

CS4620/5620: Lecture 5

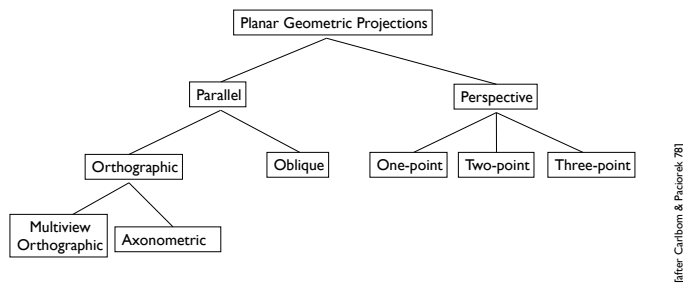
Perspective

Ray generation vs. projection

- Viewing in ray tracing
 - start with image point
 - compute 3D point that projects to that point using ray
 - do this using geometry
- Viewing by projection
 - start with 3D point
 - compute image point that it projects to
 - do this using transforms
- Inverse processes

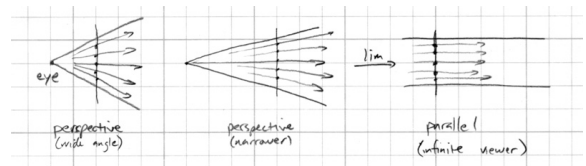
Classical projections

- Emphasis on cube-like objects
 - traditional in mechanical and architectural drawing

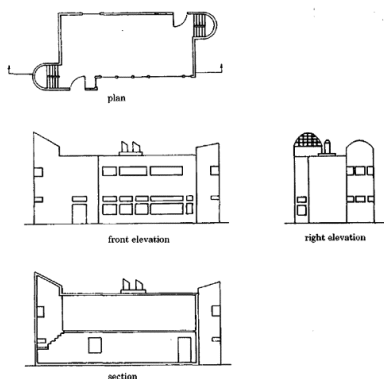


Parallel projection

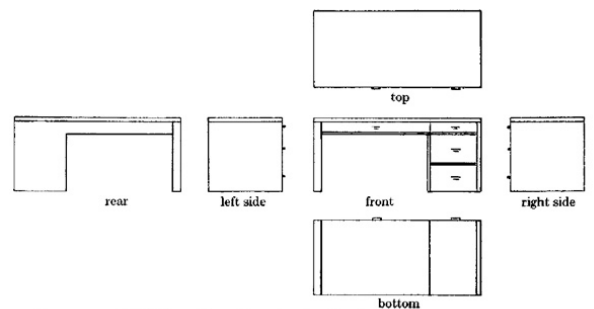
- Viewing rays are parallel rather than diverging
 - like a perspective camera that's far away



Multiview orthographic

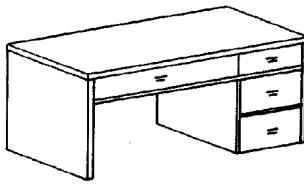


Multiview orthographic

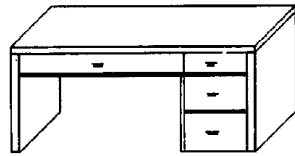


- projection plane parallel to a coordinate plane
- projection direction perpendicular to projection plane

Off-axis parallel



axonometric: projection plane perpendicular to projection direction but not parallel to coordinate planes

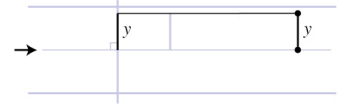


oblique: projection plane parallel to a coordinate plane but not perpendicular to projection direction.

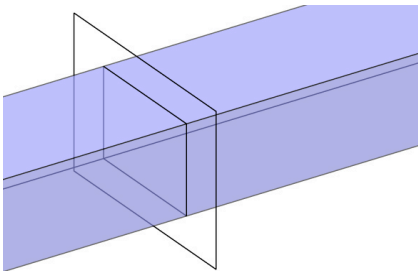
[Carlson & Piciorek '78]

“Orthographic” projection

- In graphics usually we lump axonometric with orthographic
 - projection plane perpendicular to projection direction
 - image height determines size of objects in image

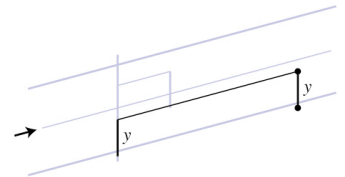


View volume: orthographic



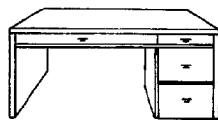
Oblique projection

- View direction no longer coincides with projection plane normal (one more parameter)
 - objects at different distances still same size
 - objects are shifted in the image depending on their depth



Perspective

one-point: projection plane parallel to a coordinate plane (to two coordinate axes)



one-point

two-point: projection plane parallel to one coordinate axis



two-point

three-point: projection plane not parallel to a coordinate axis

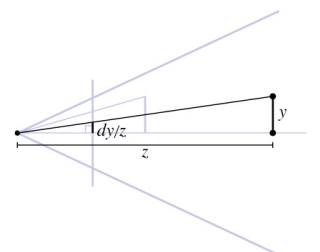


three-point

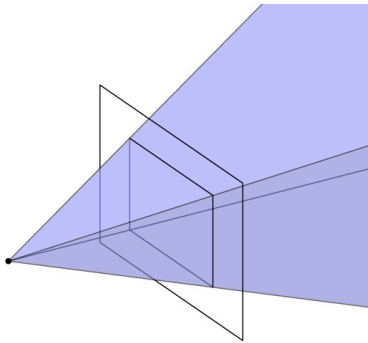
[Carlson & Piciorek '78]

Perspective projection (normal)

- Perspective is projection by lines through a point; “normal” = plane perpendicular to view direction
 - magnification determined by:
 - image height
 - object depth
 - image plane distance
 - f.o.v. $\alpha = 2 \arctan(h/(2d))$
 - $y' = d y / z$
 - “normal” case corresponds to common types of cameras



View volume: perspective



Field of view (or f.o.v.)

- The angle between the rays corresponding to opposite edges of a perspective image
 - easy to compute only for “normal” perspective
 - have to decide to measure vert., horiz., or diag.
- In cameras, determined by focal length
 - confusing because of many image sizes
 - for 35mm format (36mm by 24mm image)
 - 18mm = 67° v.f.o.v. — super-wide angle
 - 28mm = 46° v.f.o.v. — wide angle
 - 50mm = 27° v.f.o.v. — “normal”
 - 100mm = 14° v.f.o.v. — narrow angle (“telephoto”)

Field of view

- Determines “strength” of perspective effects



close viewpoint
wide angle
prominent foreshortening



far viewpoint
narrow angle
little foreshortening

[Ansel Adams]

Choice of field of view

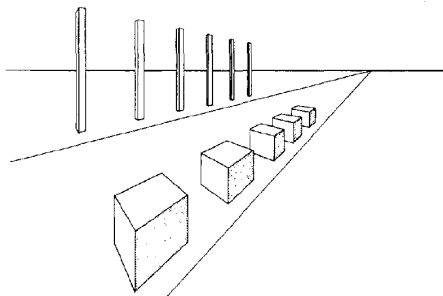
- In photography, wide angle lenses are specialty tools
 - “hard to work with”
 - easy to create weird-looking perspective effects
- In graphics, you can type in whatever f.o.v. you want
 - and people often type in big numbers!



[Ken Perlin]

Perspective distortions

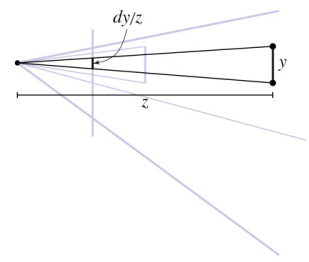
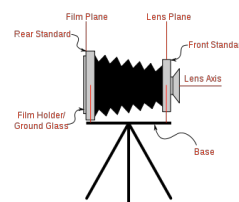
- Lengths
- Length Ratios



[Carlson & Paciorek '78]

Shifted perspective projection

- Perspective but with projection plane not perpendicular to view direction
 - additional parameter: projection plane normal
- corresponds to view camera in photography



Why shifted perspective?

- Control convergence of parallel lines
- Standard example: architecture
 - buildings are taller than you, so you look up
 - top of building is farther away, so it looks smaller
- Solution: make projection plane parallel to facade
 - top of building is the same distance *from the projection plane*



camera tilted up: converging vertical lines

[Philip Greengard]



lens shifted up: parallel vertical lines

[Philip Greengard]

Specifying perspective projections

- Many ways to do this
 - common: from, at, up, v.f.o.v. (but not for shifted)
- One way (used in ray tracer):
 - viewpoint, view direction, up
 - establishes location and orientation of viewer
 - view direction is the direction of the center ray
 - image width, image height, projection distance
 - establishes size and location of image rectangle
 - image plane normal
 - can be different from view direction to get shifted perspective