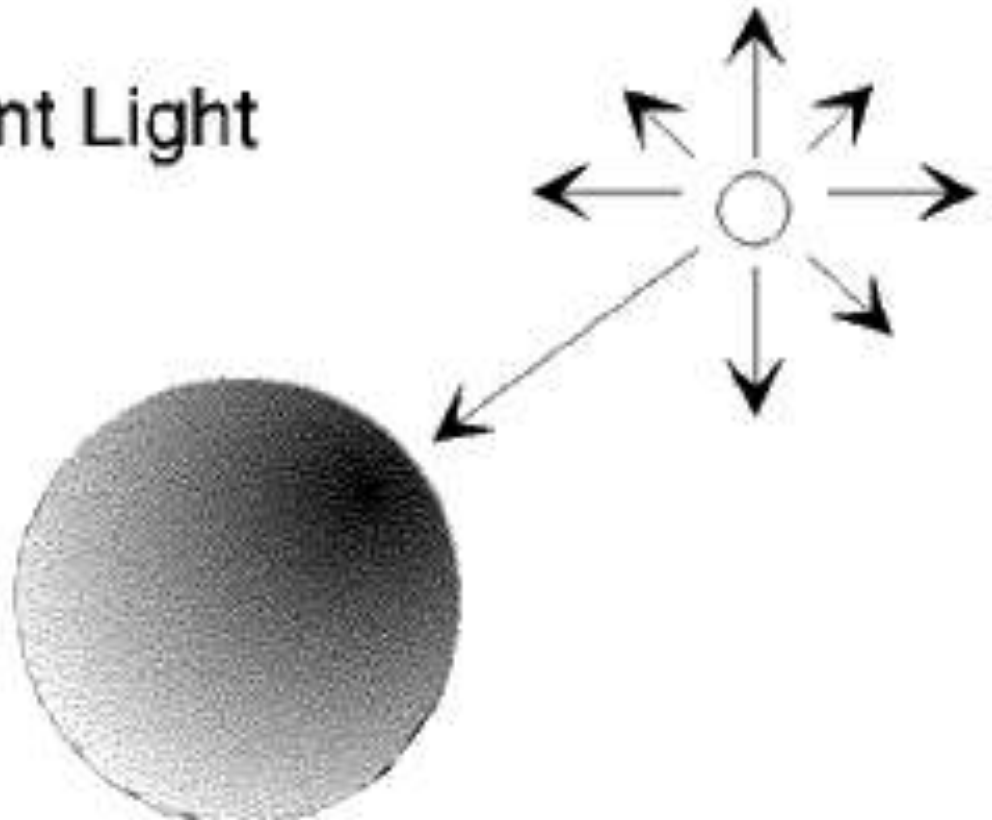
Non targeted light
source

Simulation of the
“light bulb”

Even distribution

Predictable
shadows

Point Light



omnidirectional

Non targeted light source

Simulation of the “light bulb”

Even distribution

Predictable shadows



spotlight

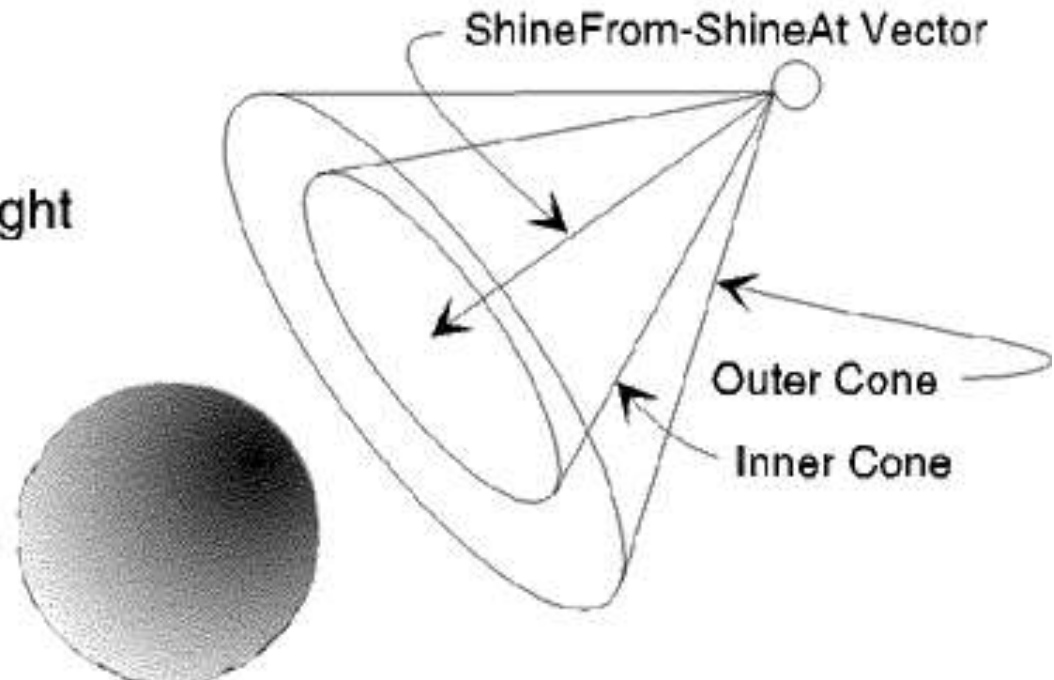
Targeted light source

More control

Distance falloff and beam falloff

Unpredictable shadows

Spot Light



spotlight

Targeted light
source

More control

Distance falloff and
beam falloff

Unpredictable
shadows

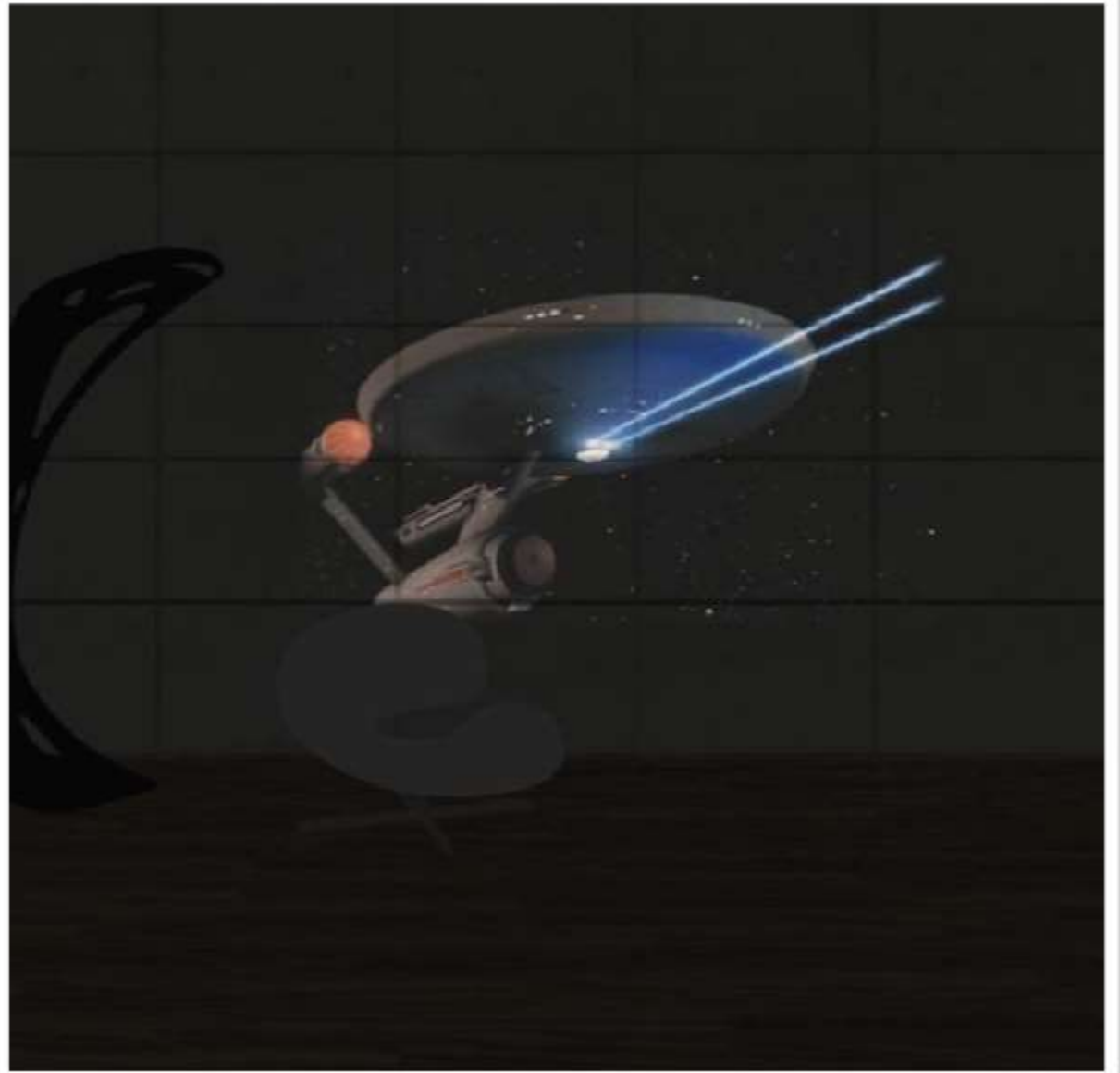


projector

Targeted light
source

Ability to project
images

Spotlight
characteristics and
controls



linear

Non targeted light
source

Uniform intensity
across length

Very high
computational
needs



area

Targeted light
source

Uniform intensity
across area

High computational
needs



glowing object

Light emits three-dimensionally from object

Extreme computational needs

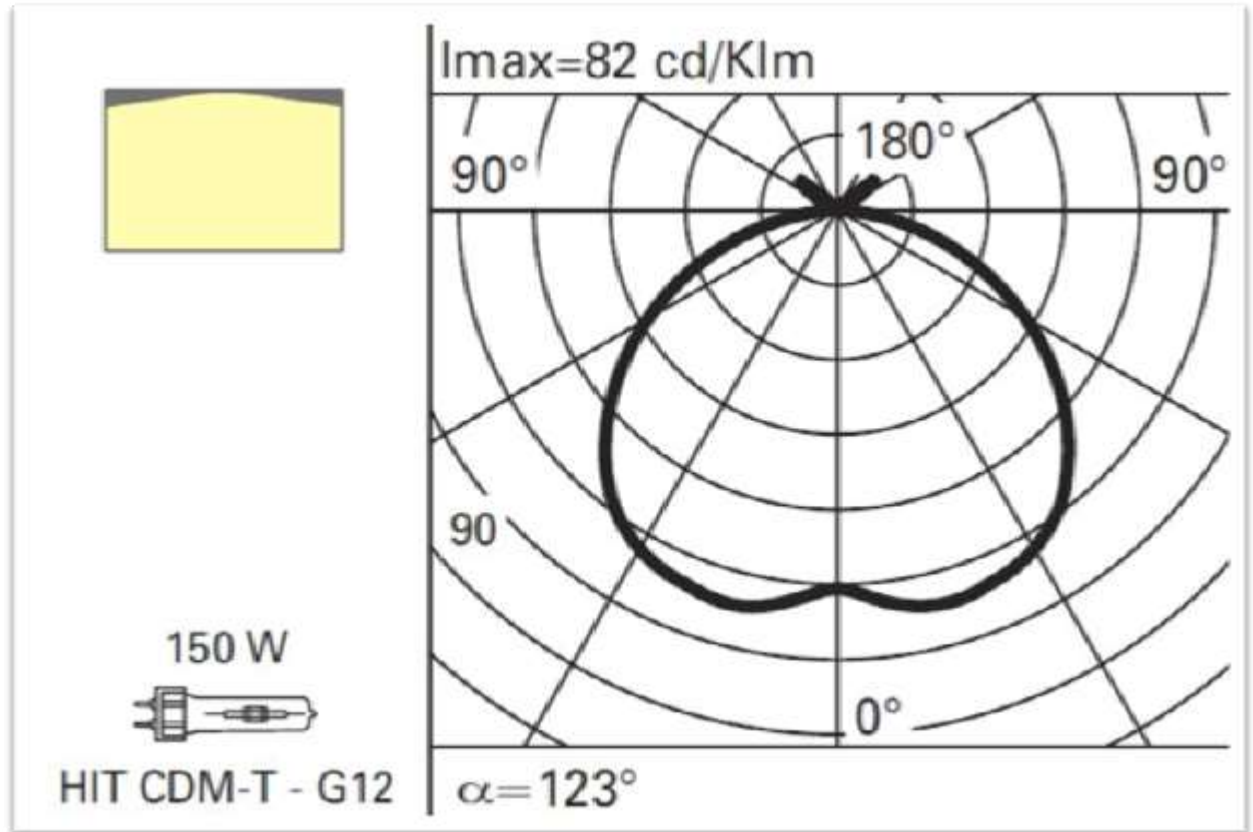


photometric

Accurate
simulation of light
sources and
distribution

Used for
measuring and
validation of
projects

Can simulate light
bulbs and light
fixtures



photometric

Accurate
simulation of light
sources and
distribution

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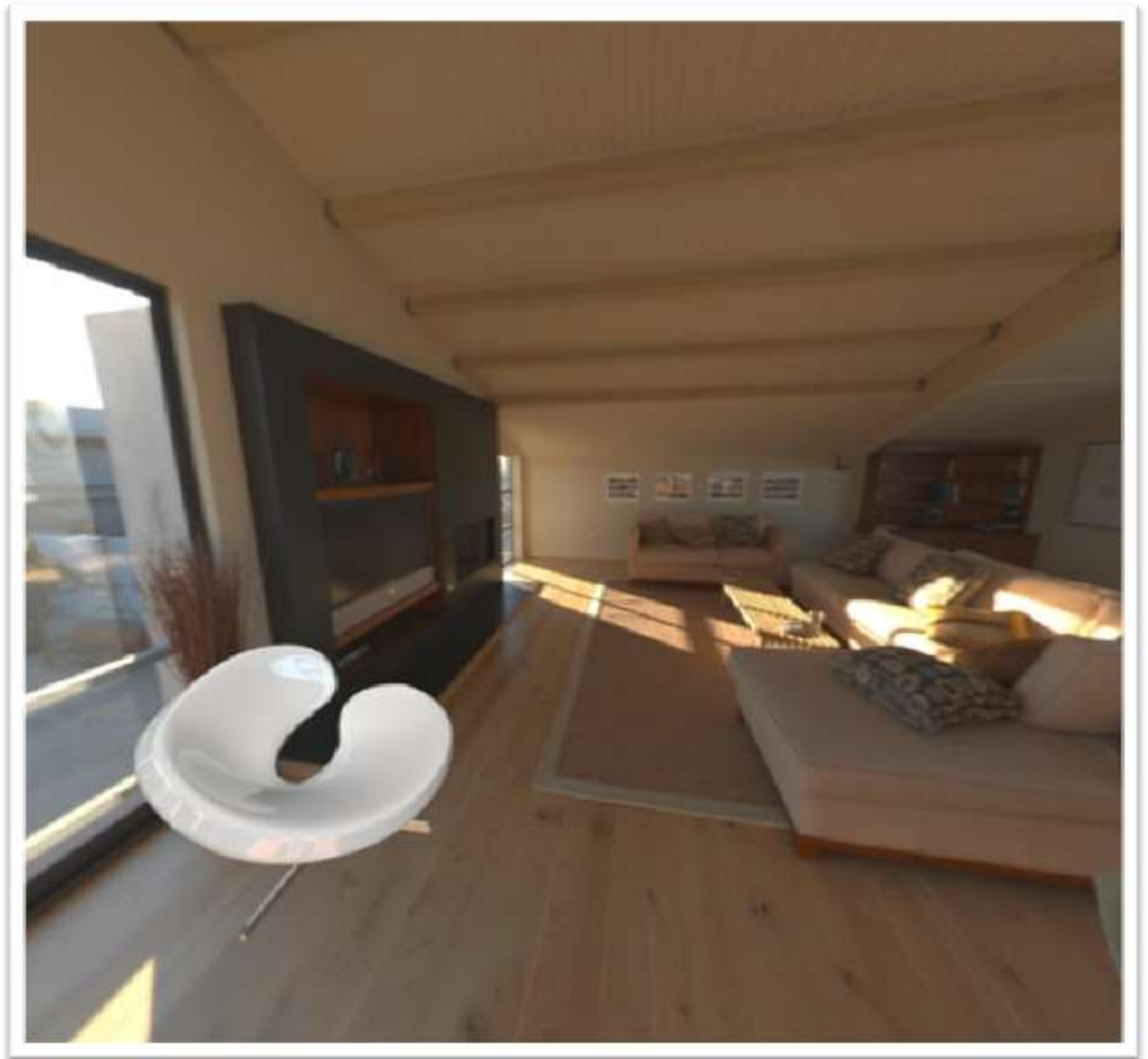
HDRI

(High Dynamic Range Image)

Replacement of the typical light source by an image

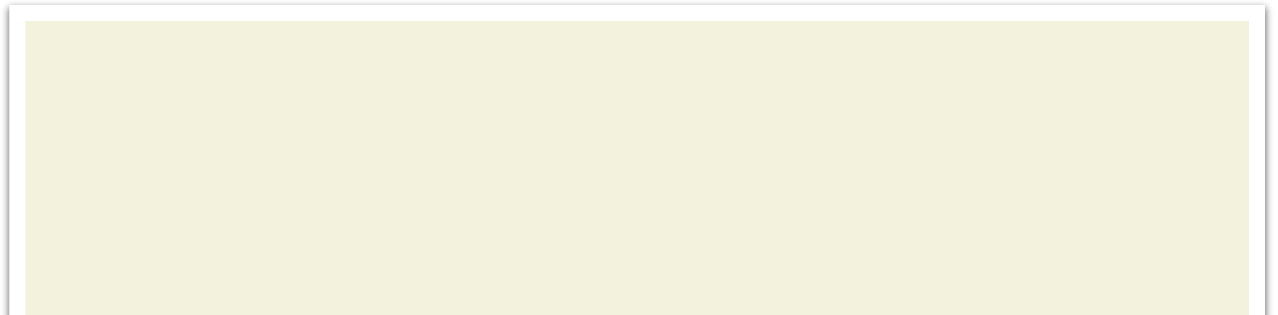
The image offers both information on light and on reflectance

32bit hdri compared to 8bit jpg means thousands of different white intensities!



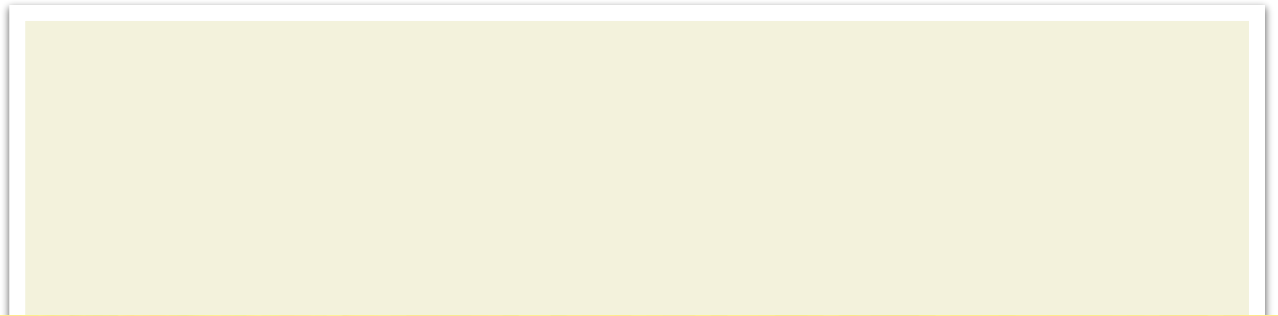
HDRI

(High Dynamic
Range Image)



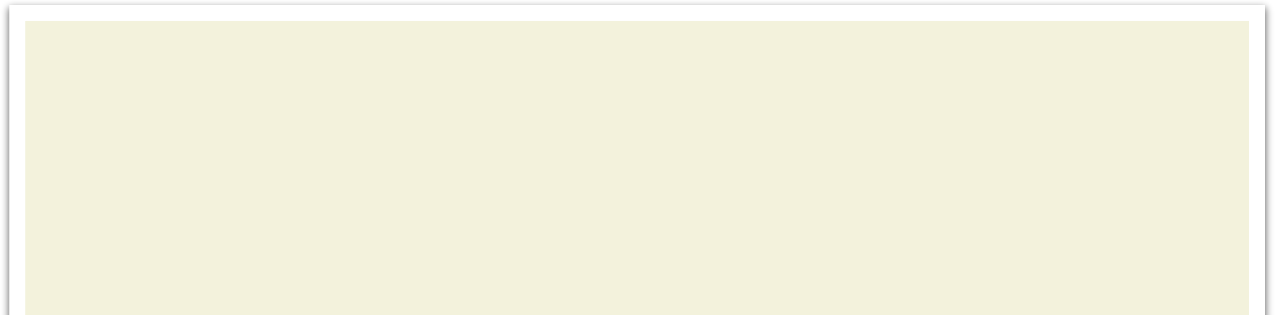
HDRI

(High Dynamic
Range Image)



HDRI

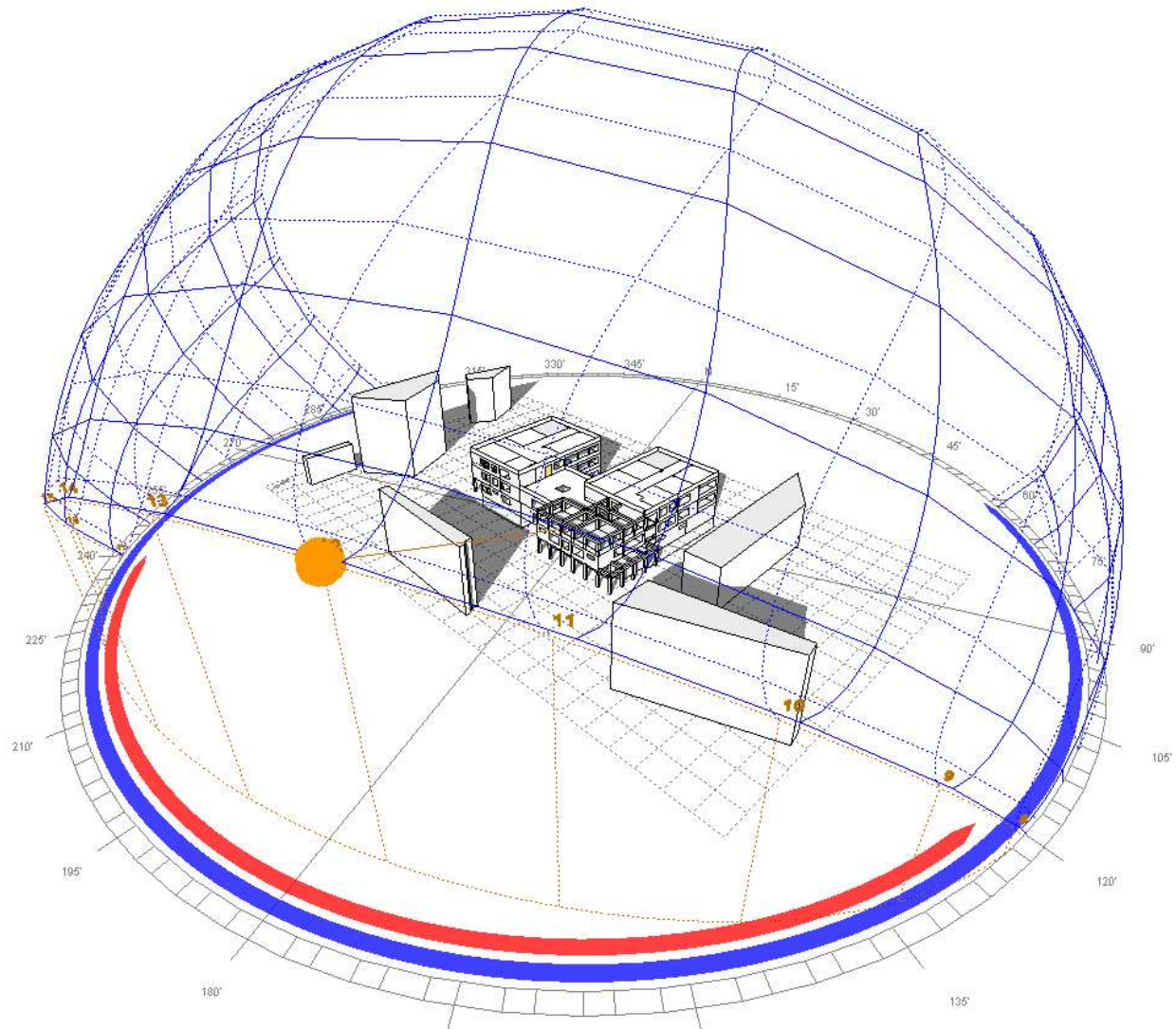
(High Dynamic
Range Image)



sunlight

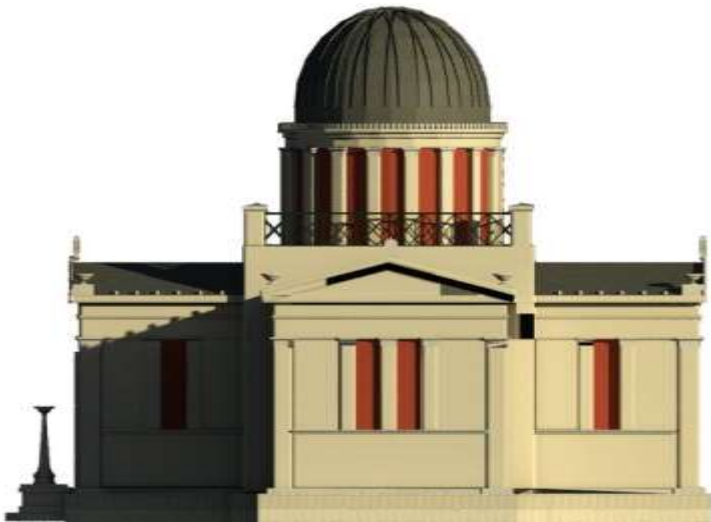


sunlight



location

Athens December 21 09:00

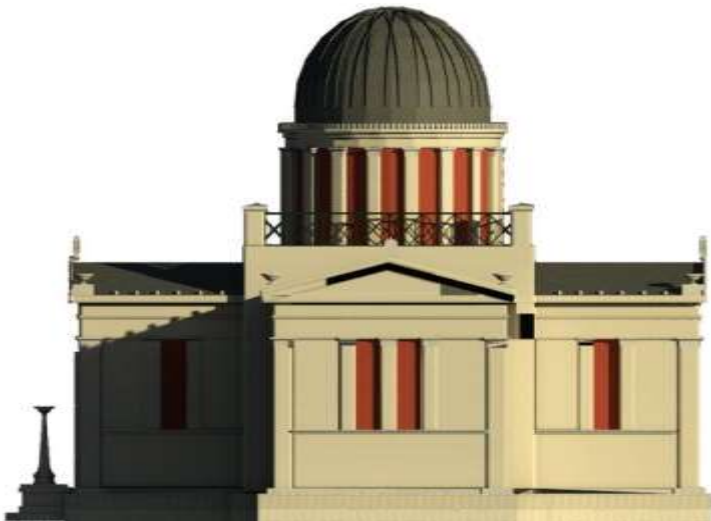


Wismar December 21 09:00

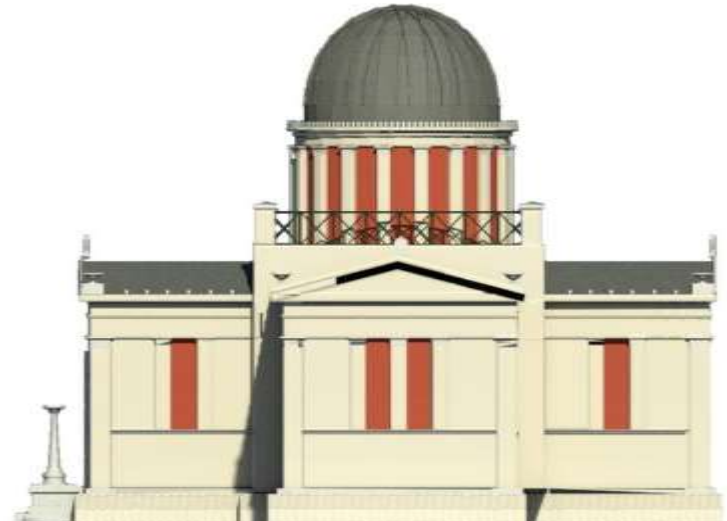


time of day

Athens December 21 09:00

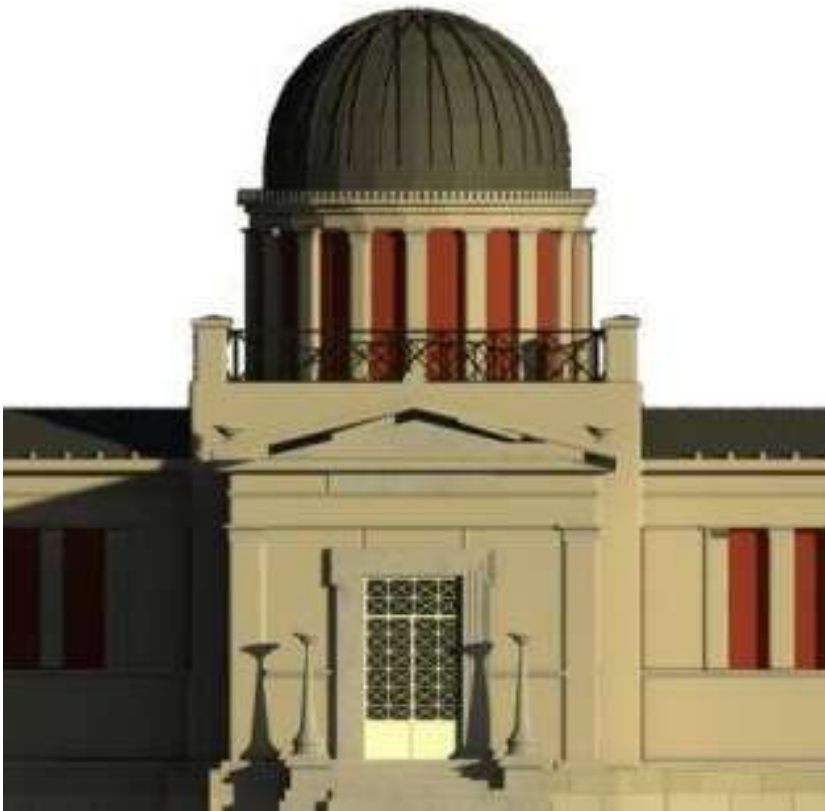


Athens December 21 13:00

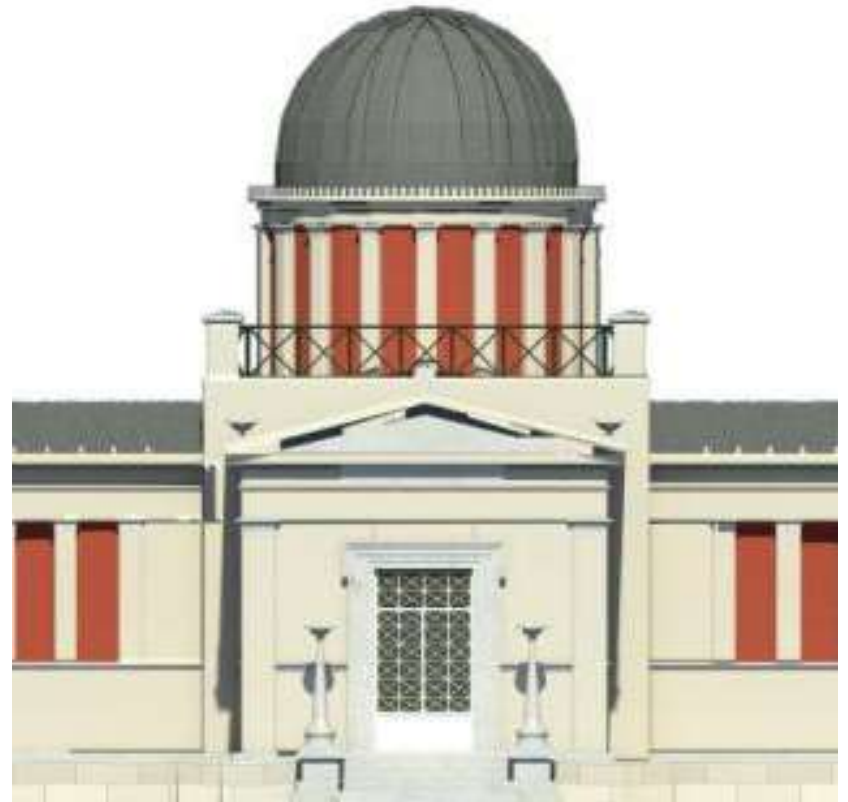


day of year

Athens December 21 17:00

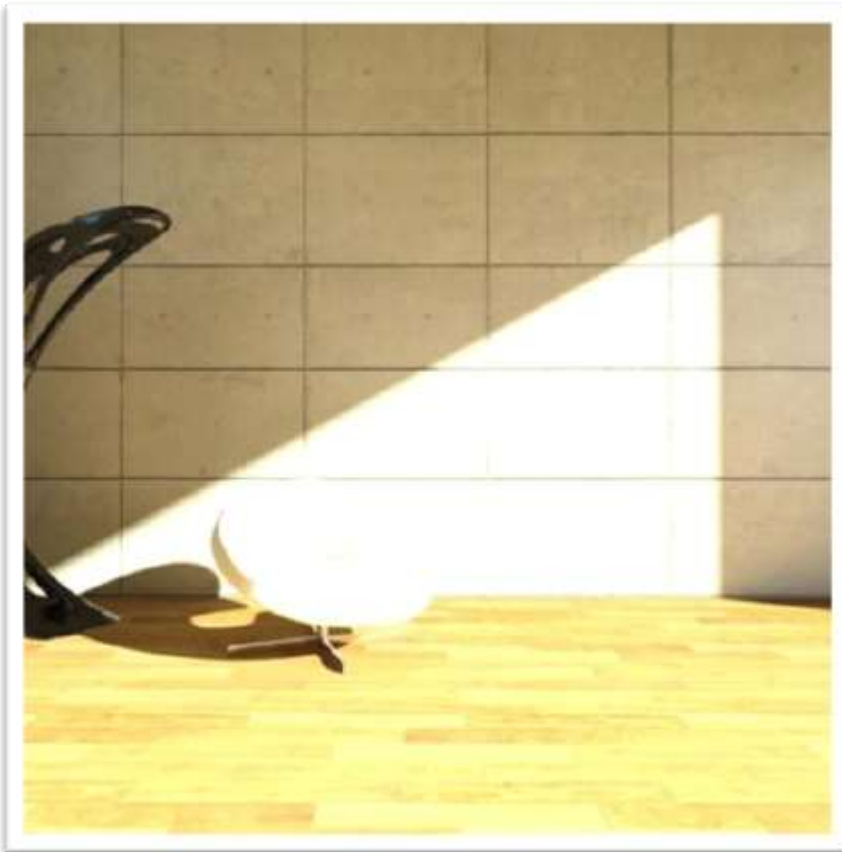


Athens June 21 17:00



interior effects

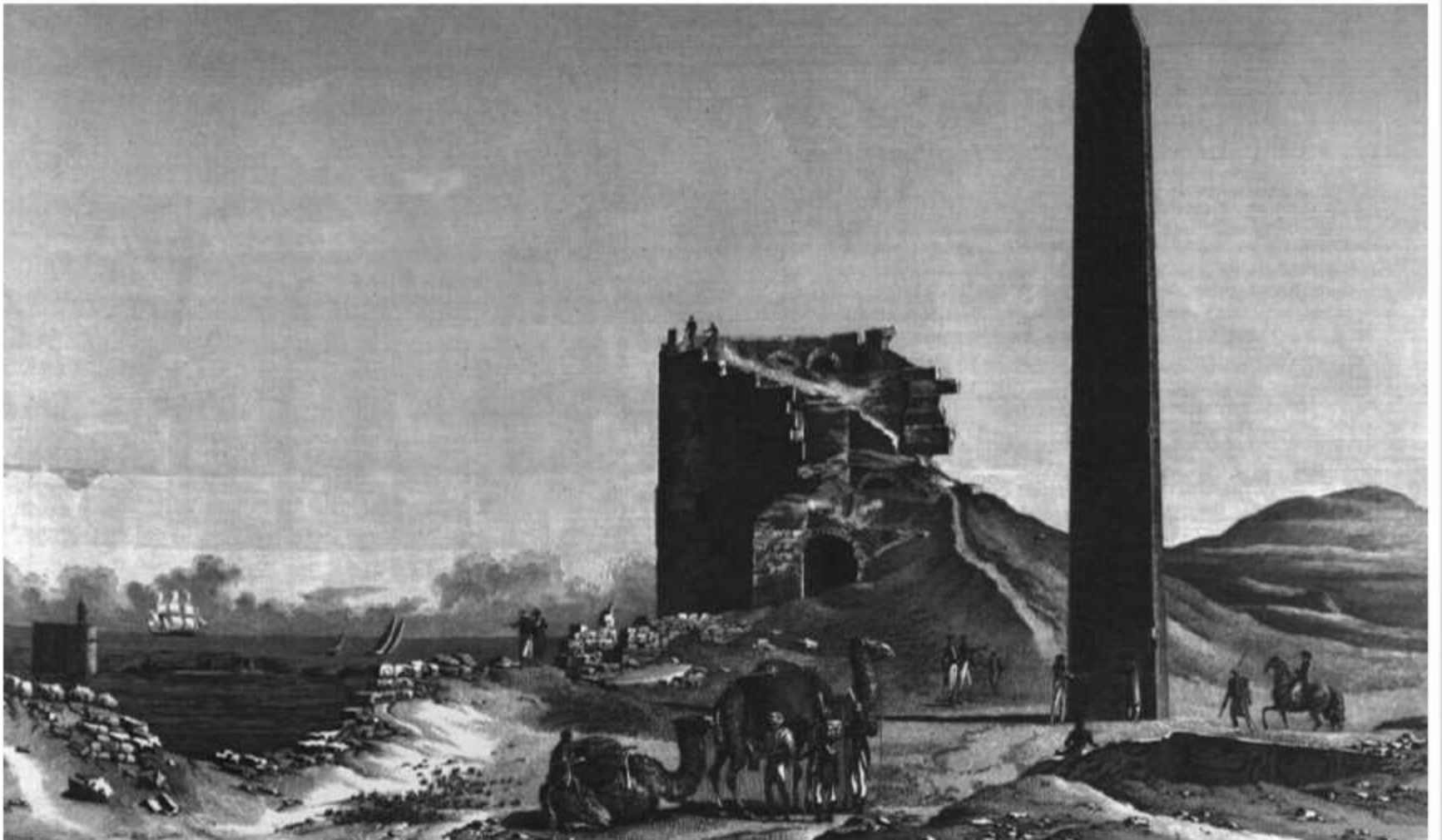
sunlight



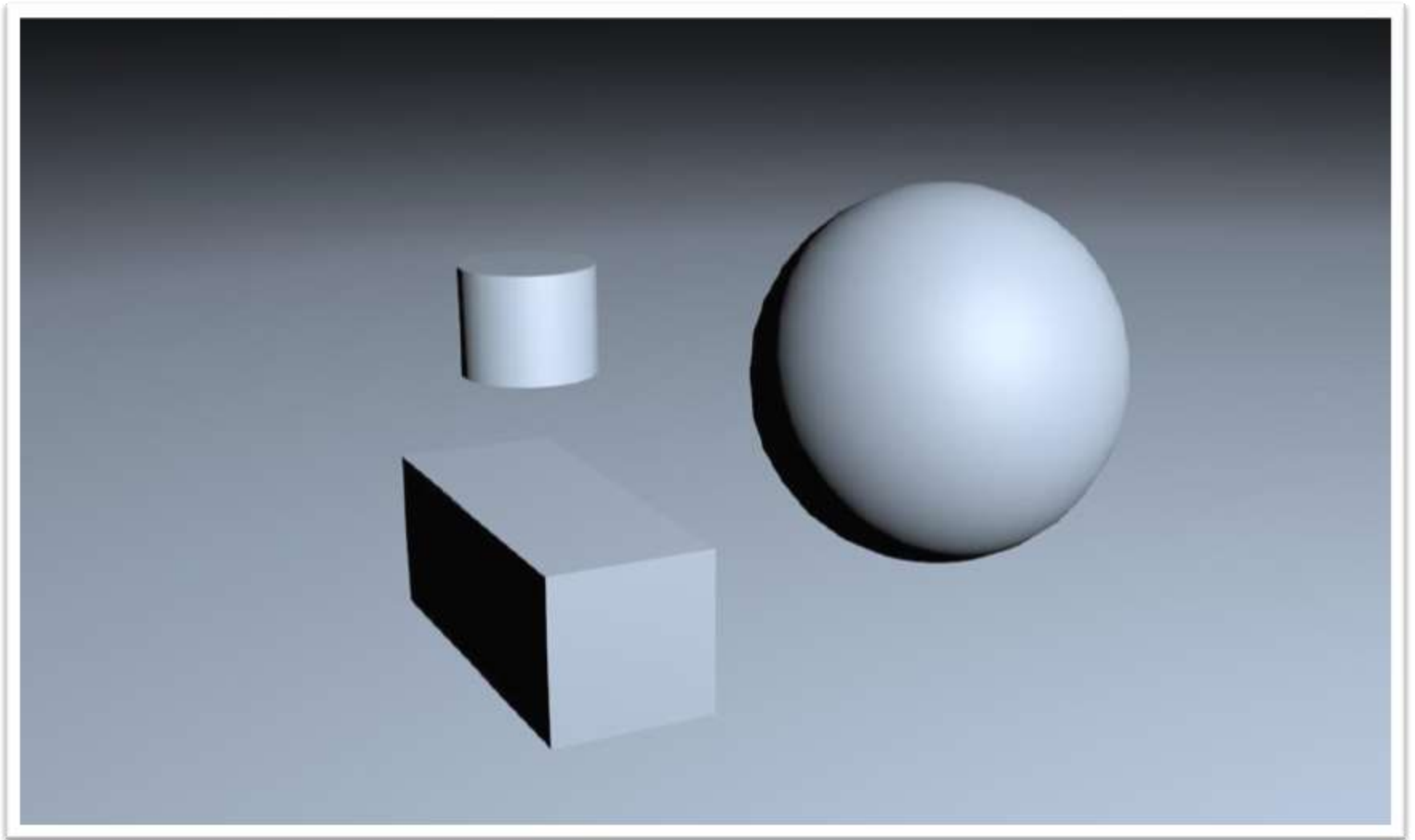
daylight



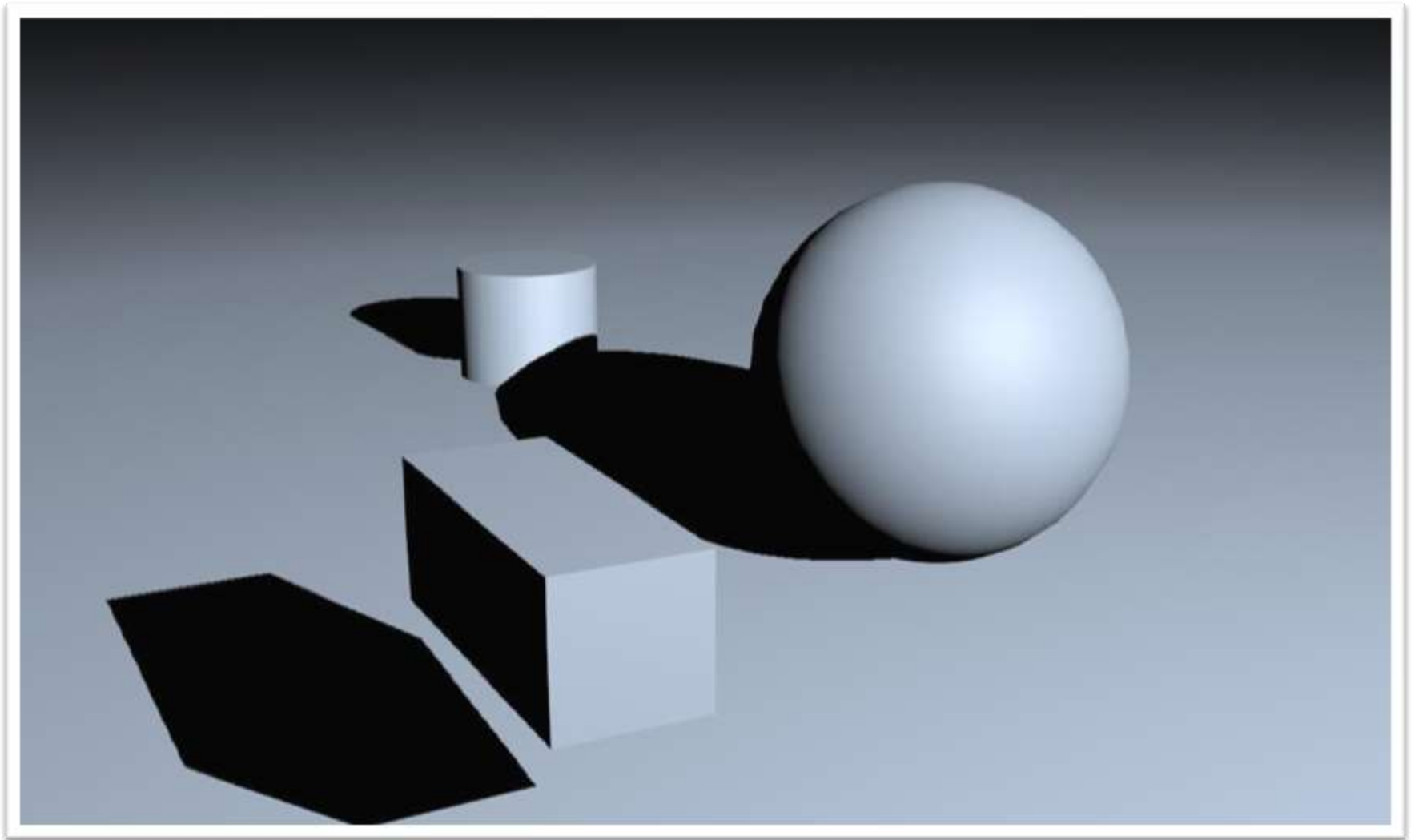
shadow



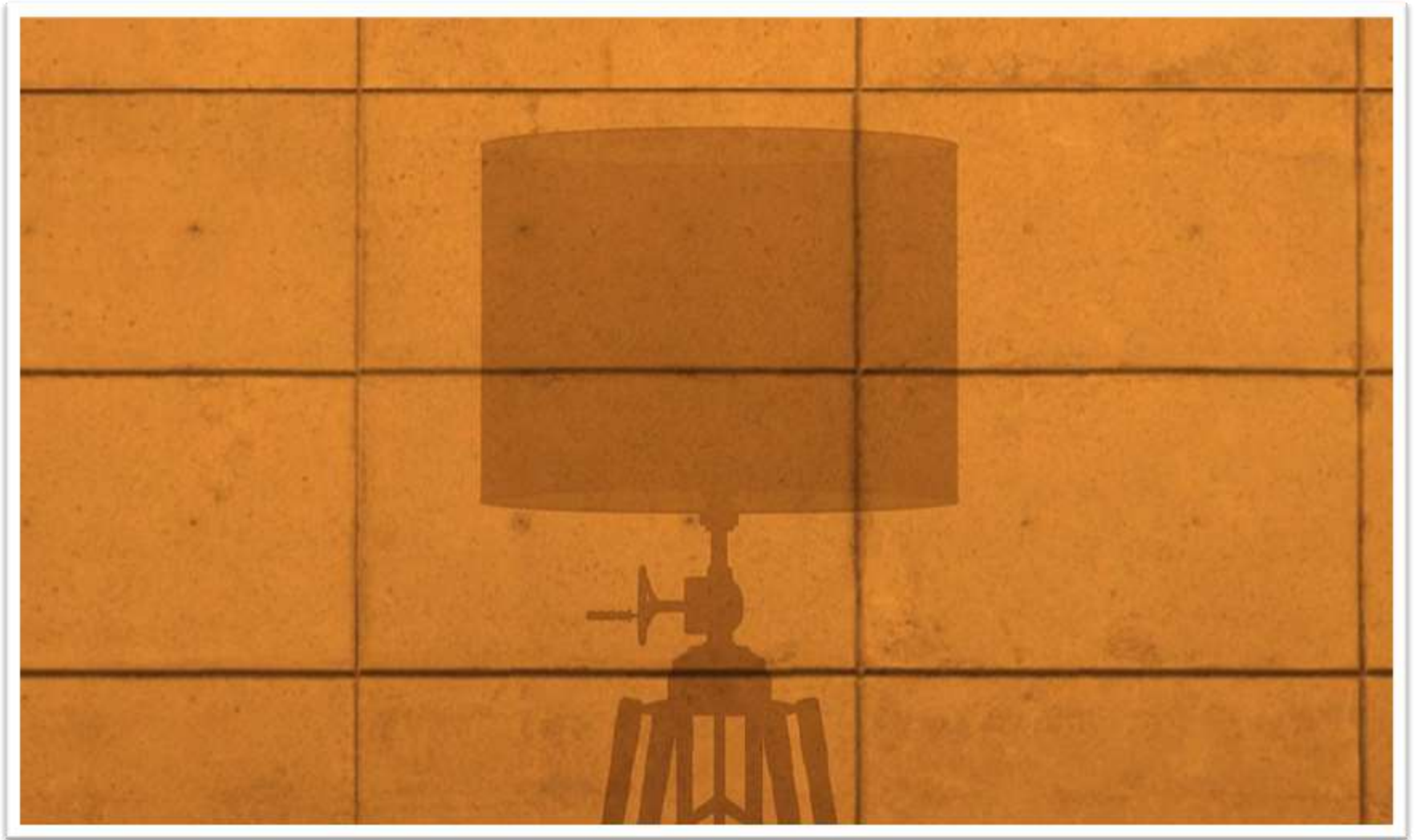
defines spatial relationships



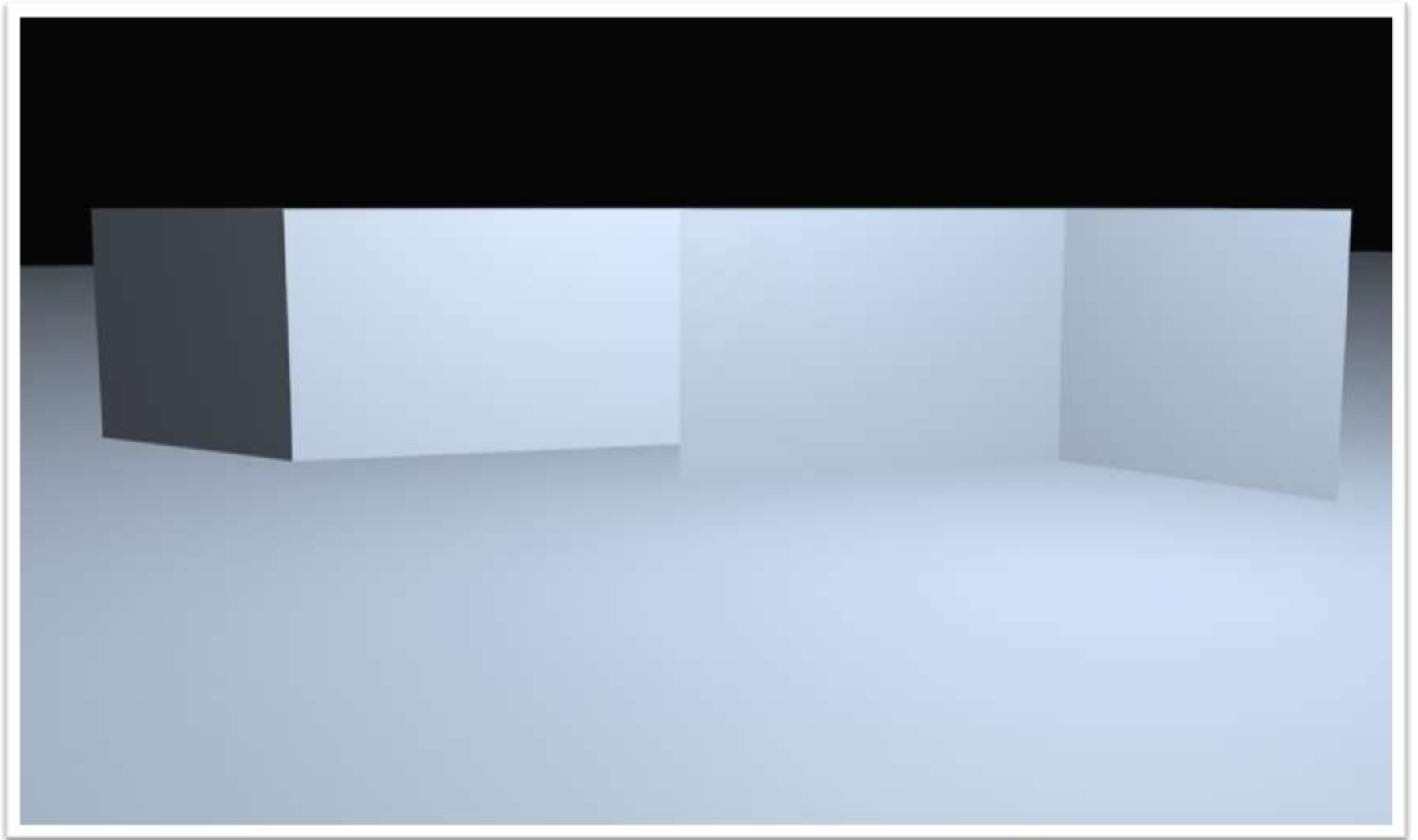
defines spatial relationships



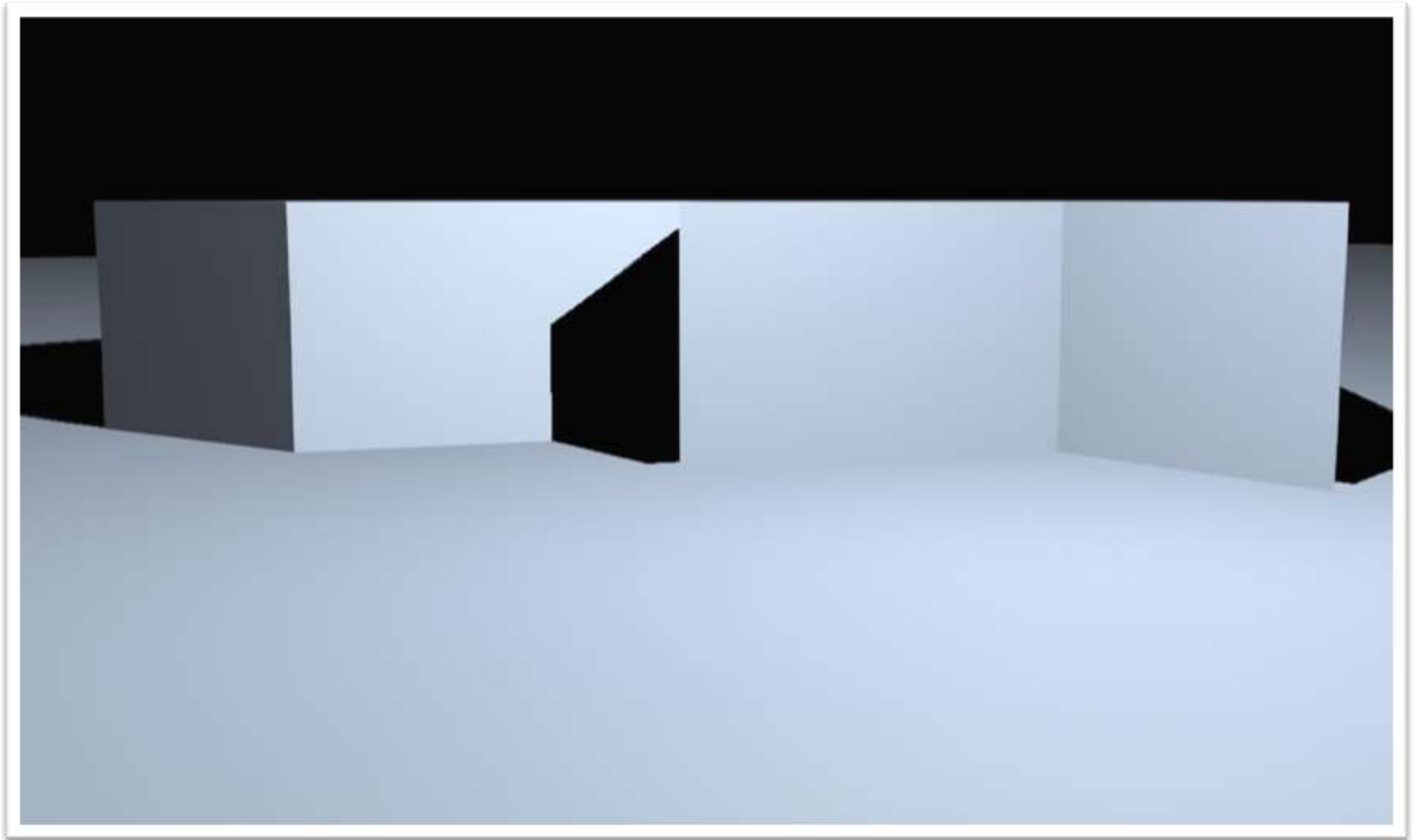
defines characteristics of shape



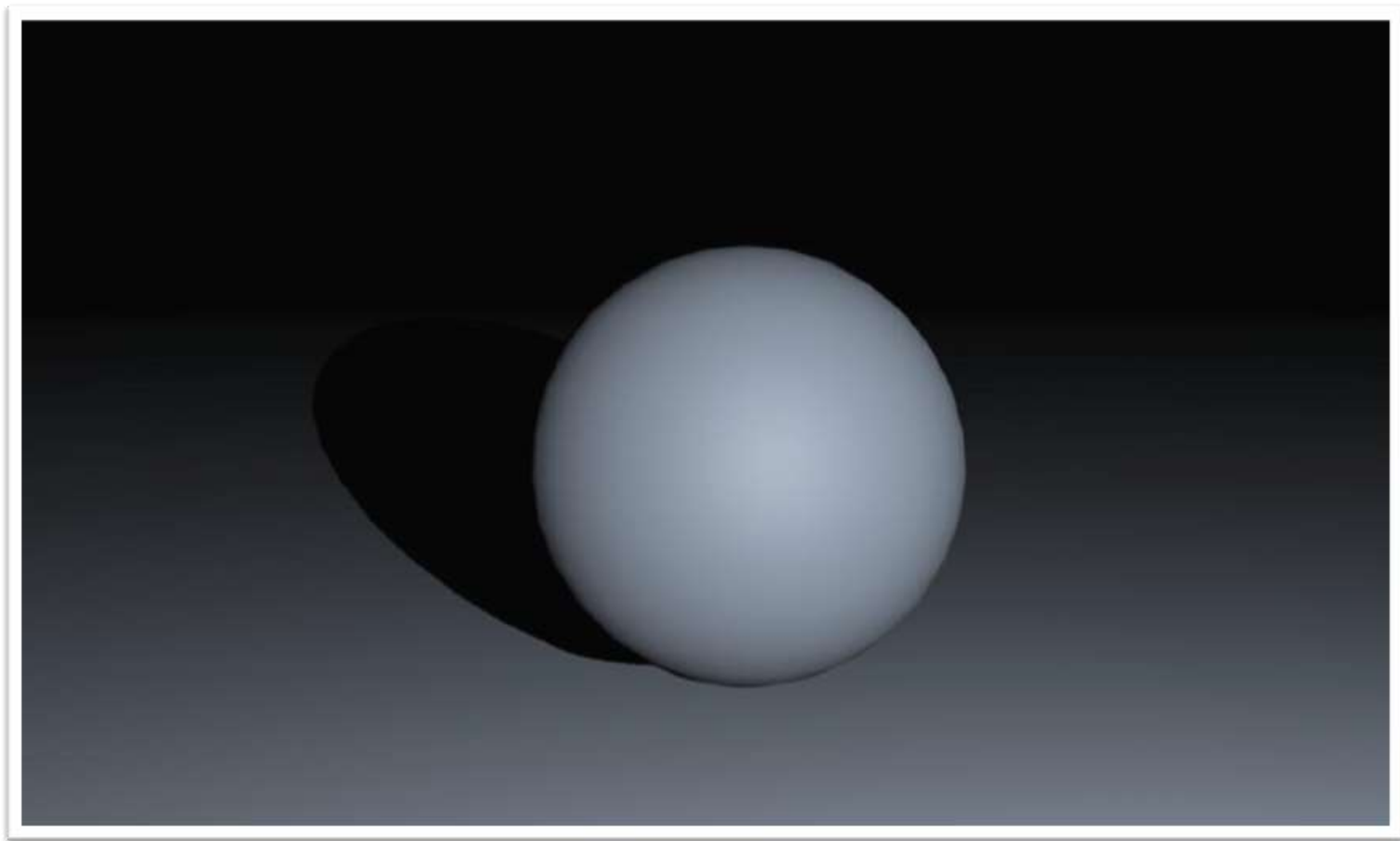
defines same colour objects



defines same colour objects



blends in with darkness



?-point lighting



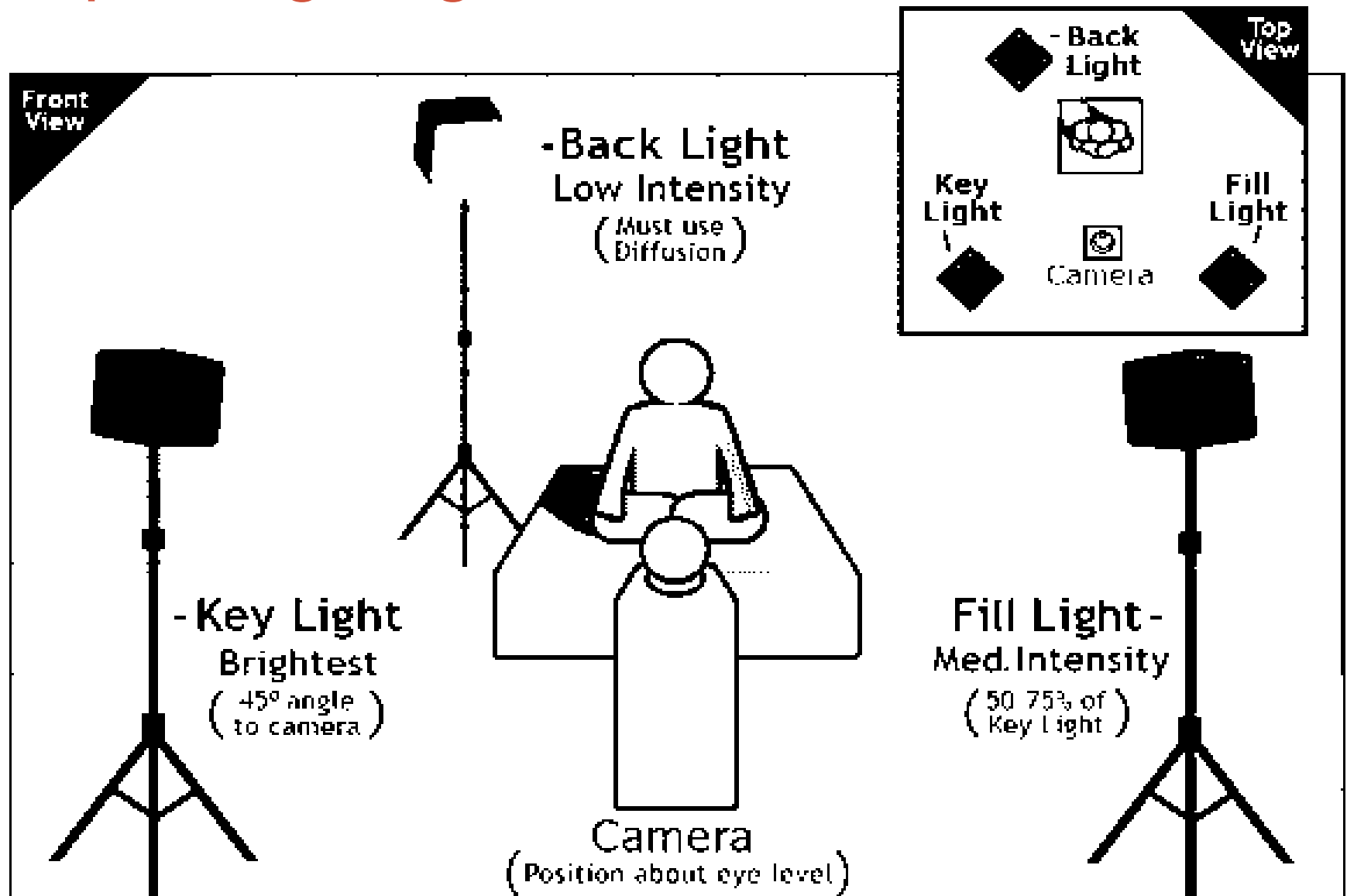
?-point lighting



?-point lighting



3-point lighting

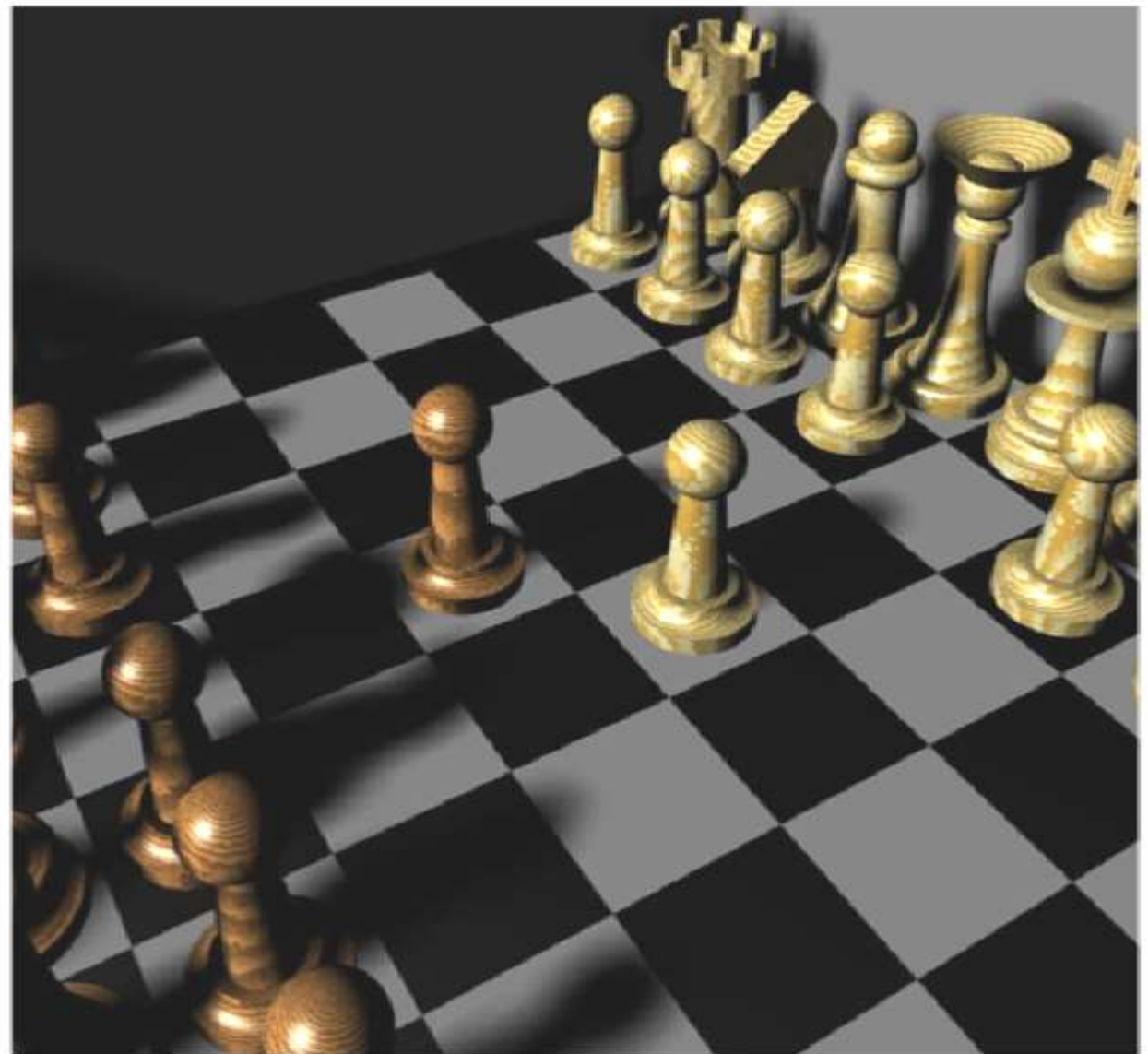


key light

Defines the position of the main lighting source

The most bright light source

Defines the colour and contrast of the shadows

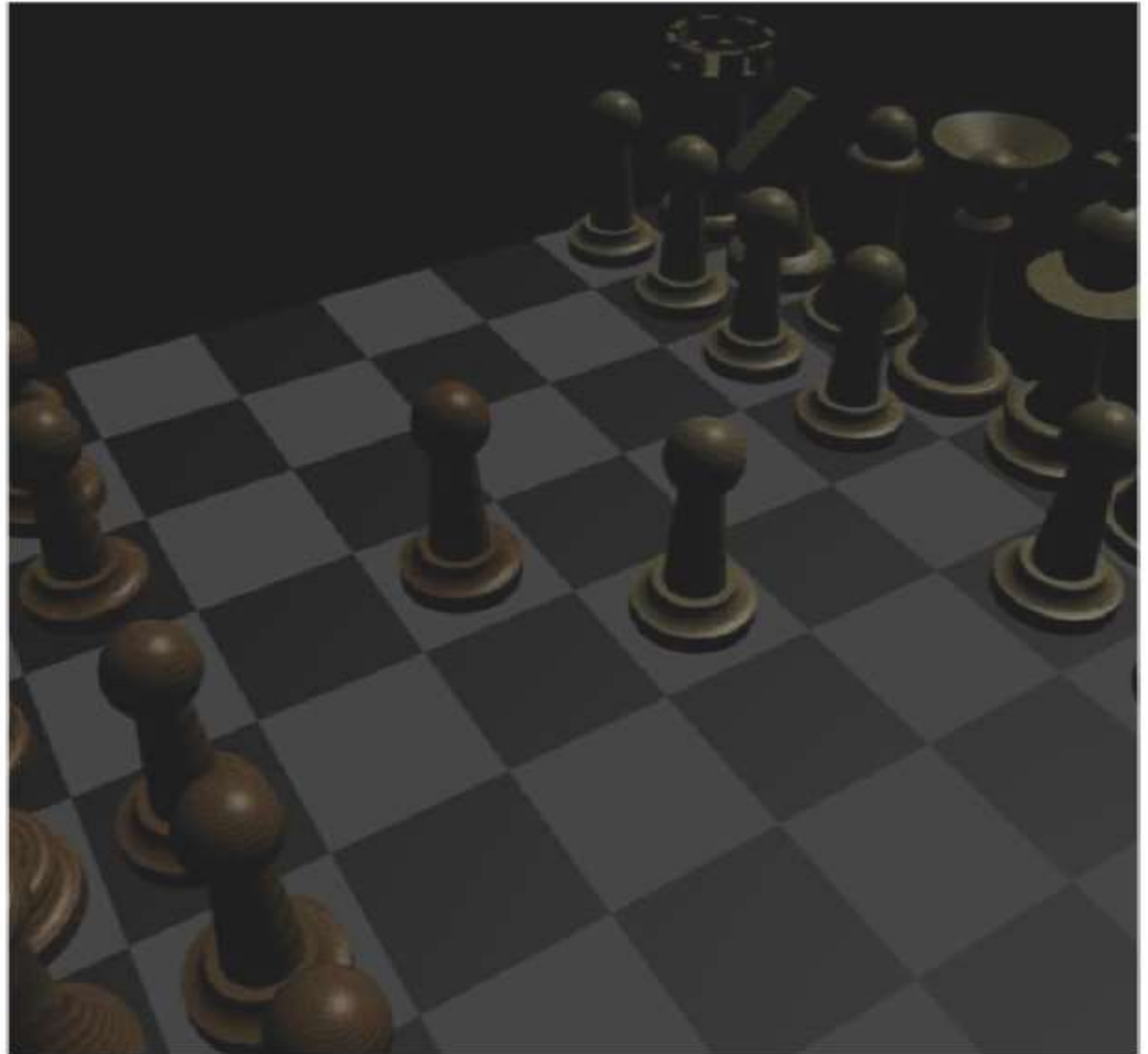


fill light

Controls the quality of the shadows

Usually placed 90 degrees from the key light

Many fill lights can be used



back light

Provides visual depth

Defines the shape of objects by projecting light from the back



3-point lighting



rendering algorithms

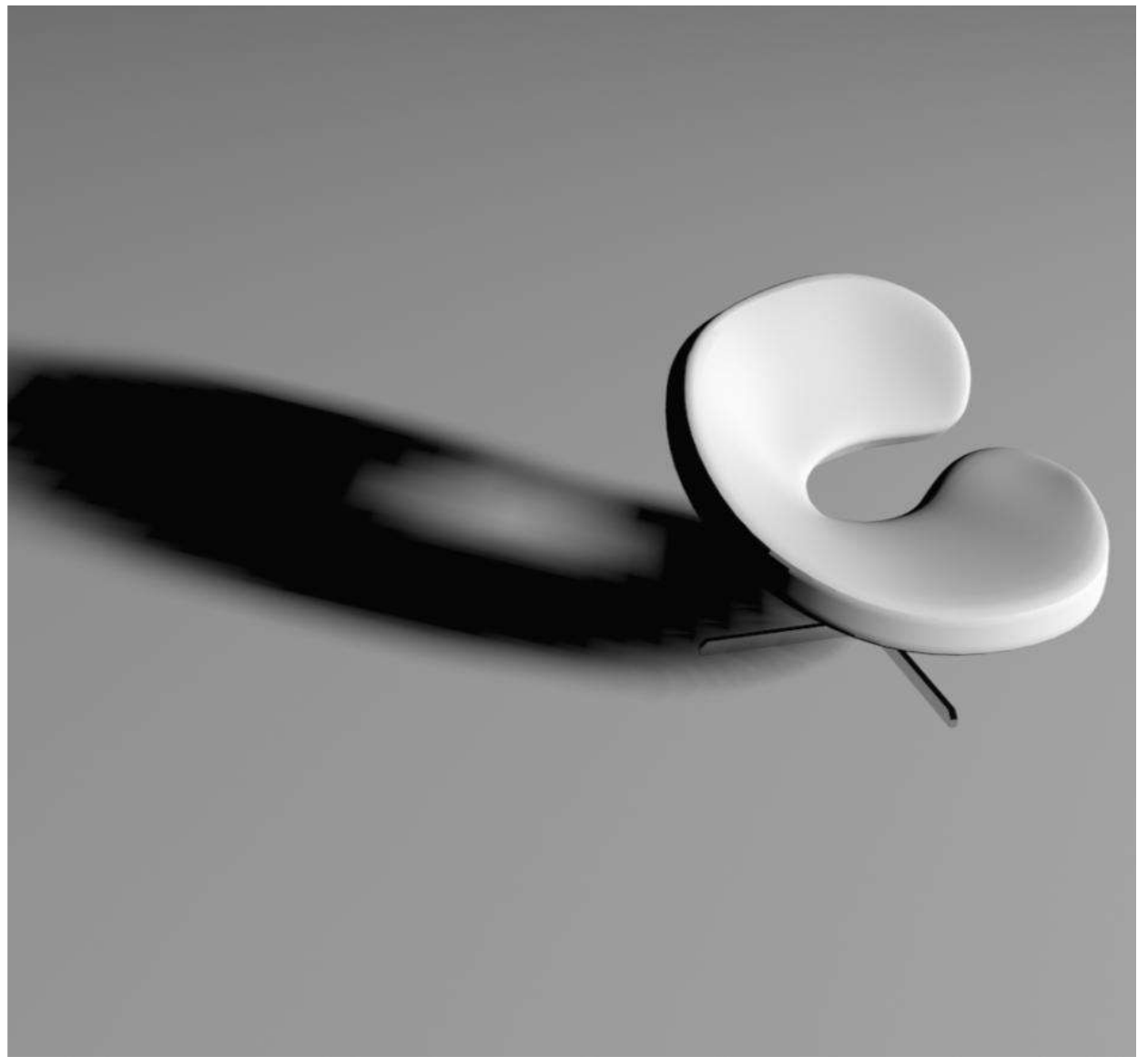


Shadow mapping

Creates an image to display shadows

Quality depends on image size

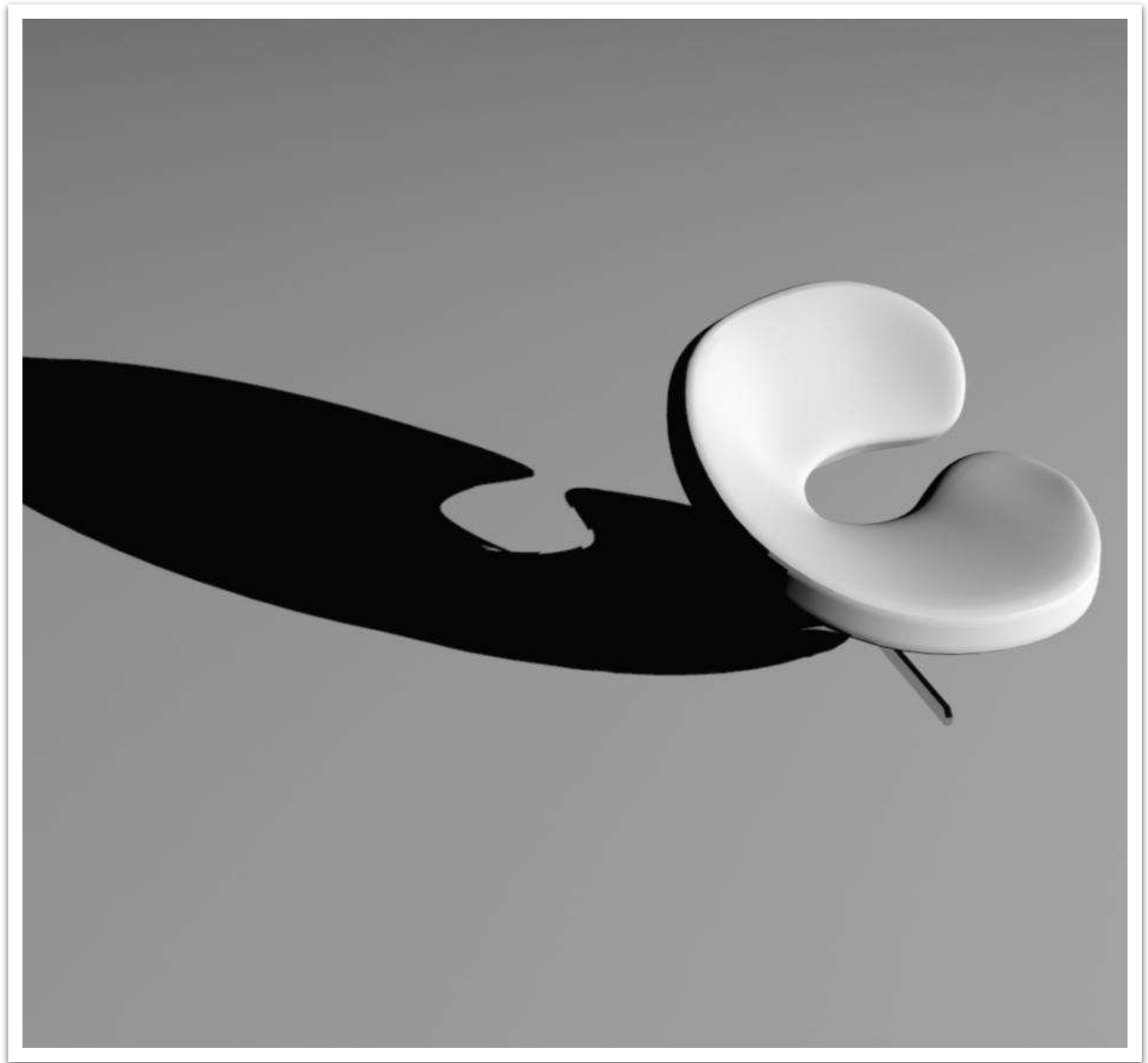
Does not take into account material properties and cannot depict transparent shadows



raytracing

Follows the path
from the light
source to the
object

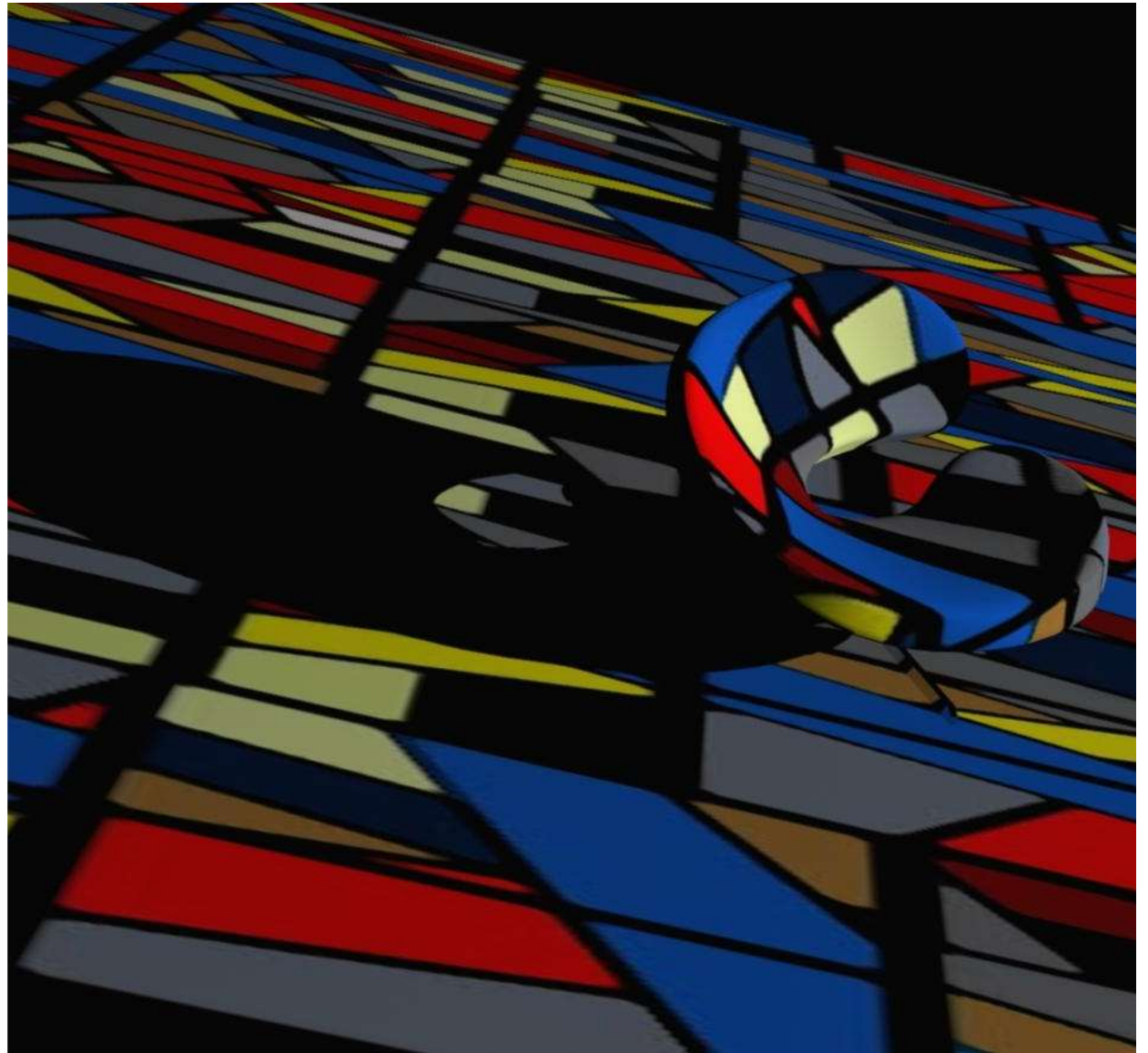
Since the final
result depends on
sampling, quality
depends on the
number of rays
calculated



raytracing

Takes into account
material properties

Can reproduce
shadows from
transparent
materials



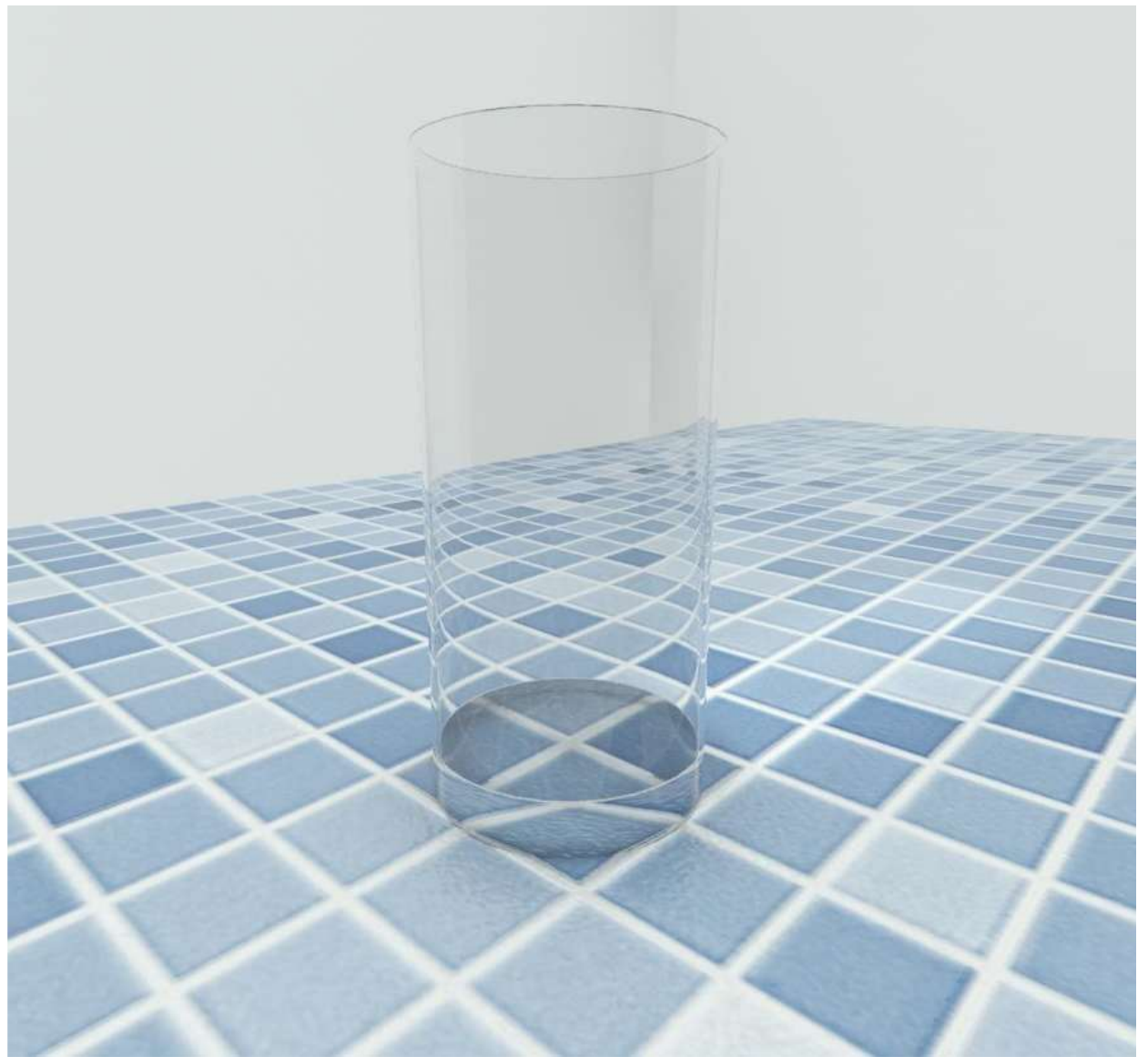
reflectance

Can accurately
depict the
reflectance of the
environment

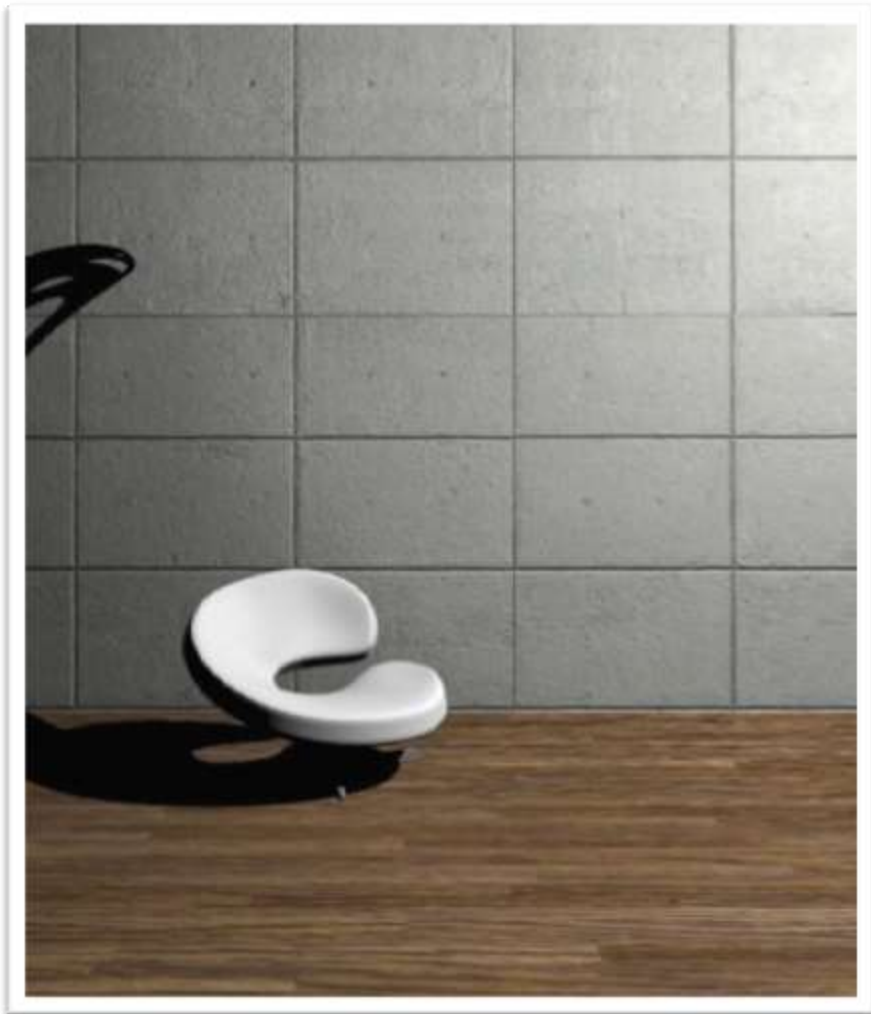


refraction

Can calculate
refraction qualities



local vs global illumination



colour bleeding

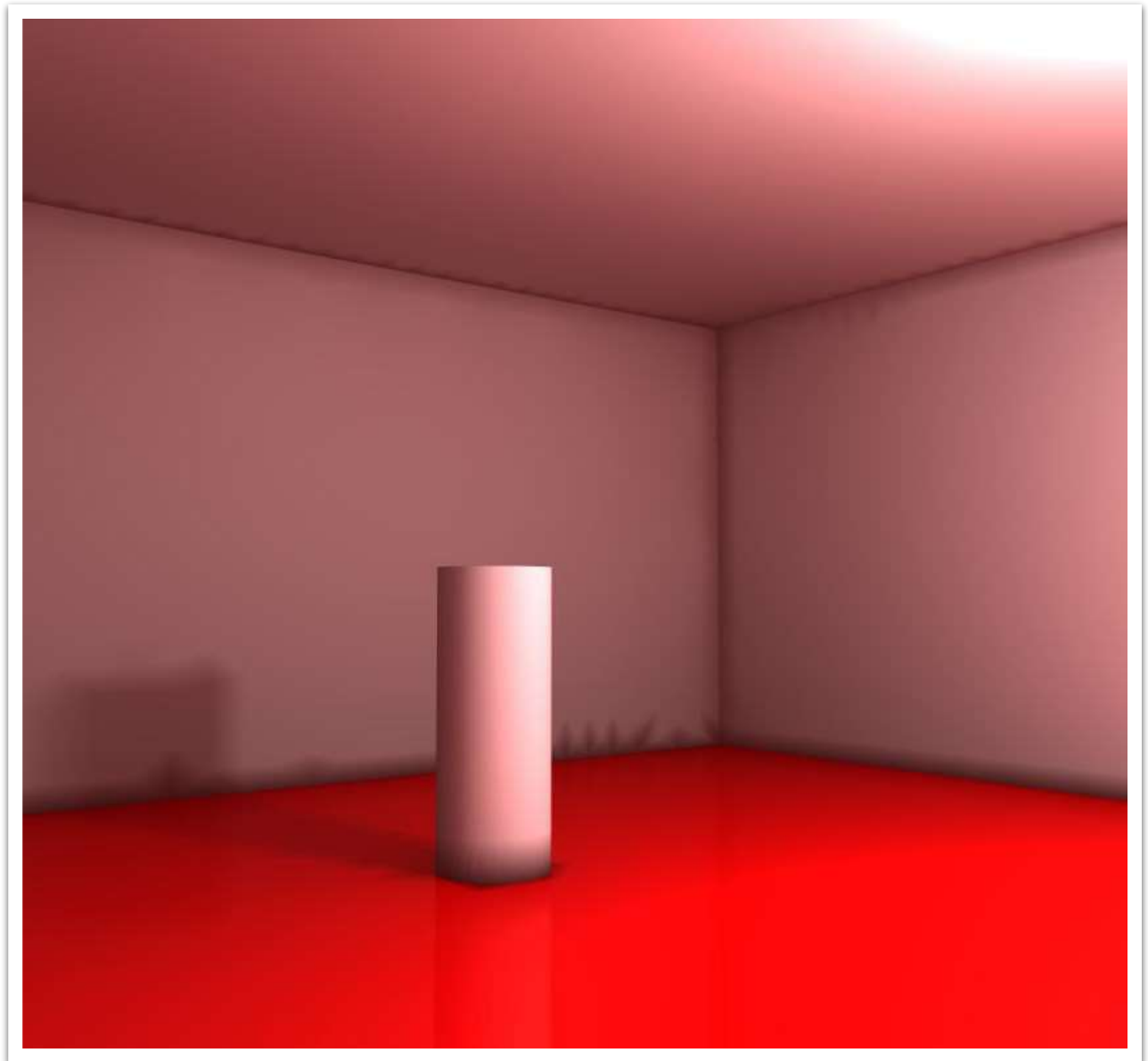
-

radiance

Reflected light from a coloured surface transfers its colour to adjacent objects.

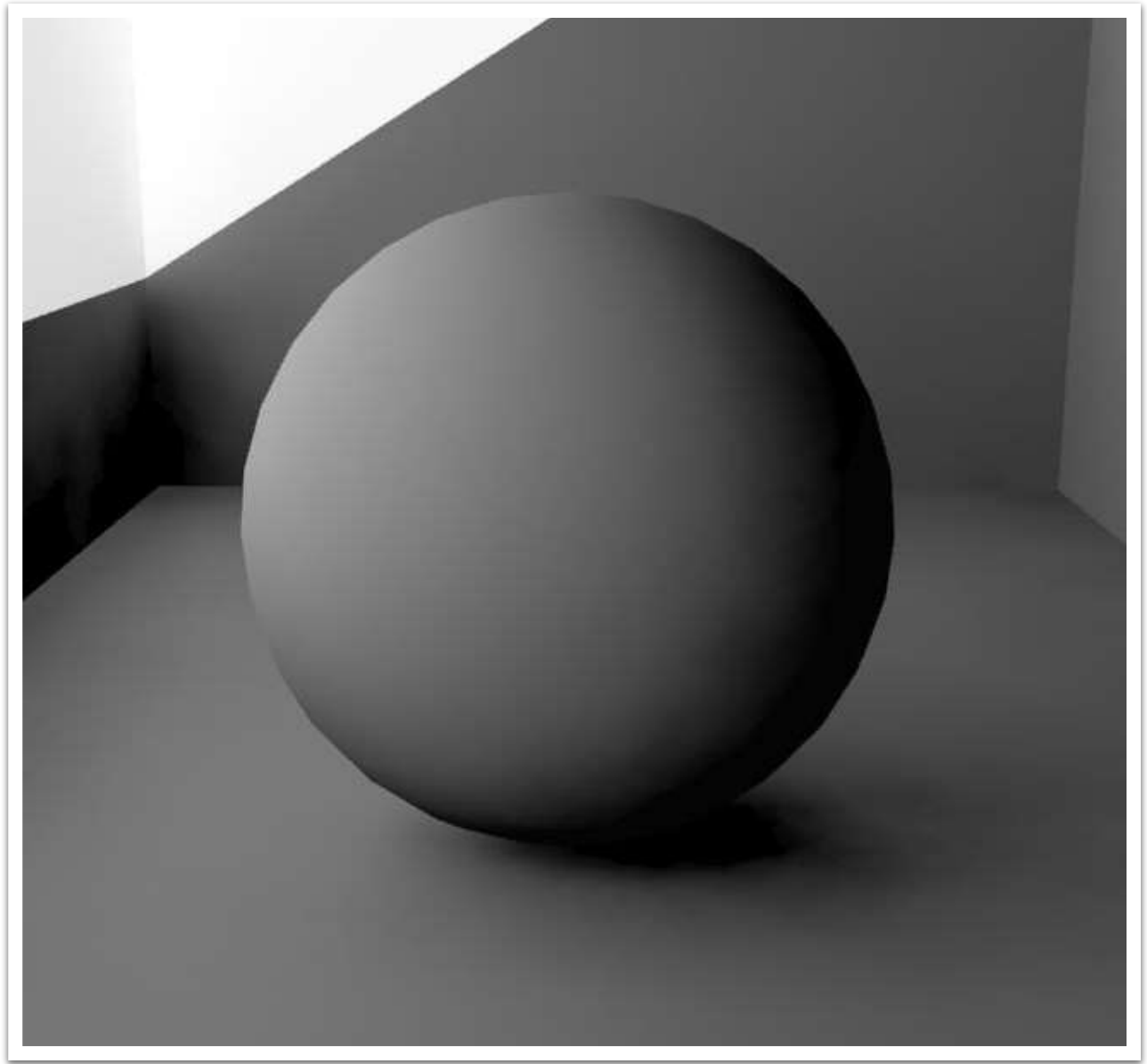
i.e. if white light hits a reflective red surface it will absorb the blue and green wavelengths and reflect the red one.

Light reflecting between objects of the same colour creates a very saturated effect



ambient occlusion

Provides visual
information on the
occlusion of
ambient lighting by
the geometry of
objects



caustics

Focused light by multiple reflections and refractions defined by the geometry of the transparent object



data visualisation

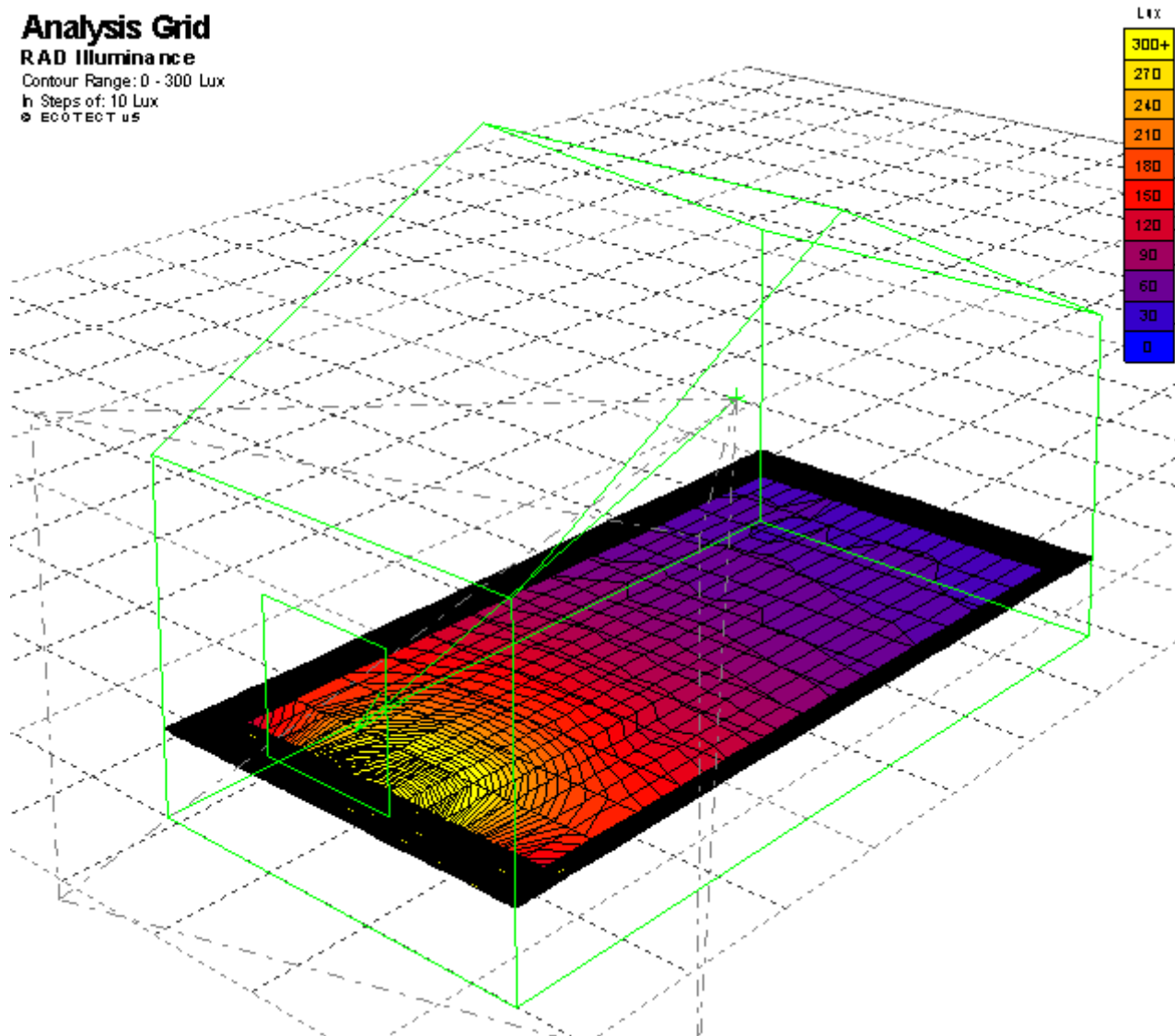
Analysis Grid

RAD Illuminance

Contour Range: 0 - 300 Lux

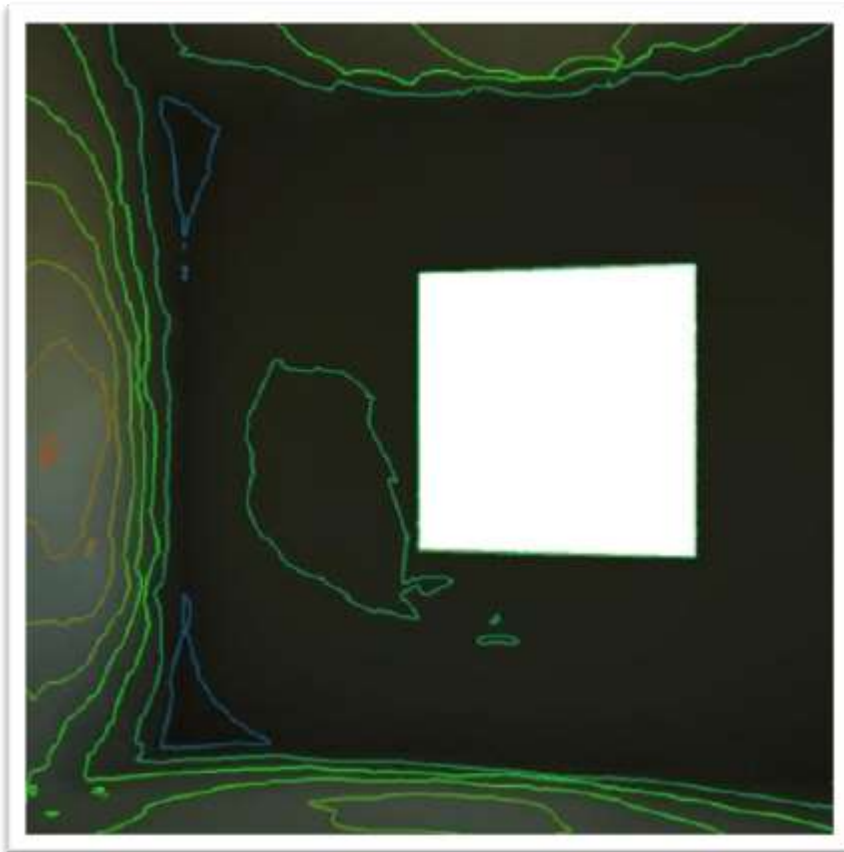
In Steps of: 10 Lux

© ECOTECT u5

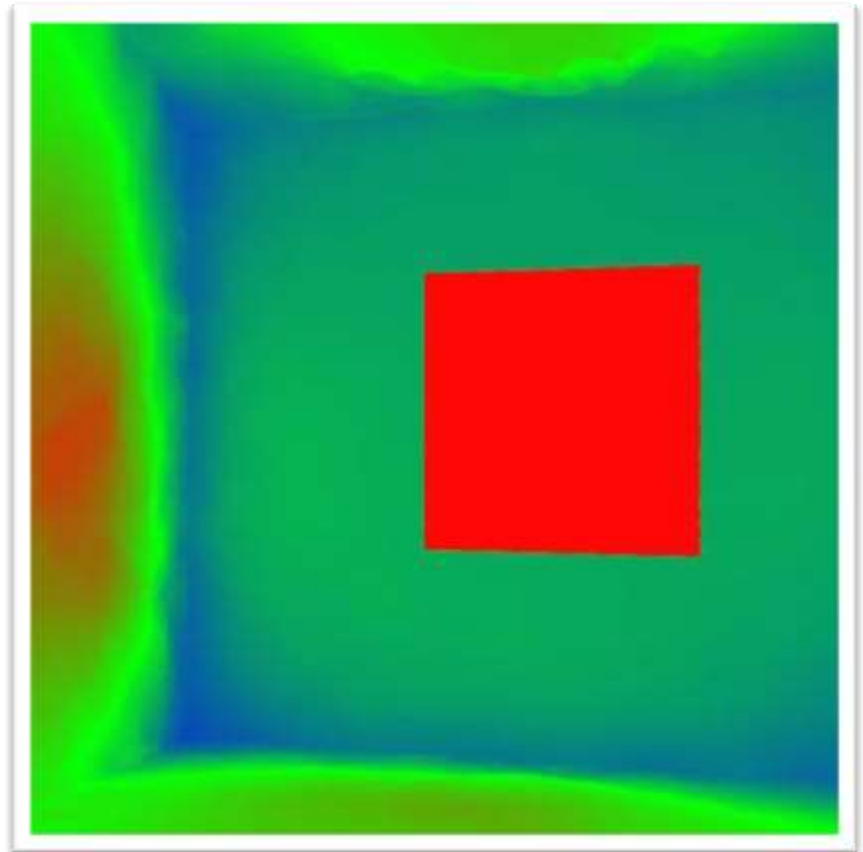


false colour representation

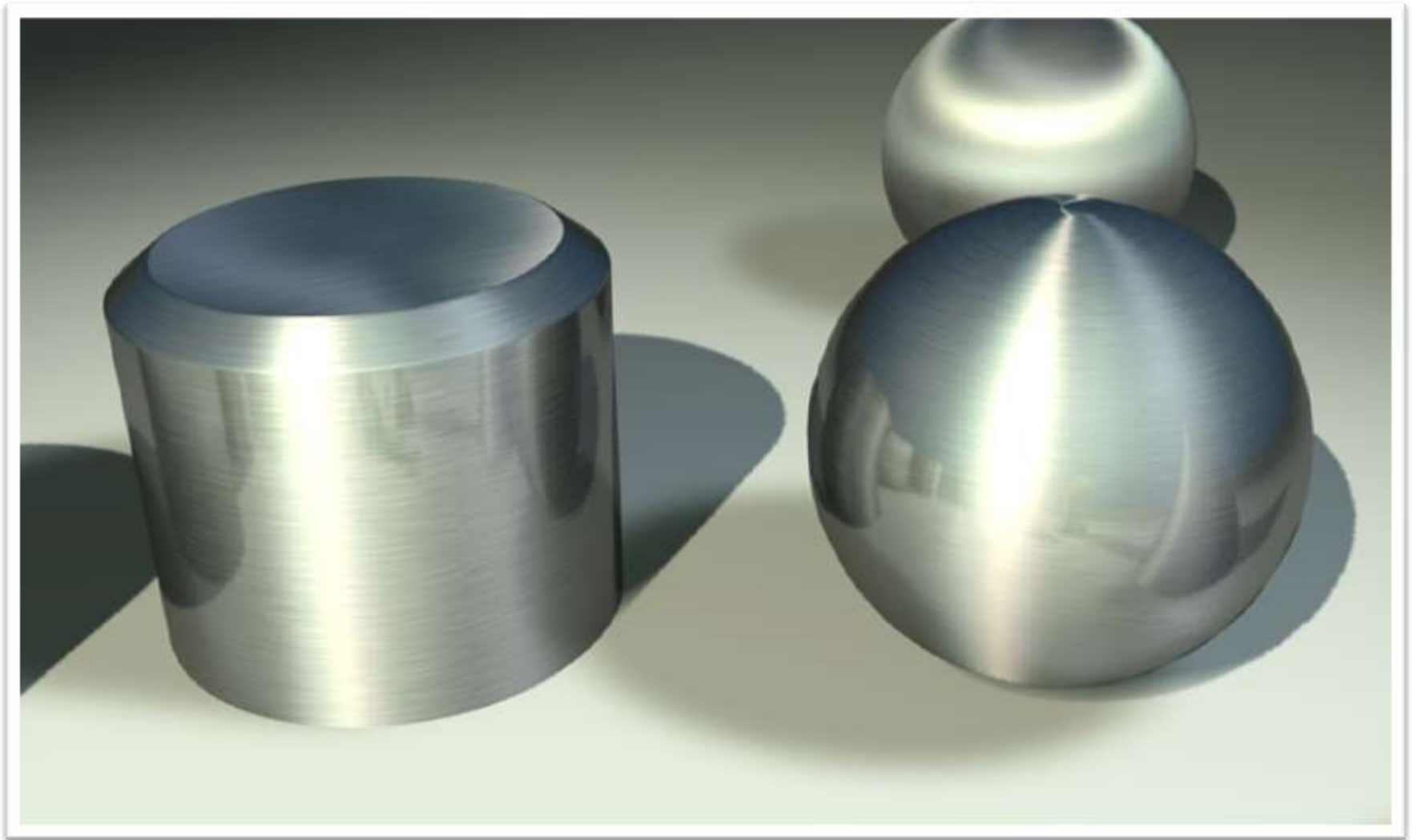
Isolux lines



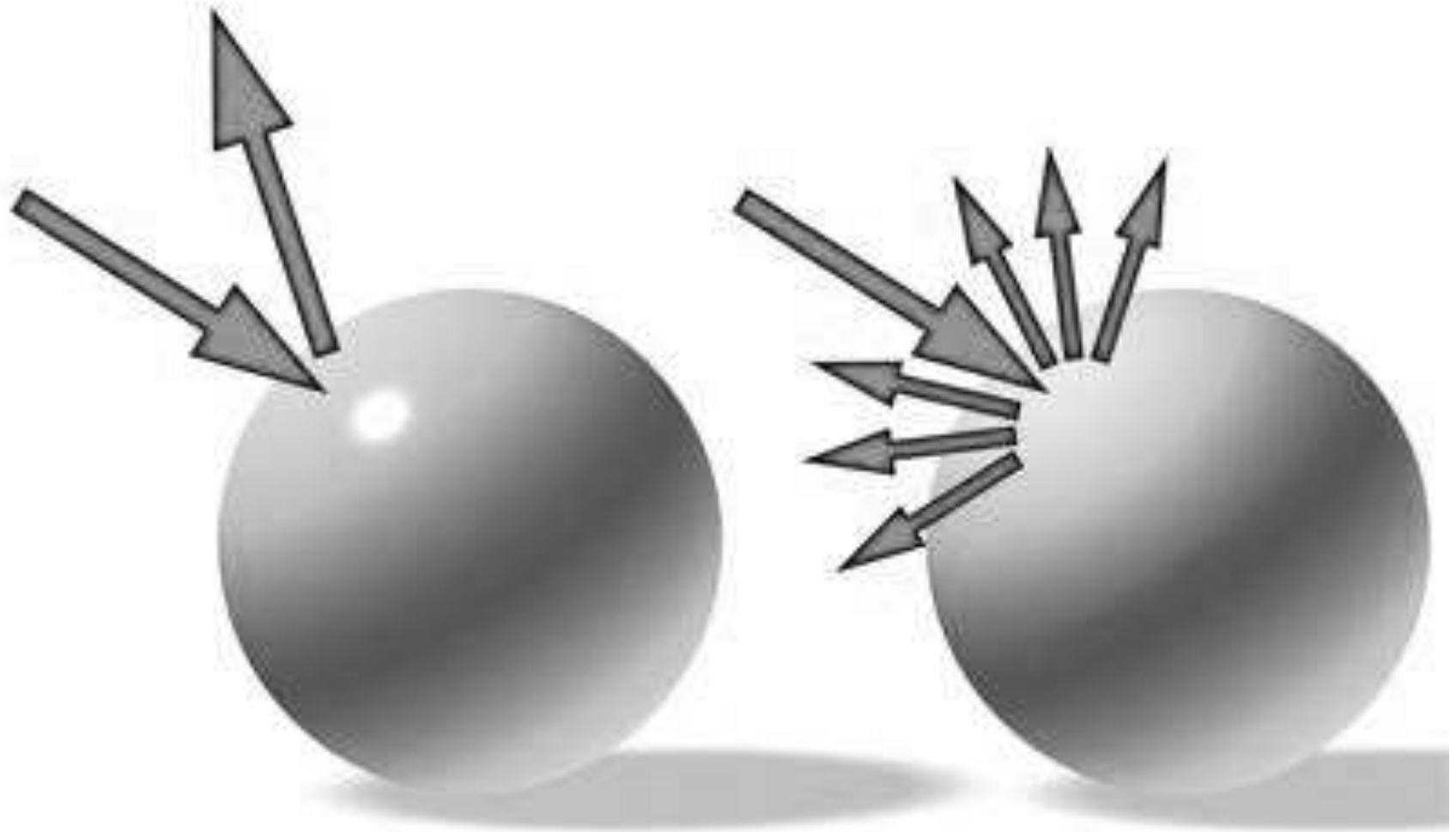
pseudocolour



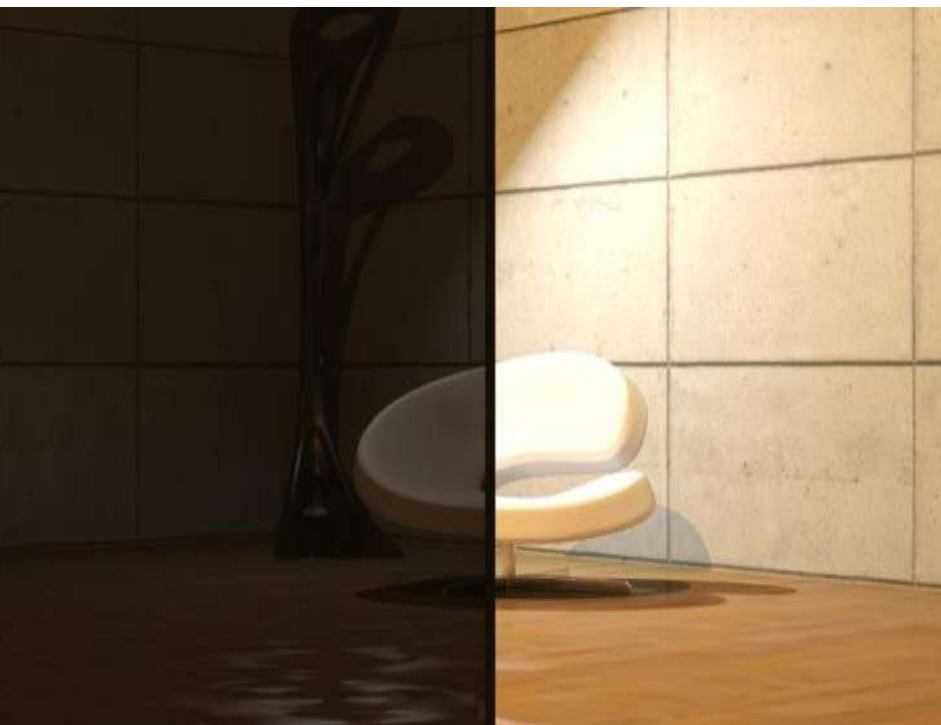
materials



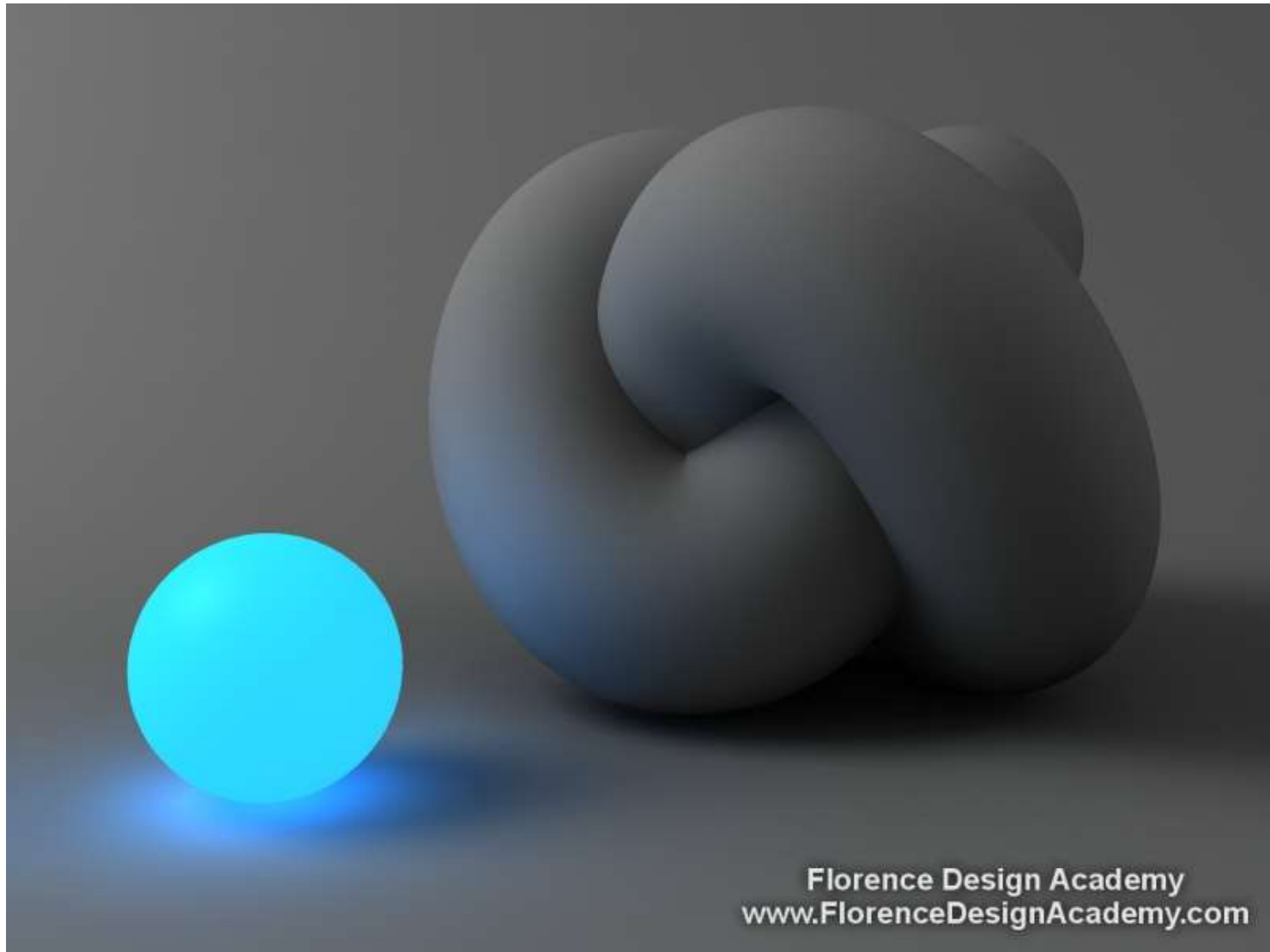
specular vs diffuse reflection



transparency and refraction



glow



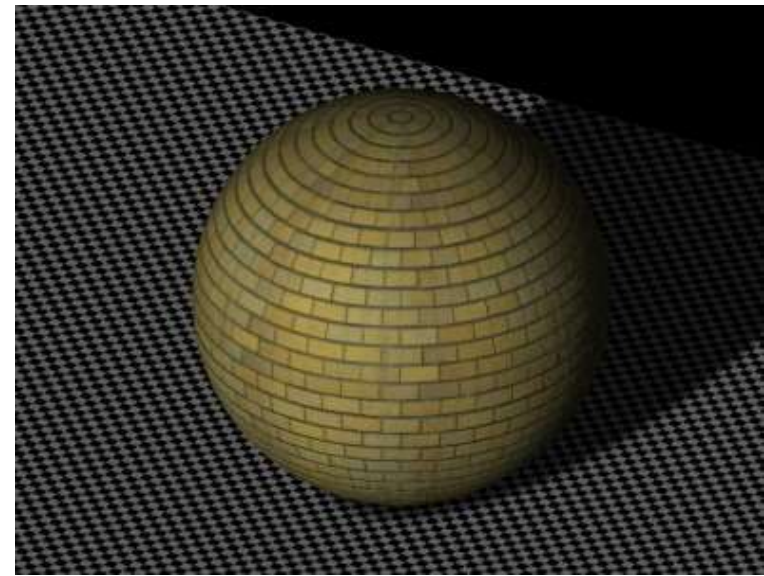
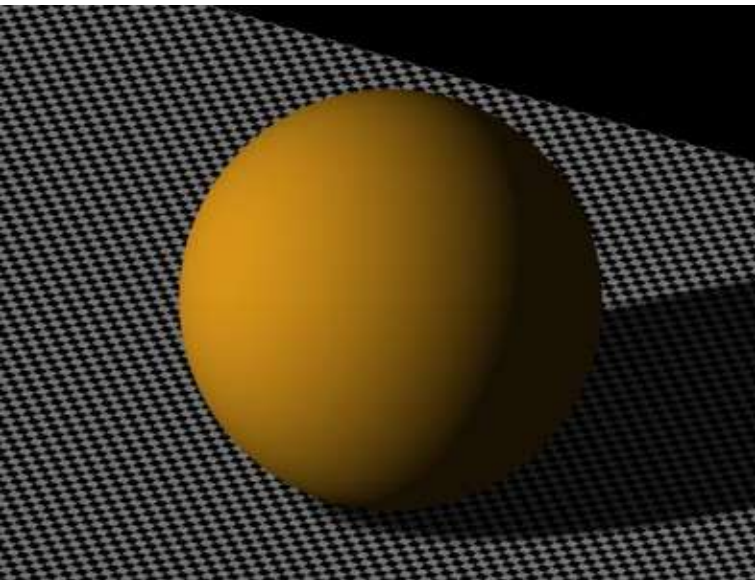
reflectivity



texture

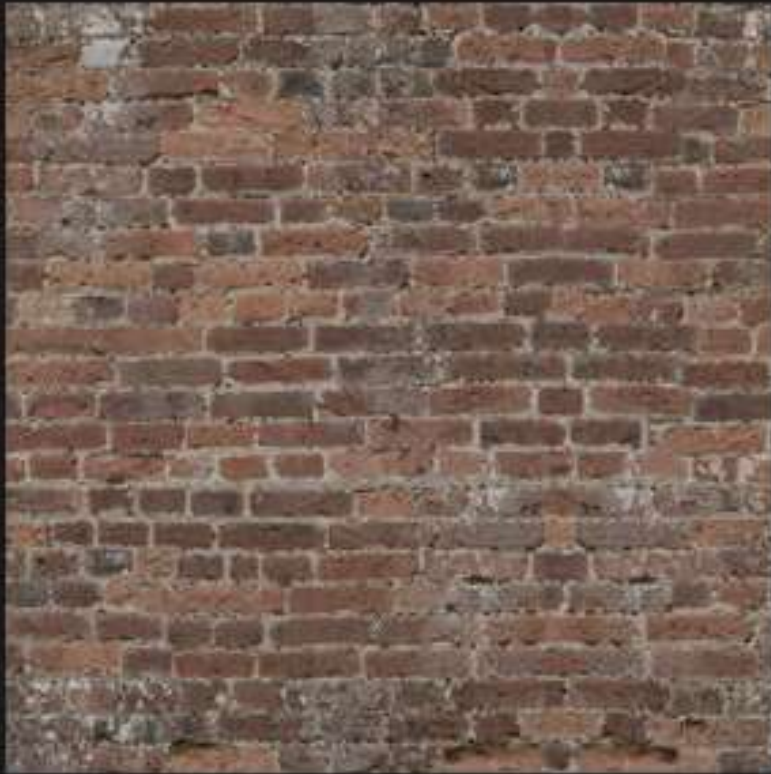


color mapping



bump mapping

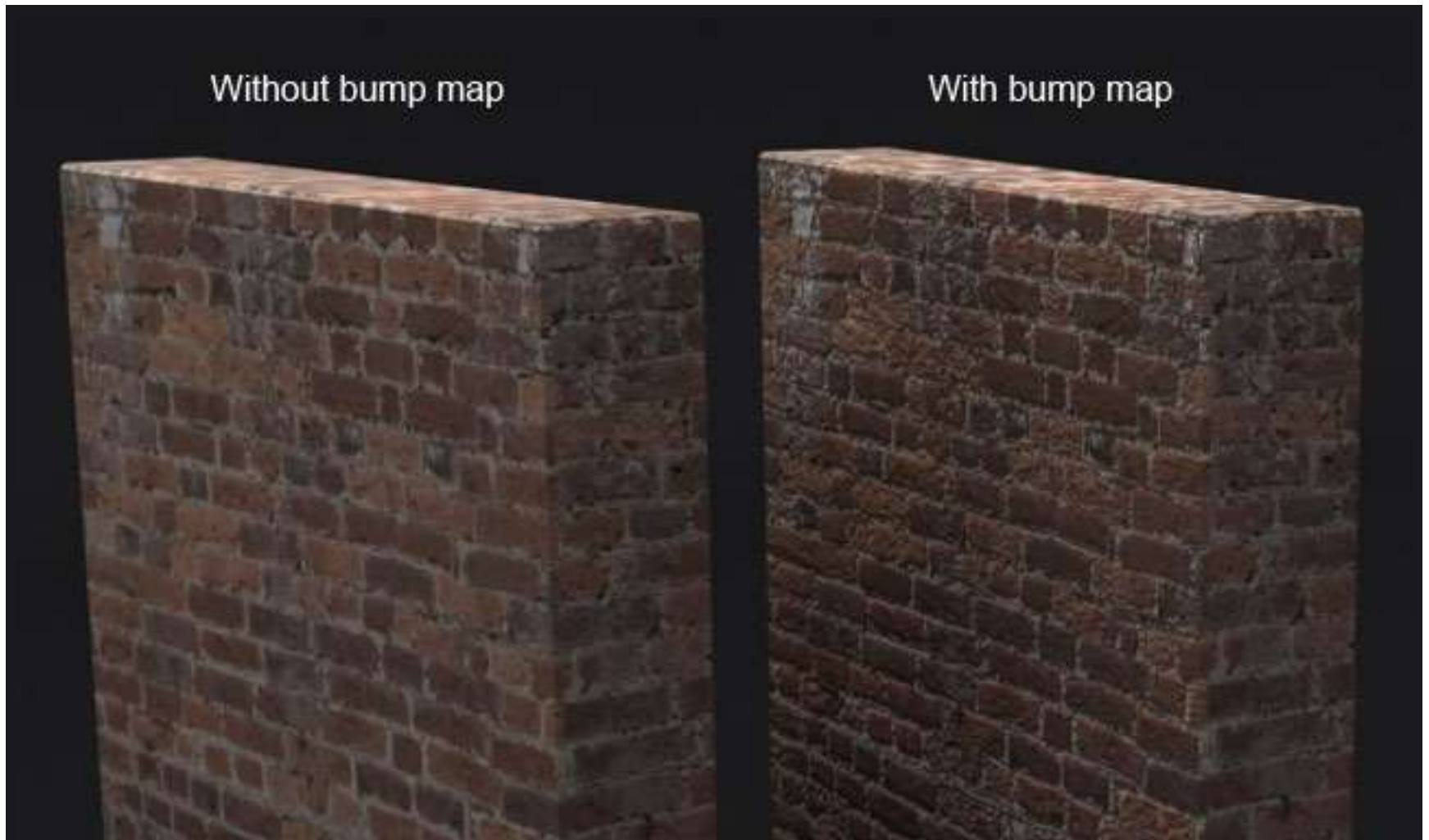
Texture map



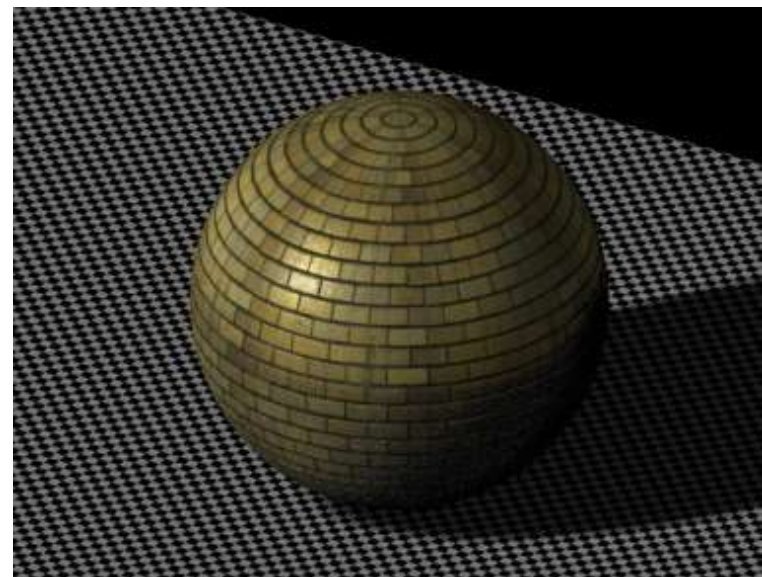
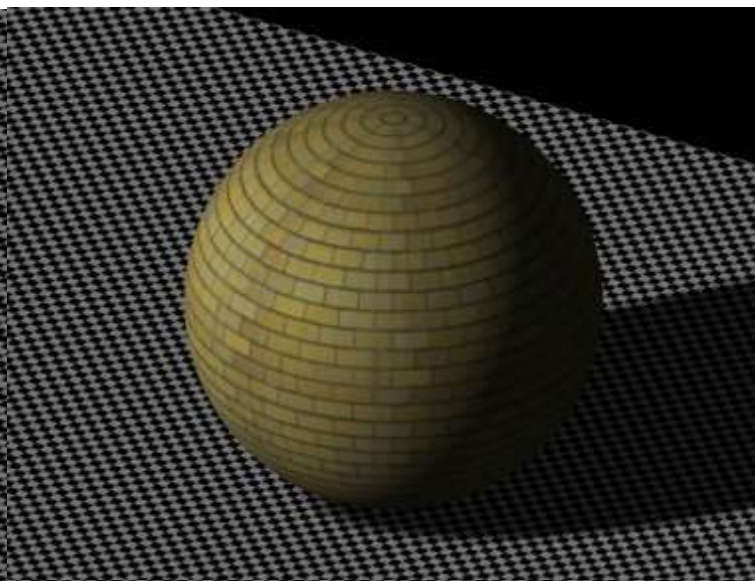
Bump Map



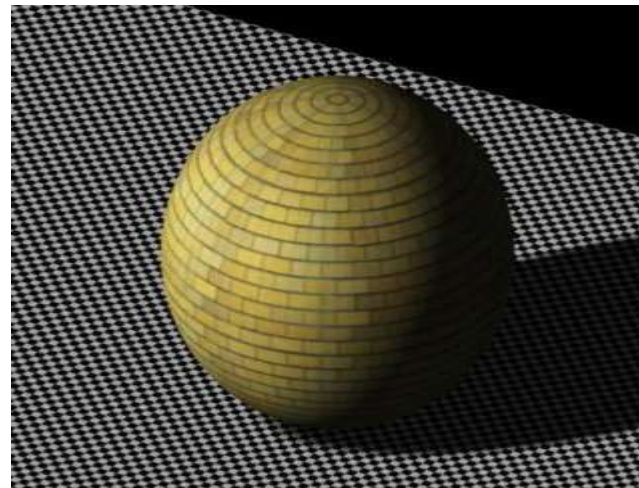
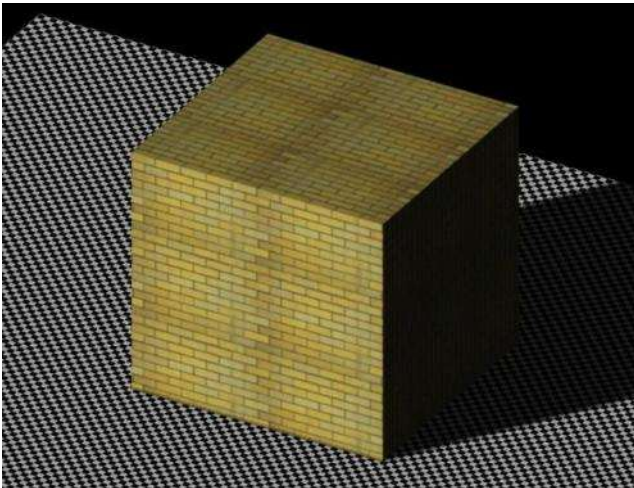
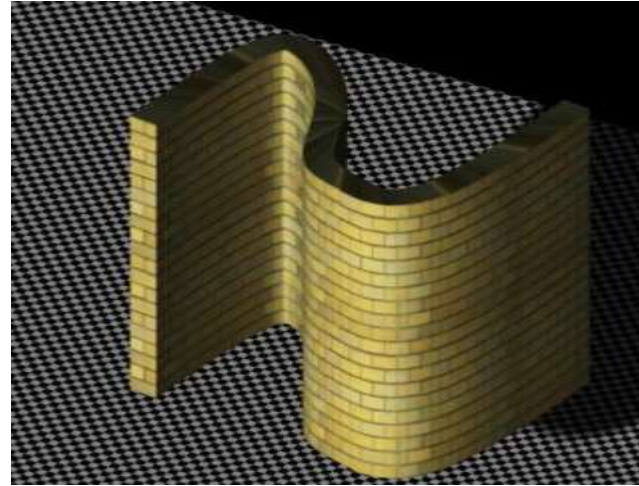
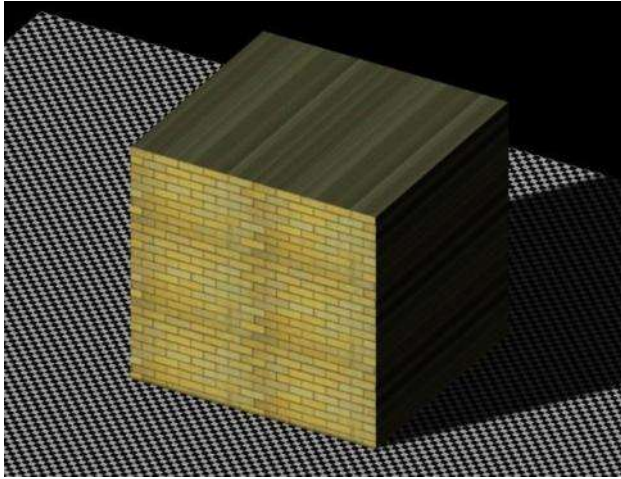
bump mapping



specular mapping



mapping techniques



UV mapping



THANK YOU FOR YOUR ATTENTION

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