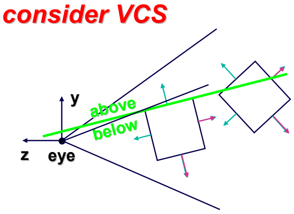
Back-face Culling

First consider VCS



First idea:
cull if $N_Z < 0$

Works, but sometimes misses polygons that should be culled

Better idea:
cull if eye is below polygon plane

Back-face Culling (continued)

Build plane equation:
$Plane(P) = N \bullet P + D \quad = 0$

Cull if eye point is below plane:

$N \bullet P_{eye} + D < 0$

This amounts to testing $D < 0$

Reminder of how to compute D:

$D = -N \bullet P$ where P is any point on the polygon
i.e., choose any vertex

Back-face Culling (continued)

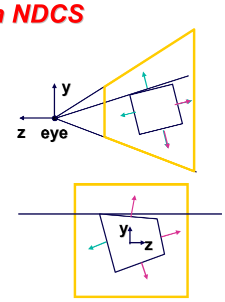
Summary of culling in VCS

- compute polygon normal, N
- cull if $-N \bullet P < 0$

Back-face Culling (continued)

Culling in NDCS

VCS



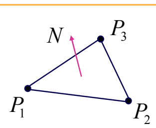
NDCS

eye

cull if $N_Z > 0$

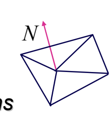
Computing Normals

- polygon:

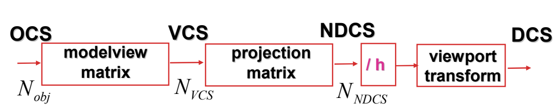


$N = (P_2 - P_1) \times (P_3 - P_1)$

- assume vertices ordered CCW when viewed from visible side of polygon
- normal for a vertex:
  - *used for lighting*
  - *supplied by model (i.e., sphere), or computed from neighboring polygons*



Transforming Normals



- first idea: set h=0

$$\begin{bmatrix} x' \\ y' \\ z' \\ 0 \end{bmatrix} = \begin{bmatrix} m_{11} & m_{12} & m_{13} & T_x \\ m_{21} & m_{22} & m_{23} & T_y \\ m_{31} & m_{32} & m_{33} & T_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 0 \end{bmatrix}$$

zero in order to avoid translations

problem: only works for some transformation matrices (rotations, uniform scales, translations)

Transforming Normals (cont.)

University of British Columbia

transform a plane

$$Plane = A \cdot x + B \cdot y + C \cdot z + D$$

$$= \begin{bmatrix} A & B & C & D \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = N^T P$$

$$P \longrightarrow P' = MP$$
$$N \longrightarrow N' = QN$$

if we know M, what should Q be?

Transforming Normals (cont.)

University of British Columbia

transform a plane

$$P \longrightarrow P' = MP$$
$$N \longrightarrow N' = QN$$

$$N^T P = 0 \qquad N'^T P' = 0$$

$$(QN)^T (MP) = 0$$

$$N^T Q^T M P = 0$$

$$Q^T M = I$$

$$Q = \left(M^{-1}\right)^T$$