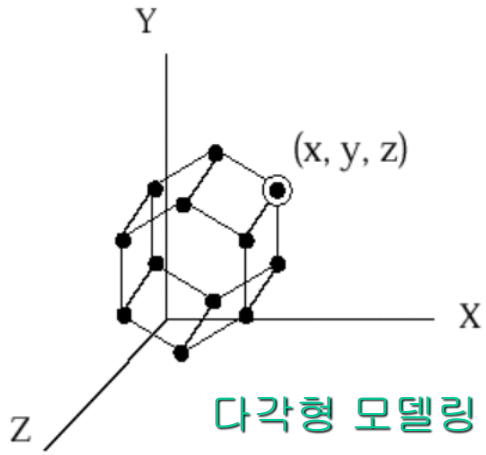
3차원 모델링

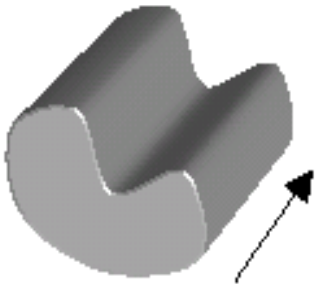
서울대학교 컴퓨터공학부
김명수
http://cse.snu.ac.kr/mskim
http://3map.snu.ac.kr

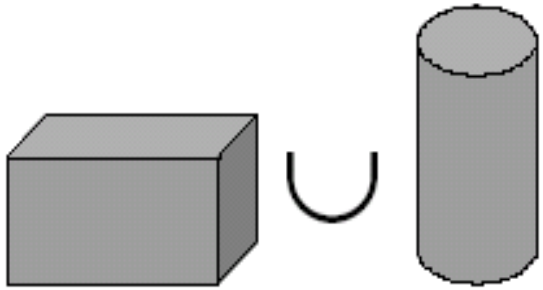
3차원 모델링

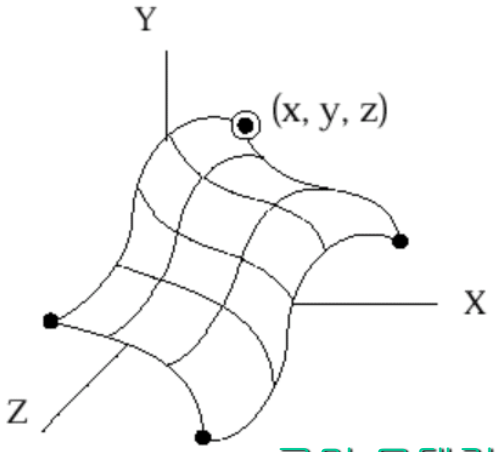
- 다각형 모델링
- 곡선 및 곡면 모델링
- 입체 모델링, 체적 모델링
- 절차적 기법에 의한 모델링



다각형 모델링

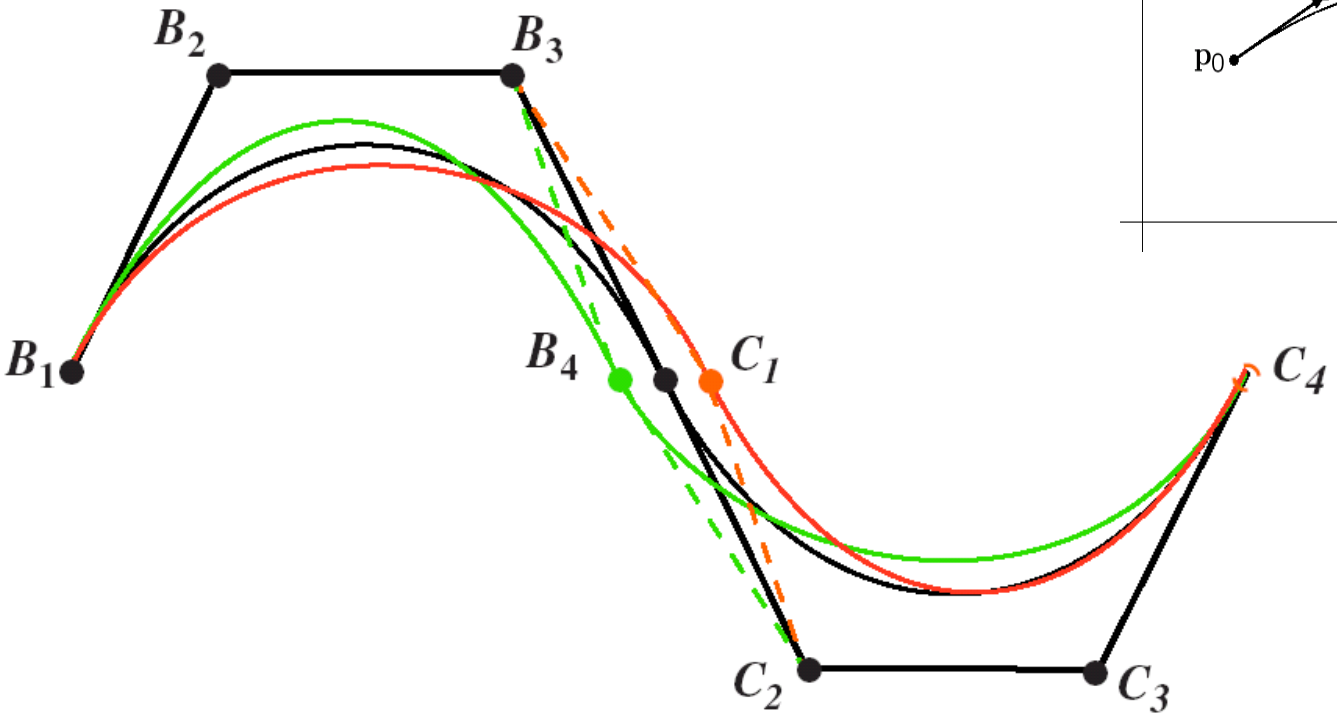


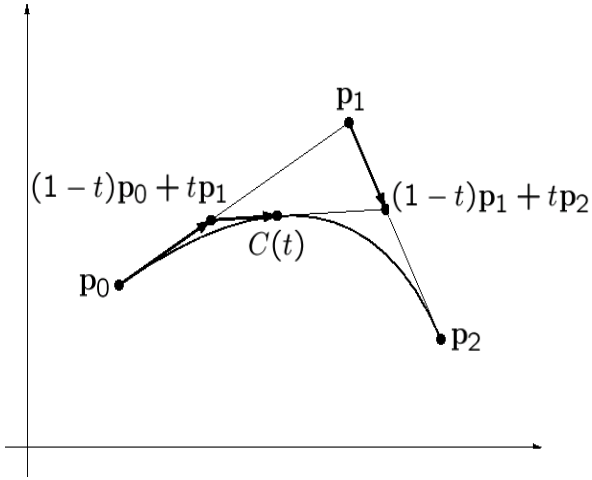




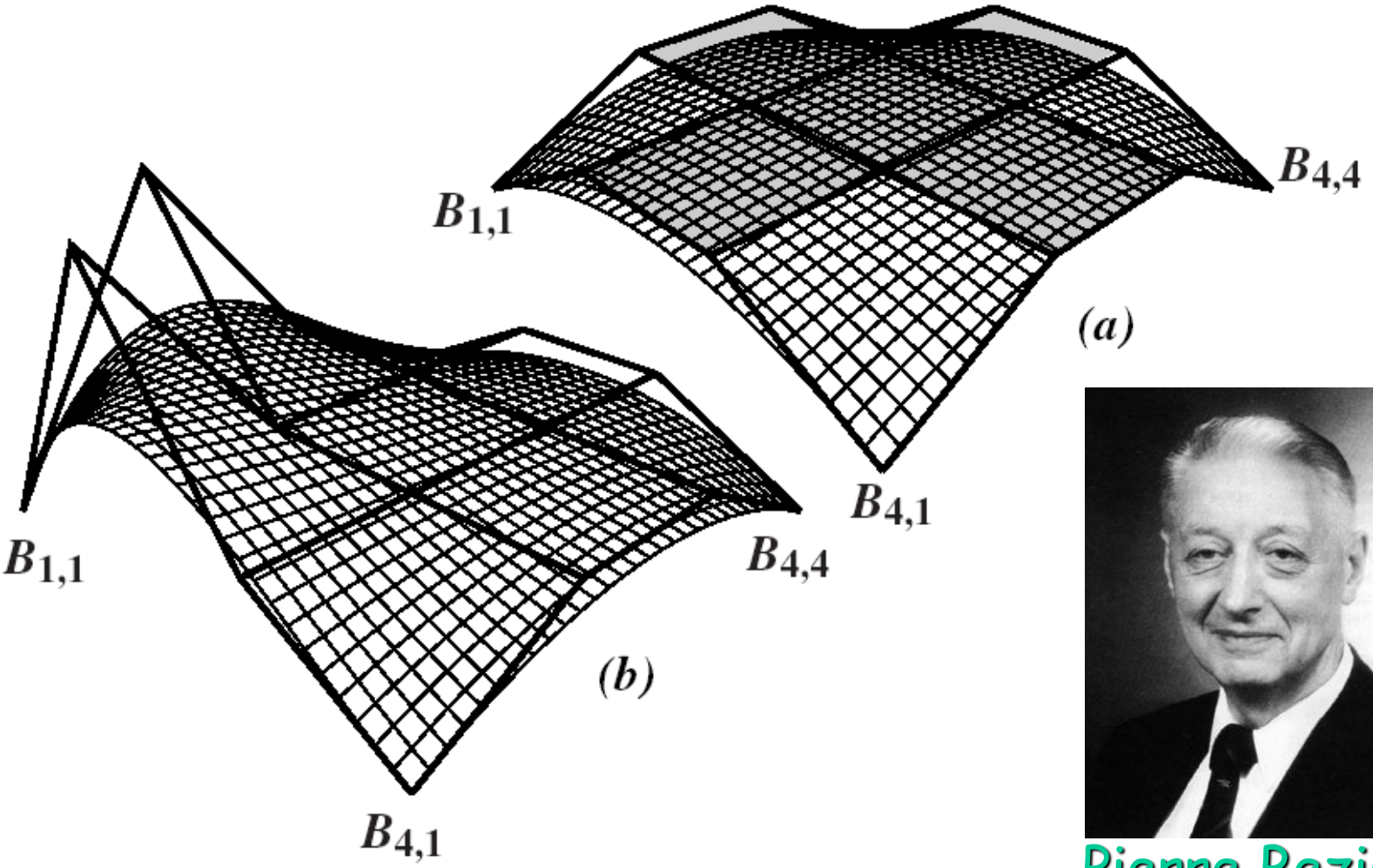
곡면 모델링

Bezier 곡선


B_1
B_2
B_3
B_4
C_1
C_2
C_3
C_4

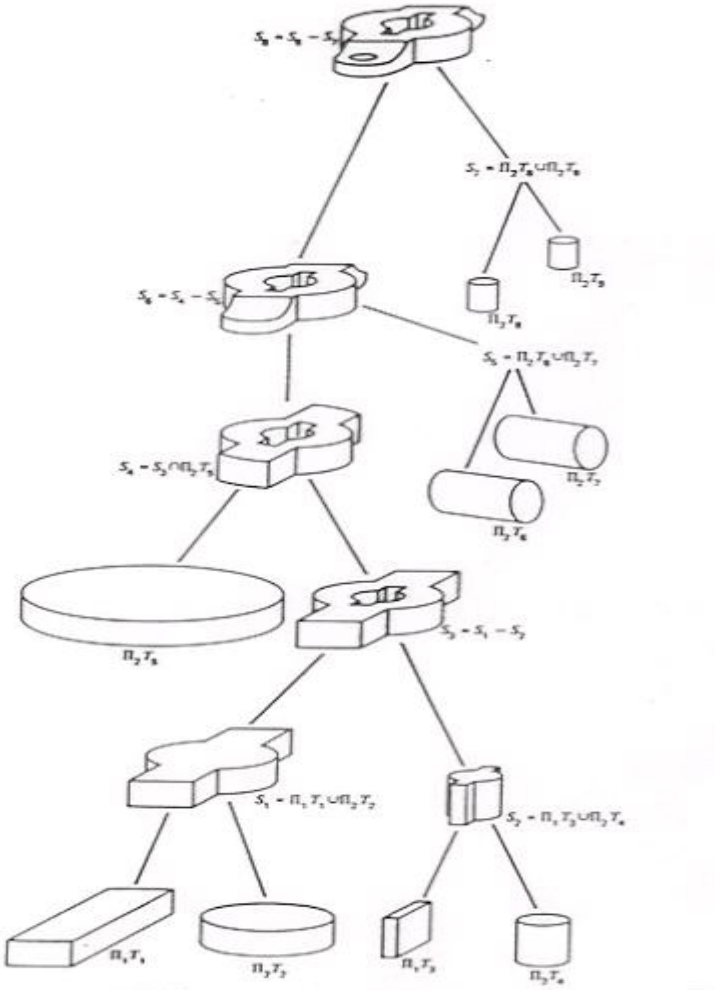

p_1
$(1-t)\mathrm{p}_0 + t\mathrm{p}_1$
$(1-t)\mathrm{p}_1 + t\mathrm{p}_2$
$C(t)$
p_0
p_2

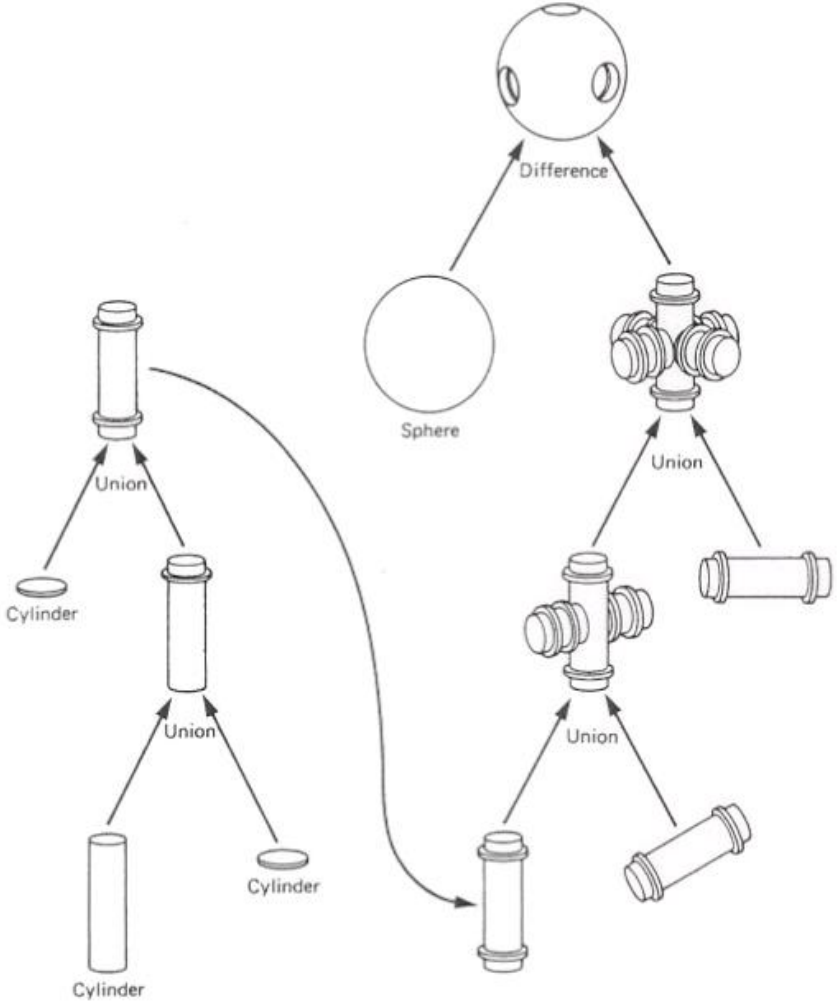
Bezier 곡면



Pierre Bezier

CSG 모델링

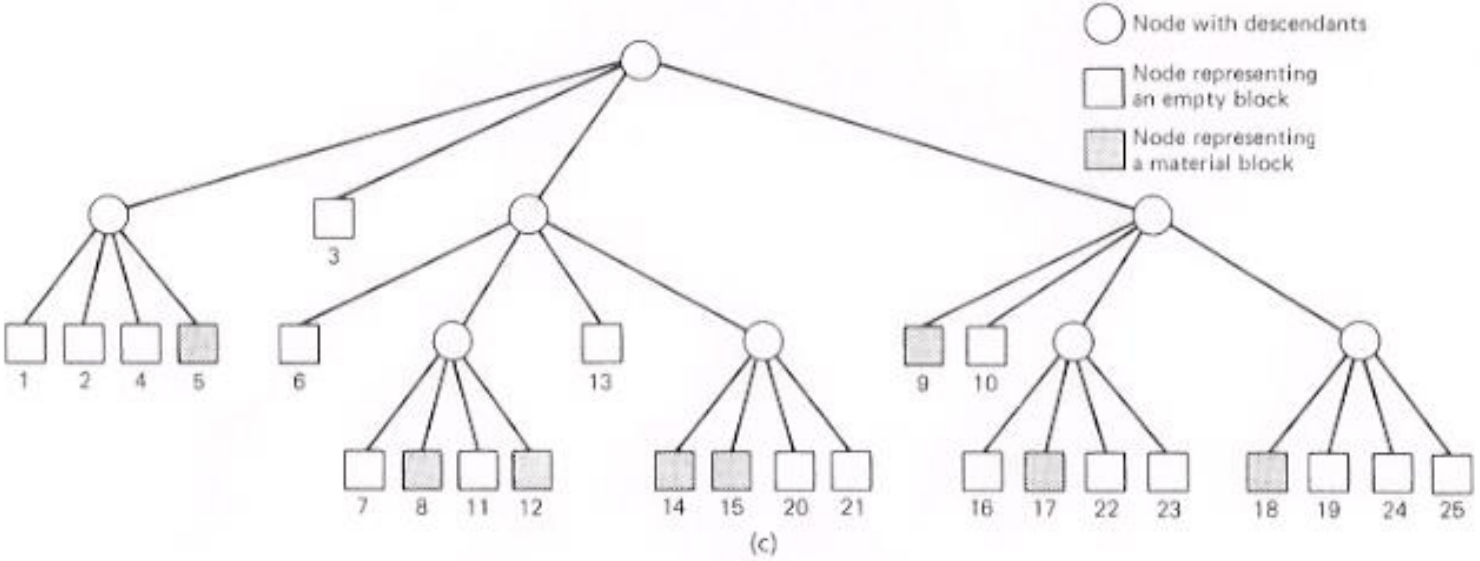



Difference
Sphere
Union
Union
Cylinder
Union
Union
Cylinder
Cylinder

Quadtree

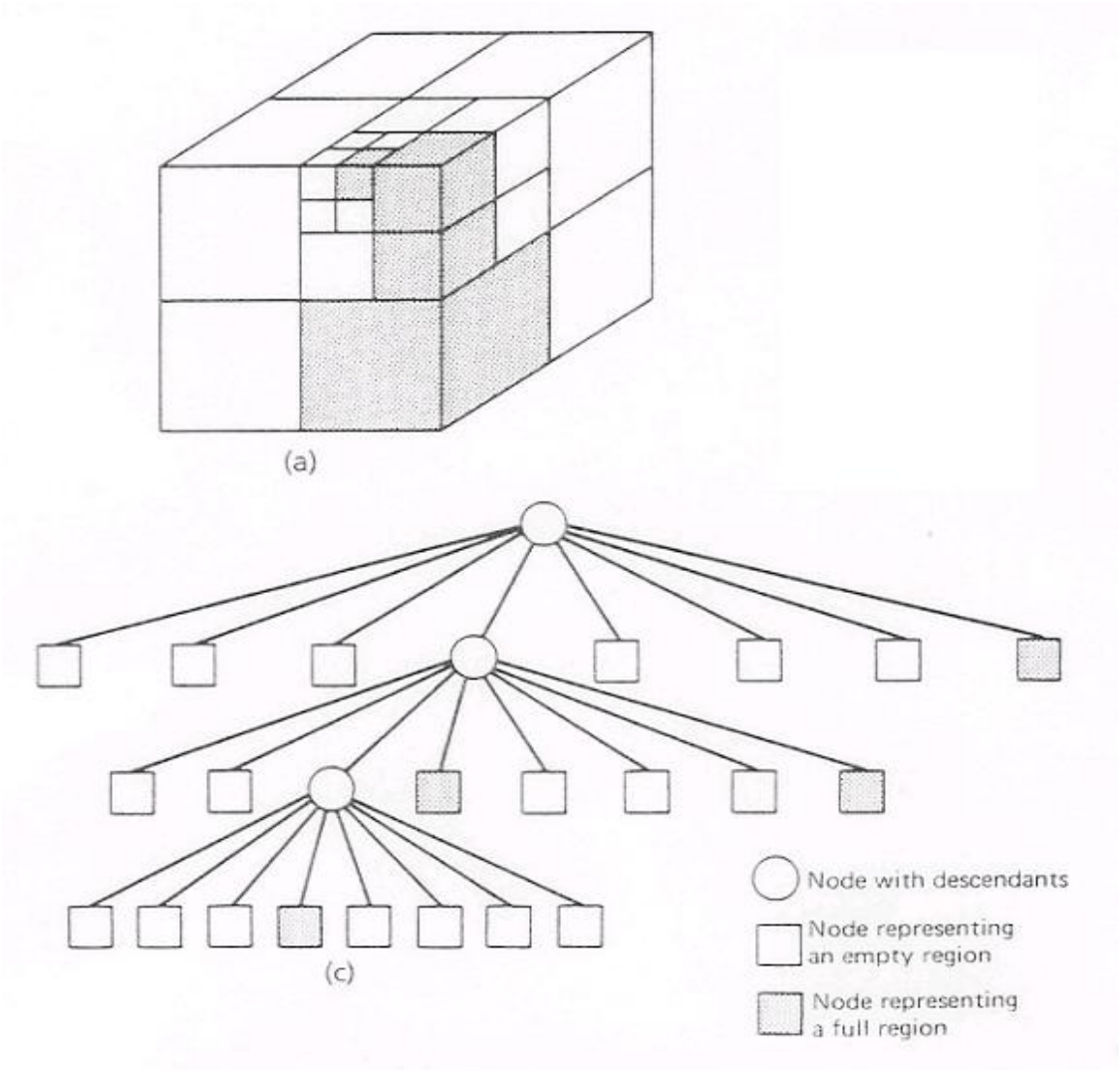
(a)

(b)

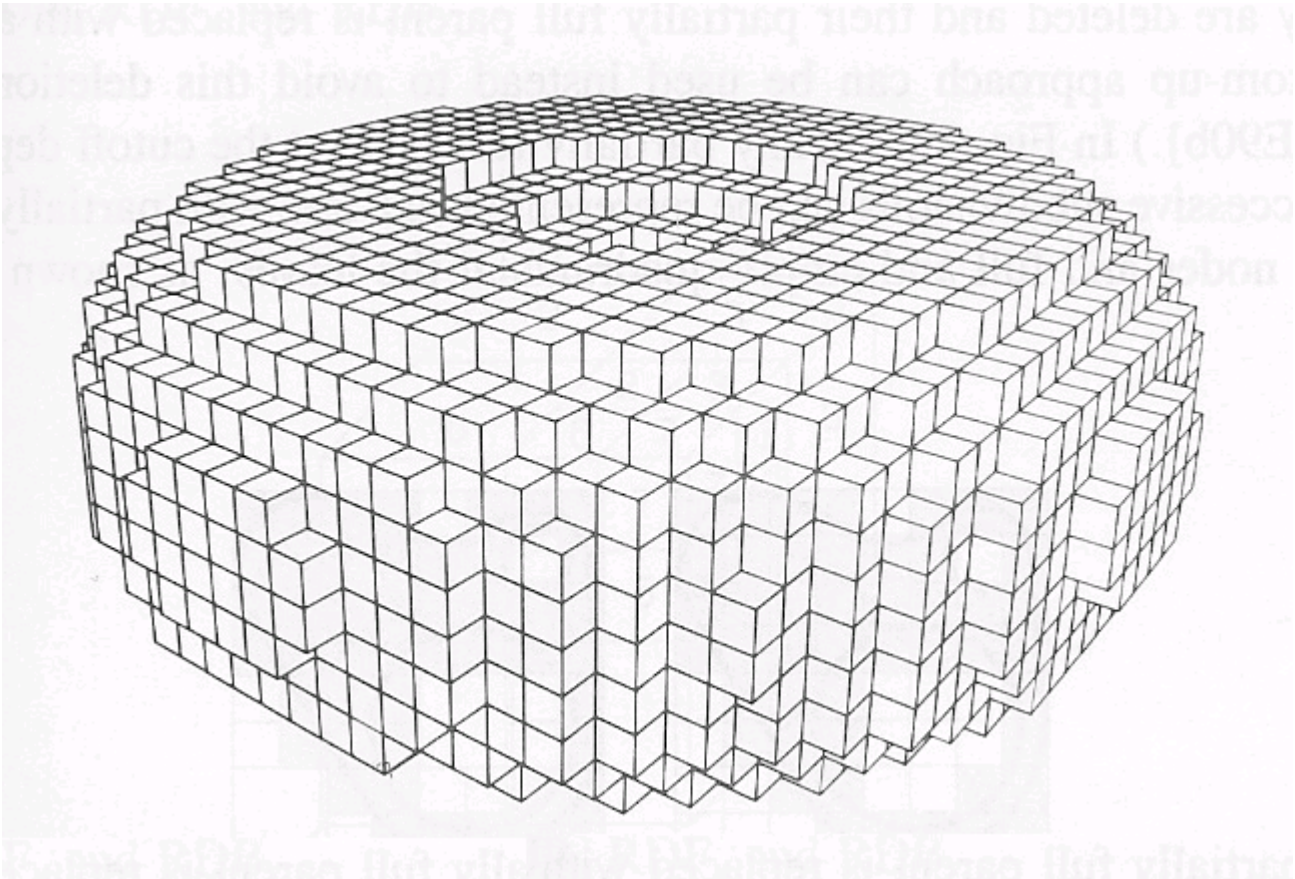


(c)

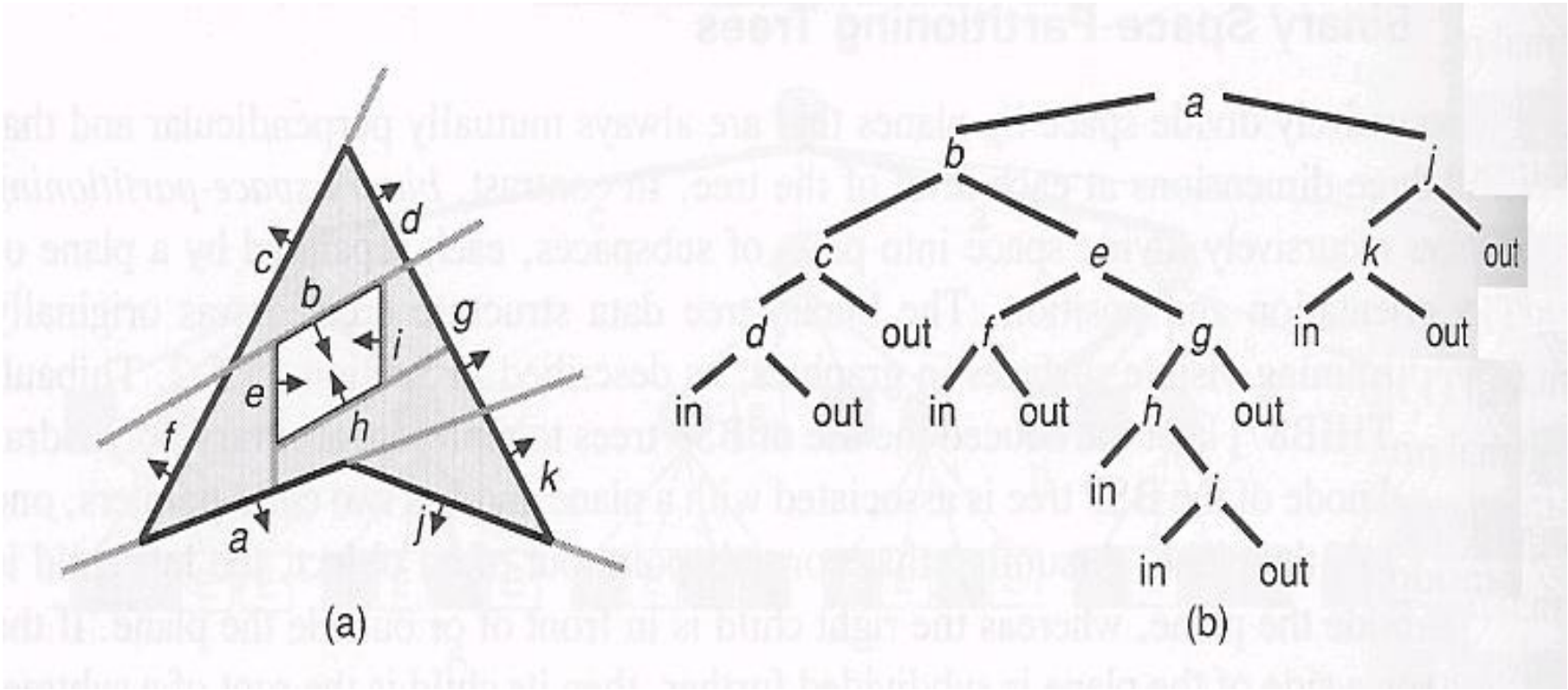
Octree


(a)
(c)
Node with descendants
Node representing an empty region
Node representing a full region

공간나열 모델링

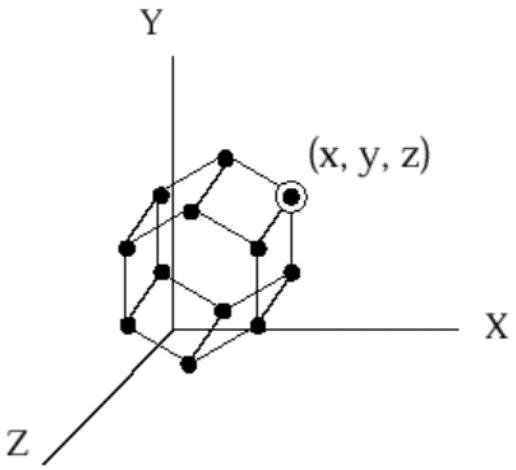


BSP Tree 모델링


a
b
c
d
e
f
g
h
i
j
k
(a)
a
b
j
c
e
k
out
d
out
f
g
in
out
in
out
in
out
h
out
in
i
in
out
(b)

다각형 모델링

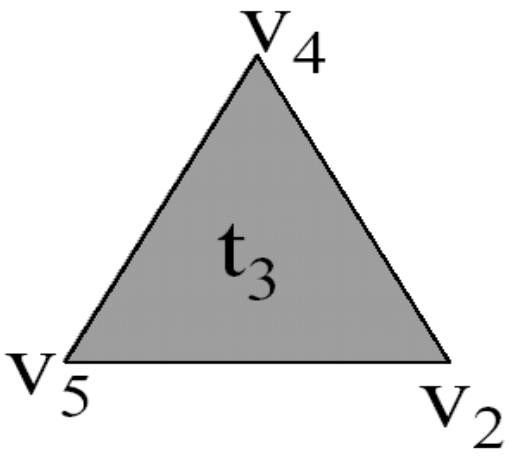
- 꼭지점들을 모두 나열한다.
- 각 다각형은 꼭지점들을 연결하여 만든다.
- 꼭지점들의 연결관계를 나타낸다.



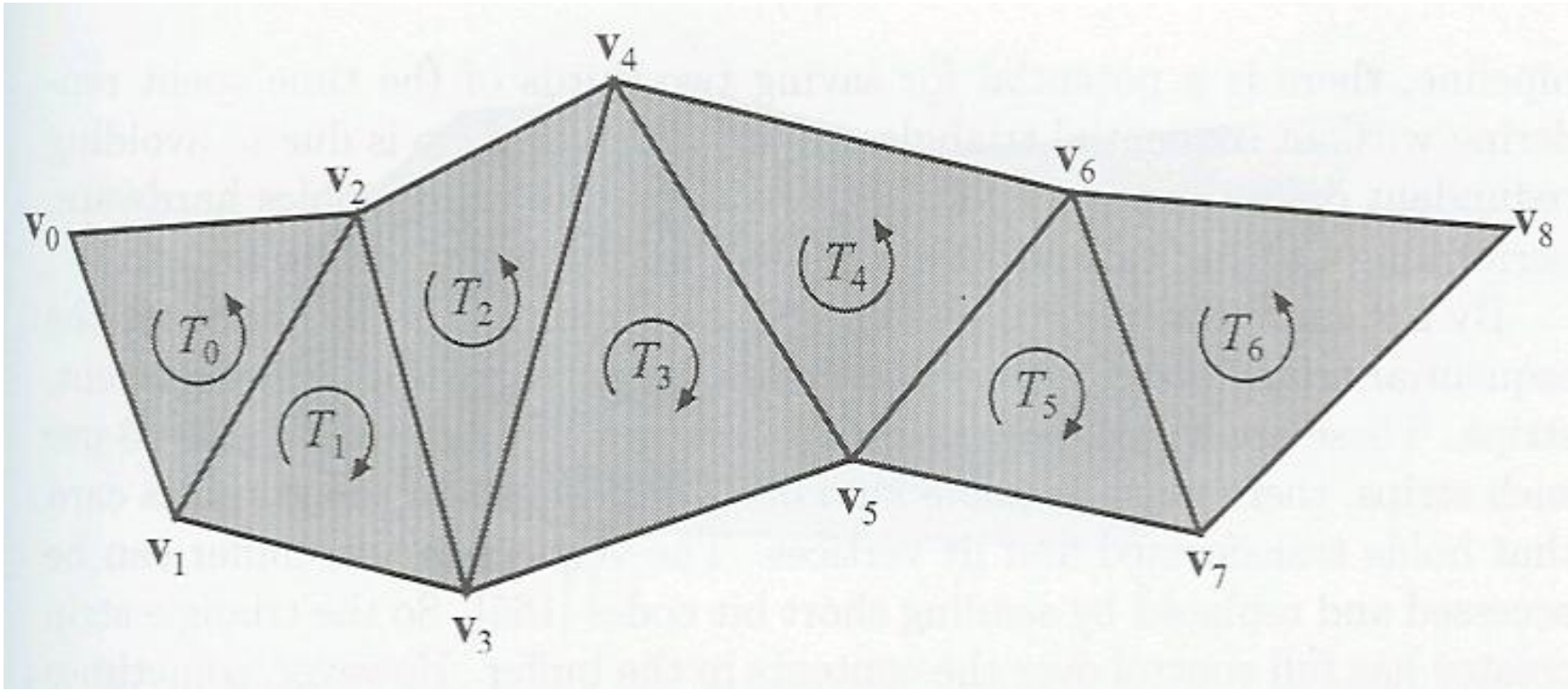
다각형 모델링

	x	y	z	c
vertex 1				
vertex 2				
vertex 3				

Triangle 1	1	2	3
Triangle 2	3	2	4
Triangle 3	4	2	5
Triangle 4	7	5	6
Triangle 5	6	5	8
Triangle 6	8	5	1

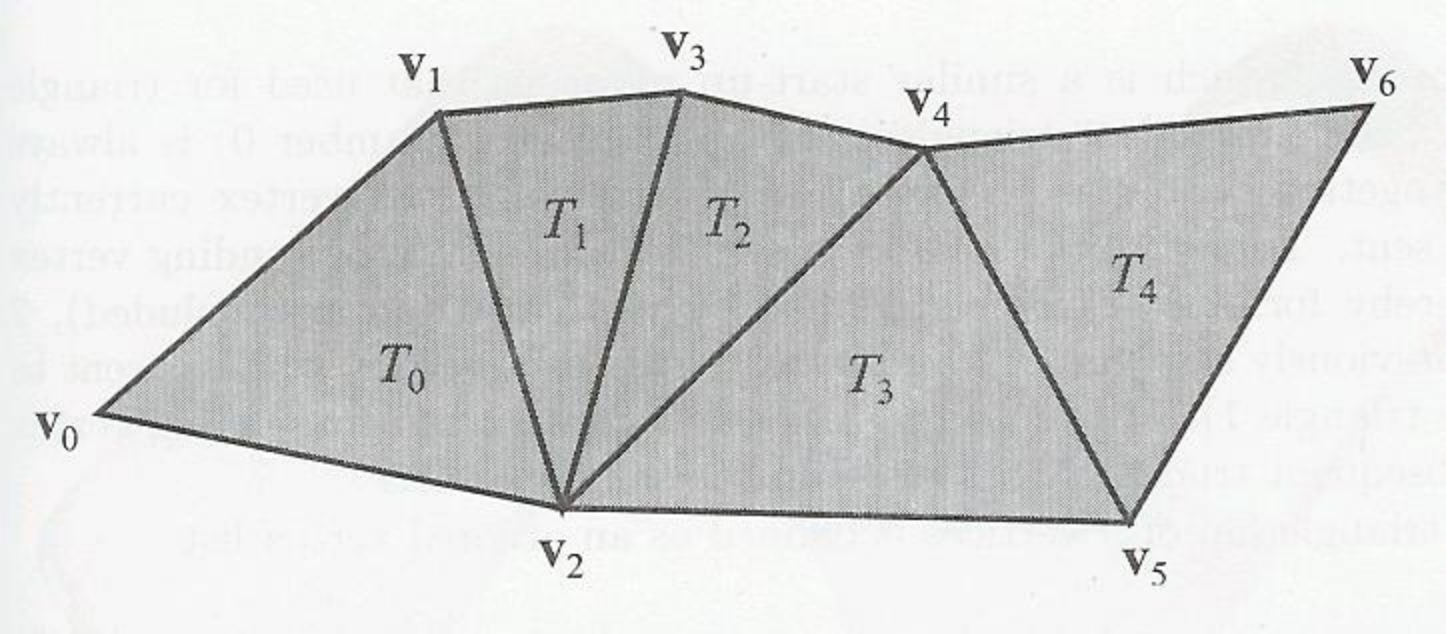


삼각형 띠



V0 V1 V2 V3 V4 V5 V6 V7 V8

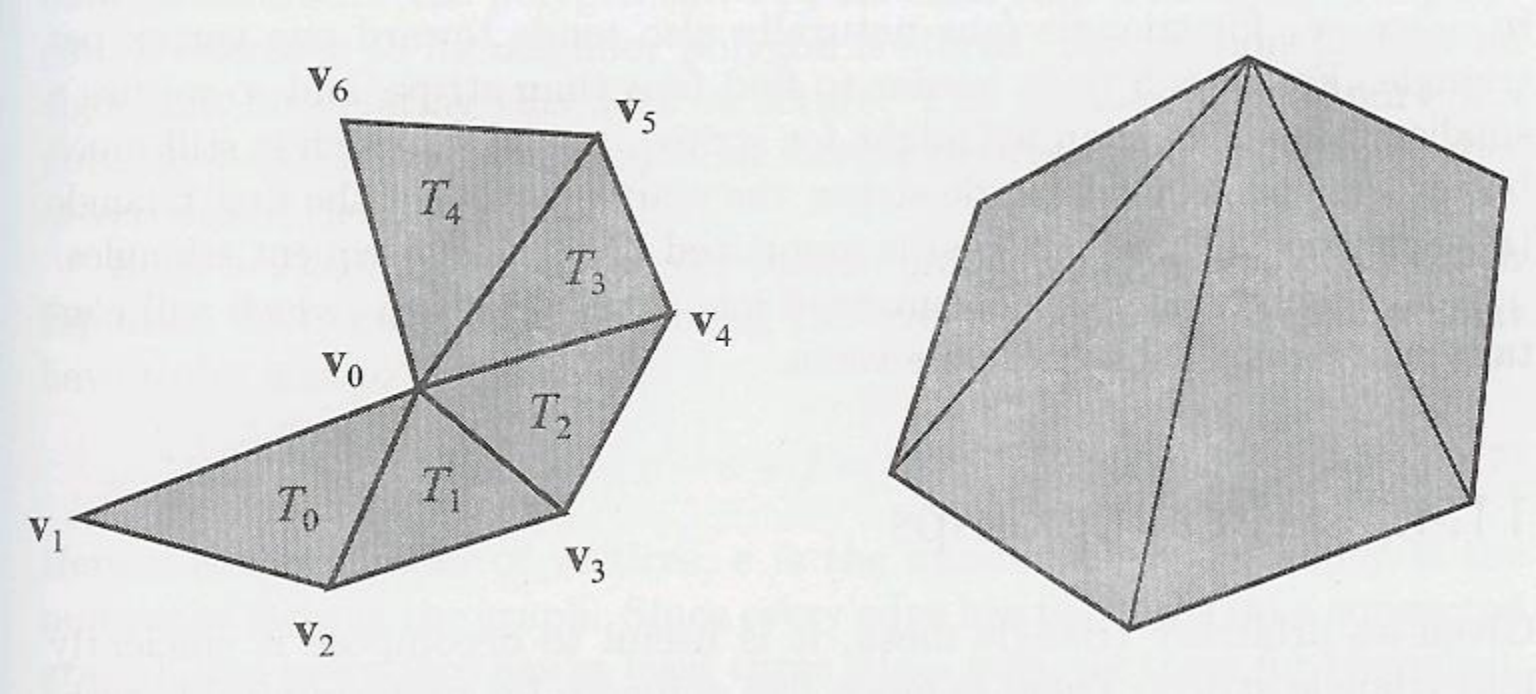
삼각형 띠



V0 V1 V2 V3 V2 V4 V5 V6

= V0 V1 V2 V3 SWAP V4 V5 V6

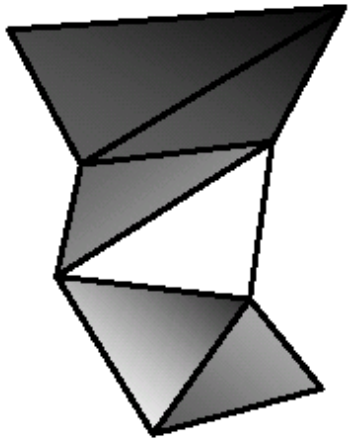
삼각형 부채



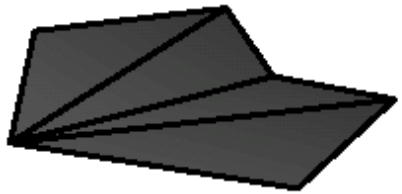
V0 V1 V2 V3 V4 V5 V6

OpenGL의 삼각형

GL_TRIANGLES



GL_TRIANGLE_STRIP



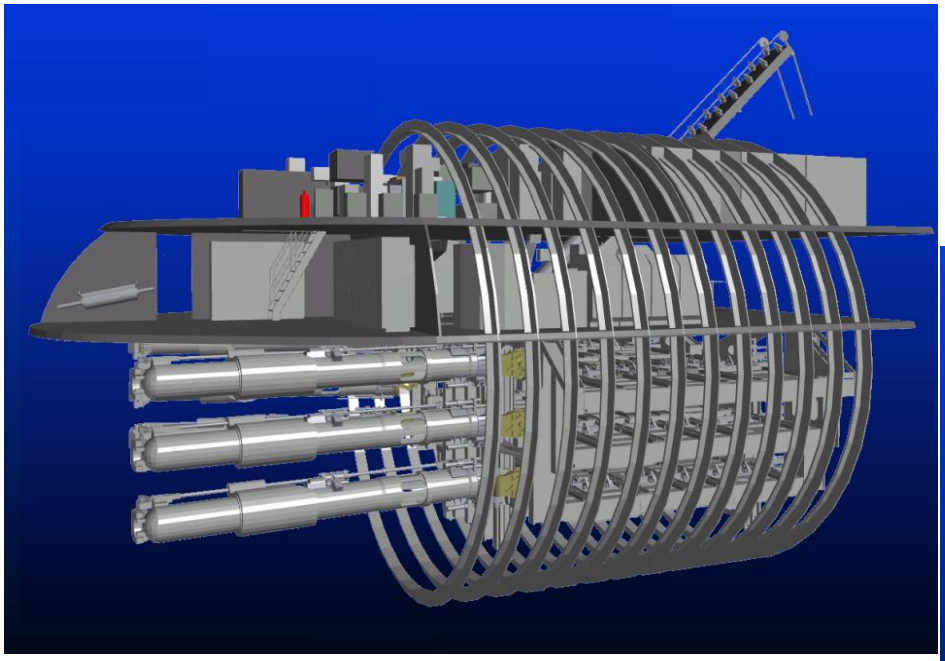
GL_TRIANGLE_FAN

다각형 모델링

```
#include <stdlib.h>
#include <GL/glut.h>


    GLfloat vertices[][3] = {{-1.0,-1.0,-1.0},{1.0,-1.0,-1.0},
    {1.0,1.0,-1.0}, {-1.0,1.0,-1.0}, {-1.0,-1.0,1.0},
    {1.0,-1.0,1.0}, {1.0,1.0,1.0}, {-1.0,1.0,1.0}};

void colorcube(void)
{

/* map vertices to faces */

     polygon(0,3,2,1);
     polygon(2,3,7,6);
     polygon(0,4,7,3);
     polygon(1,2,6,5);
     polygon(4,5,6,7);
     polygon(0,1,5,4);
}
```

```
void polygon(int a, int b, int c , int d)
{

/* draw a polygon via list of vertices */

    glBegin(GL_POLYGON);
        glColor3fv(colors[a]);
        glNormal3fv(normals[a]);
        glVertex3fv(vertices[a]);
        glColor3fv(colors[b]);
        glNormal3fv(normals[b]);
        glVertex3fv(vertices[b]);
        glColor3fv(colors[c]);
        glNormal3fv(normals[c]);
        glVertex3fv(vertices[c]);
        glColor3fv(colors[d]);
        glNormal3fv(normals[d]);
        glVertex3fv(vertices[d]);
    glEnd();
```

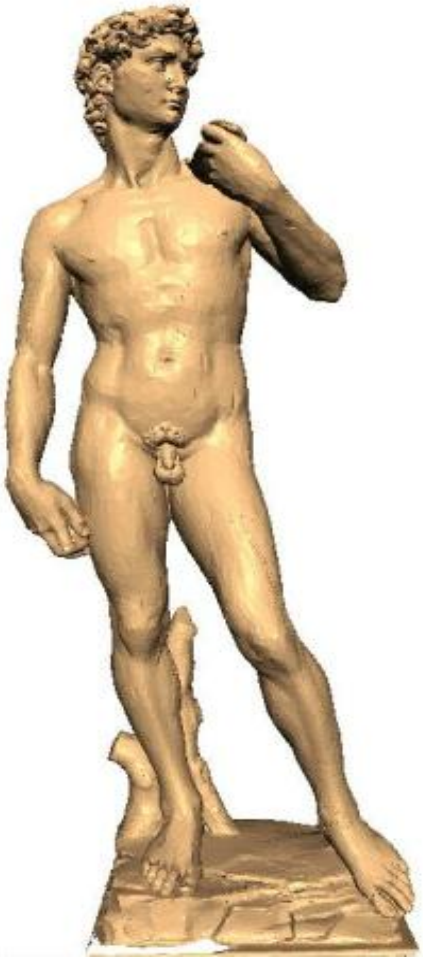
다각형 모델링의 예



70만 다각형

1300만 다각형

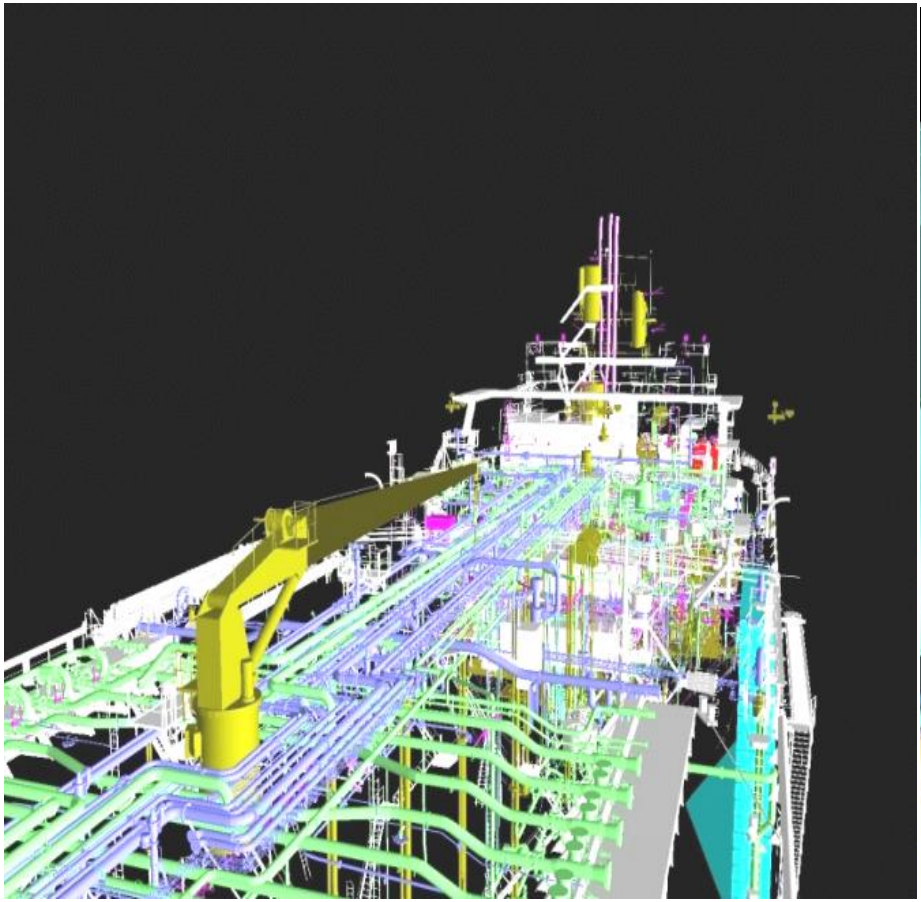
3차원 모델링의 예

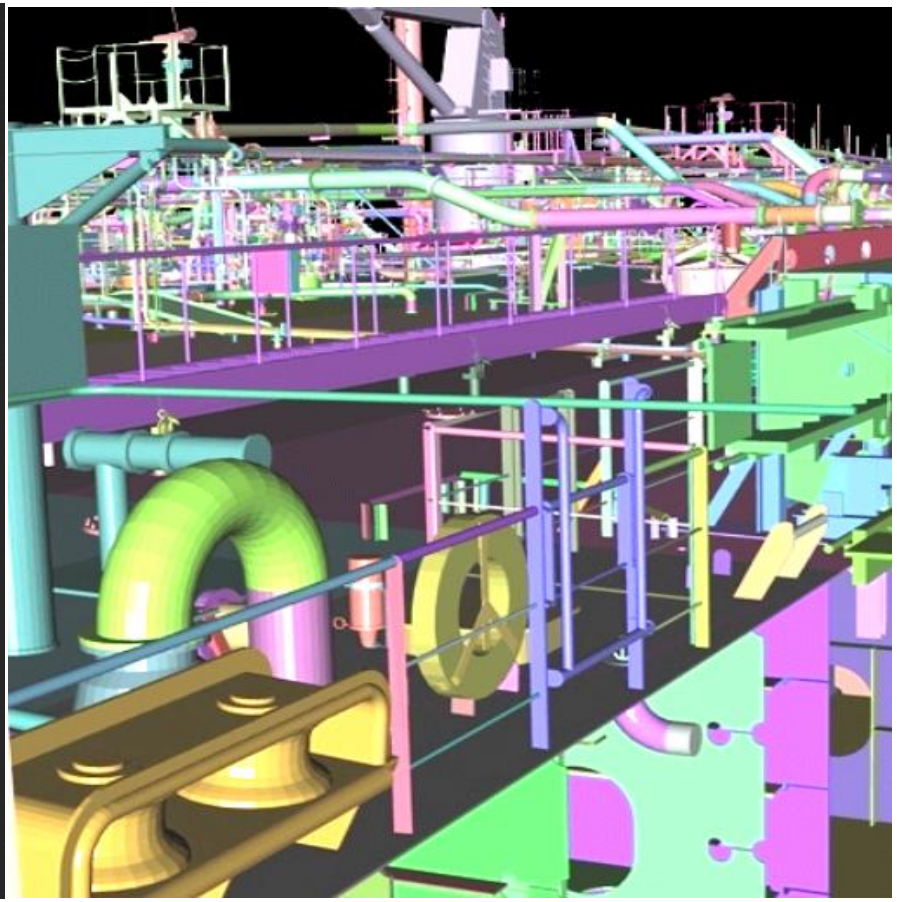


5600만 polygon

1700만 polygon

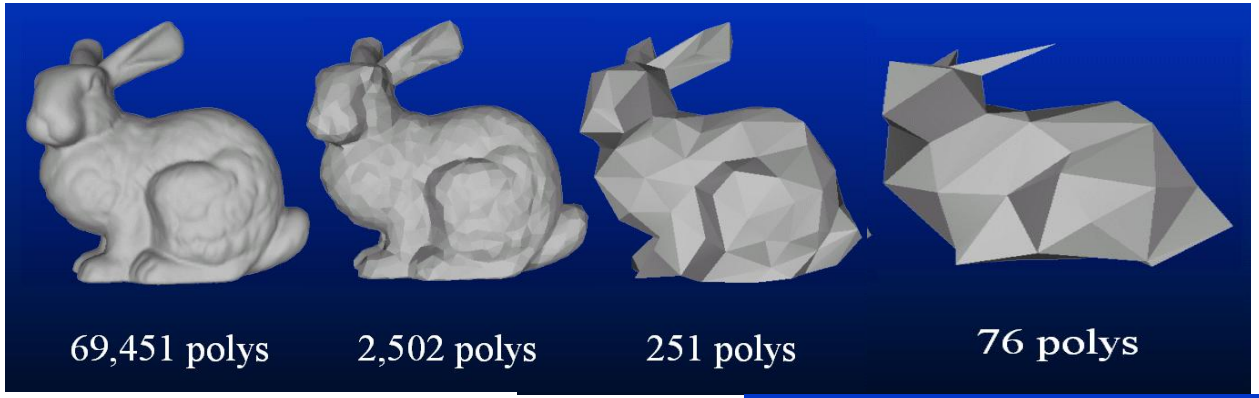
3차원 모델링의 예

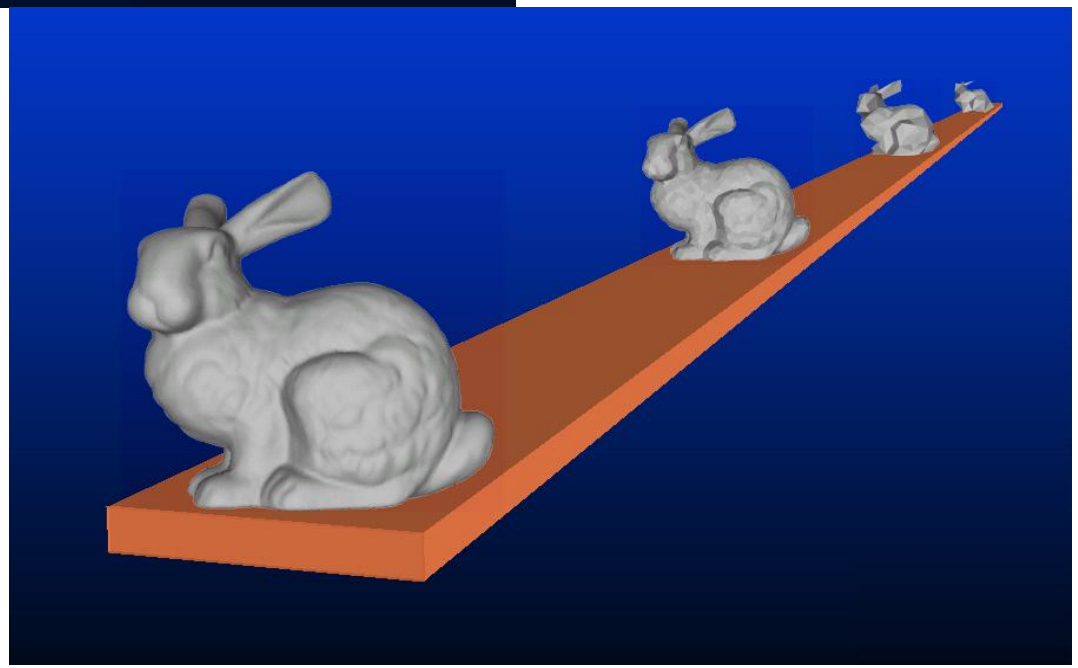




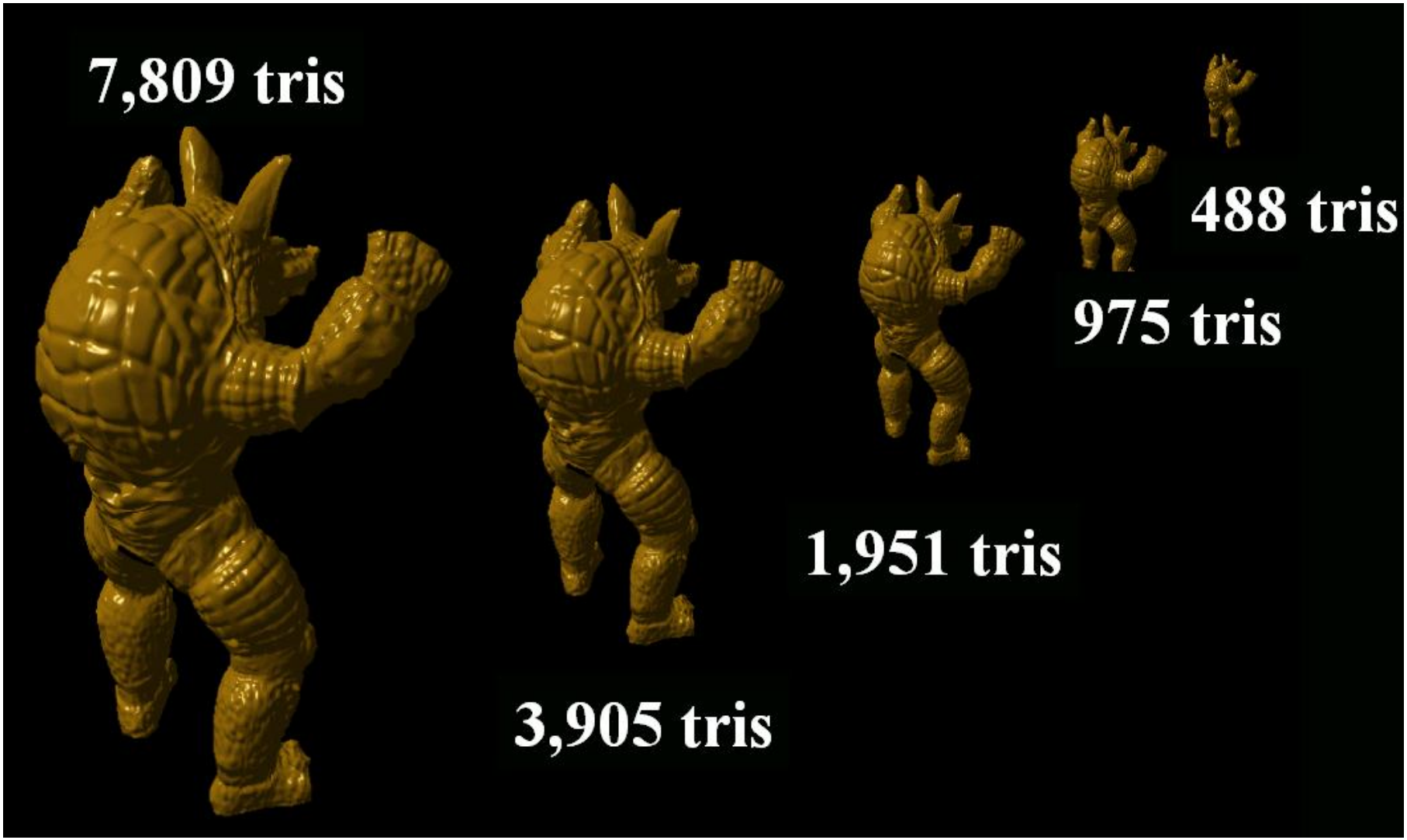
8200만 polygon

Level of Detail (LOD)



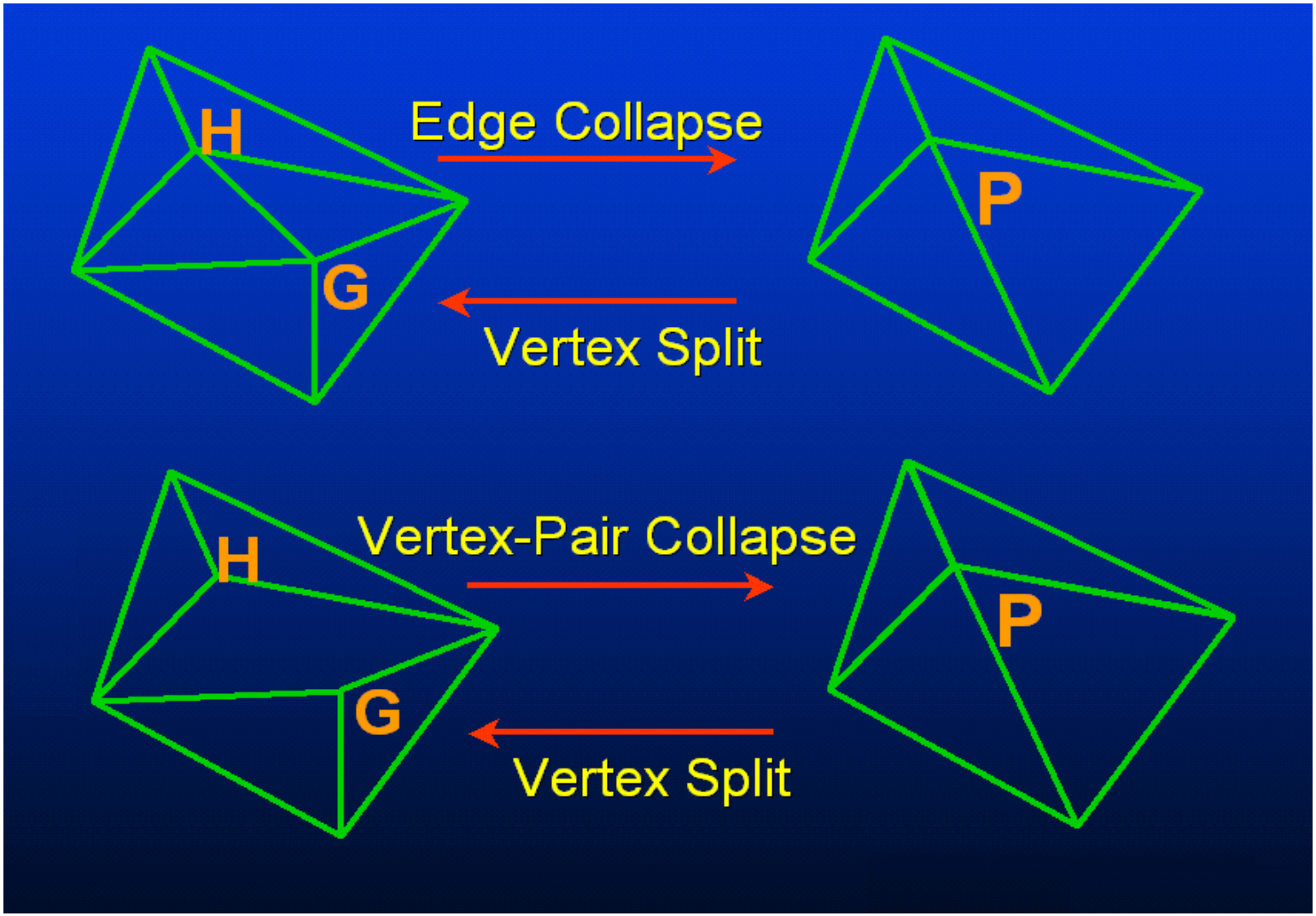


Level of Detail (LOD)

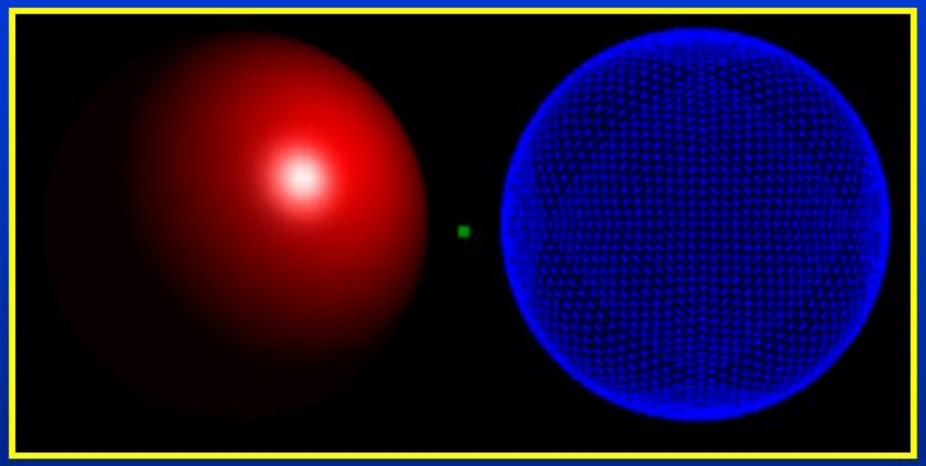


Level of Detail (LOD)

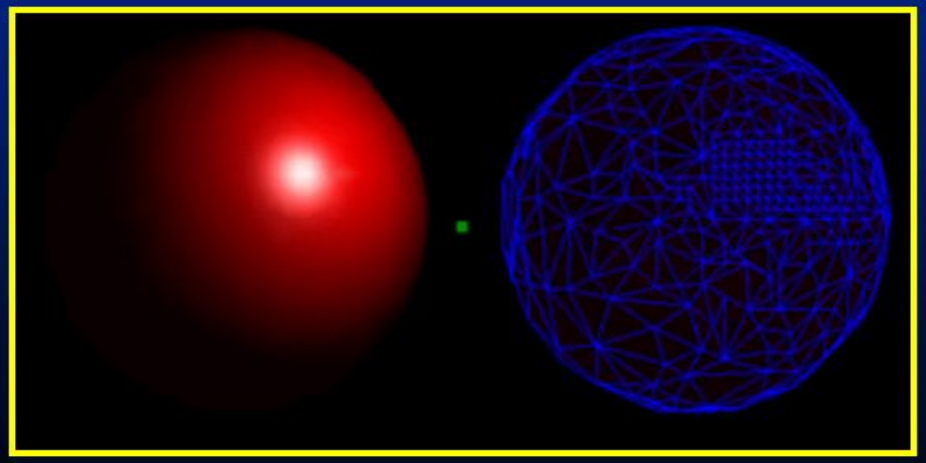
LOD 생성방법


H
Edge Collapse
P
G
Vertex Split
H
Vertex-Pair Collapse
P
G
Vertex Split

시점 종속 LOD

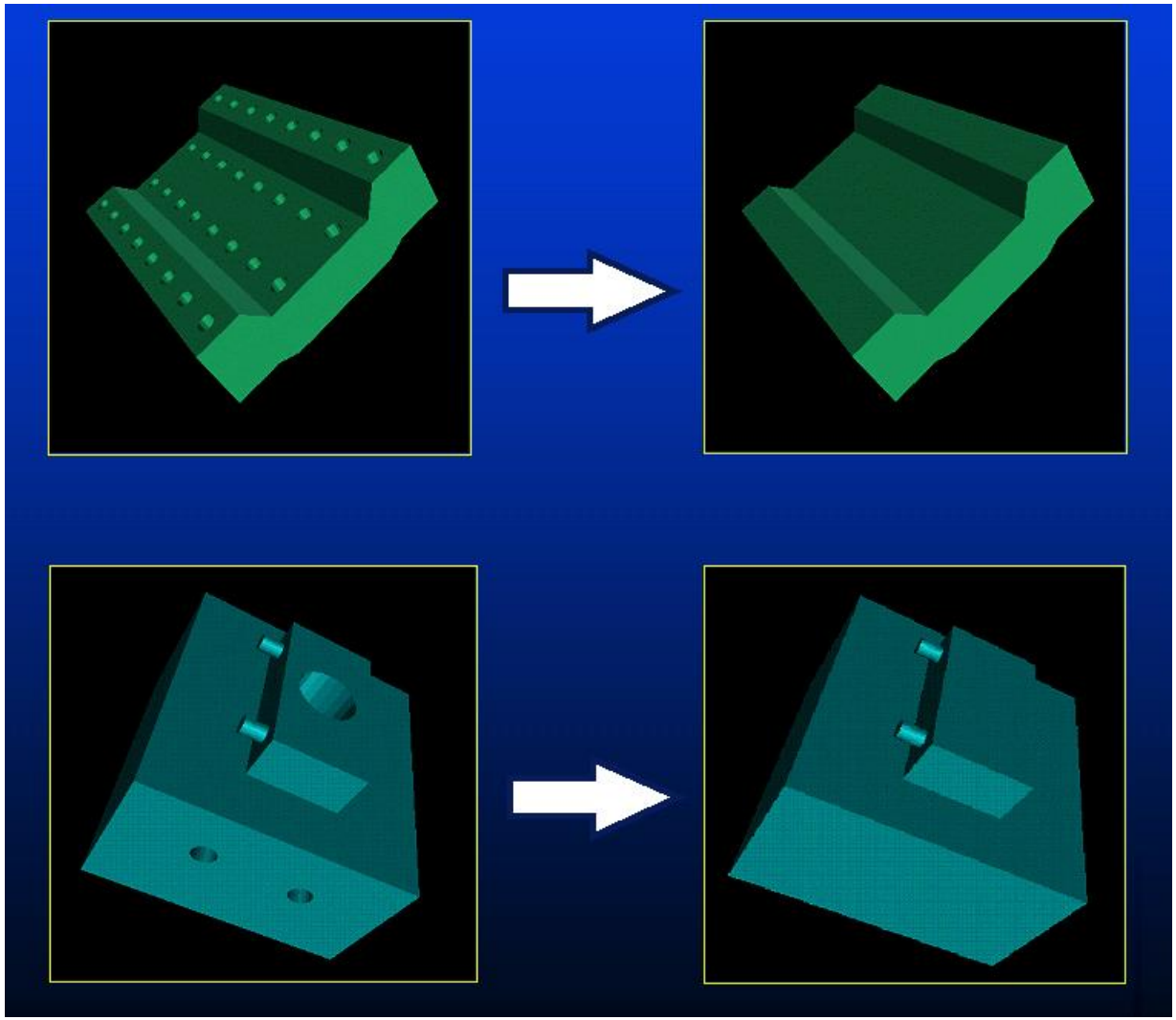


8192 triangles

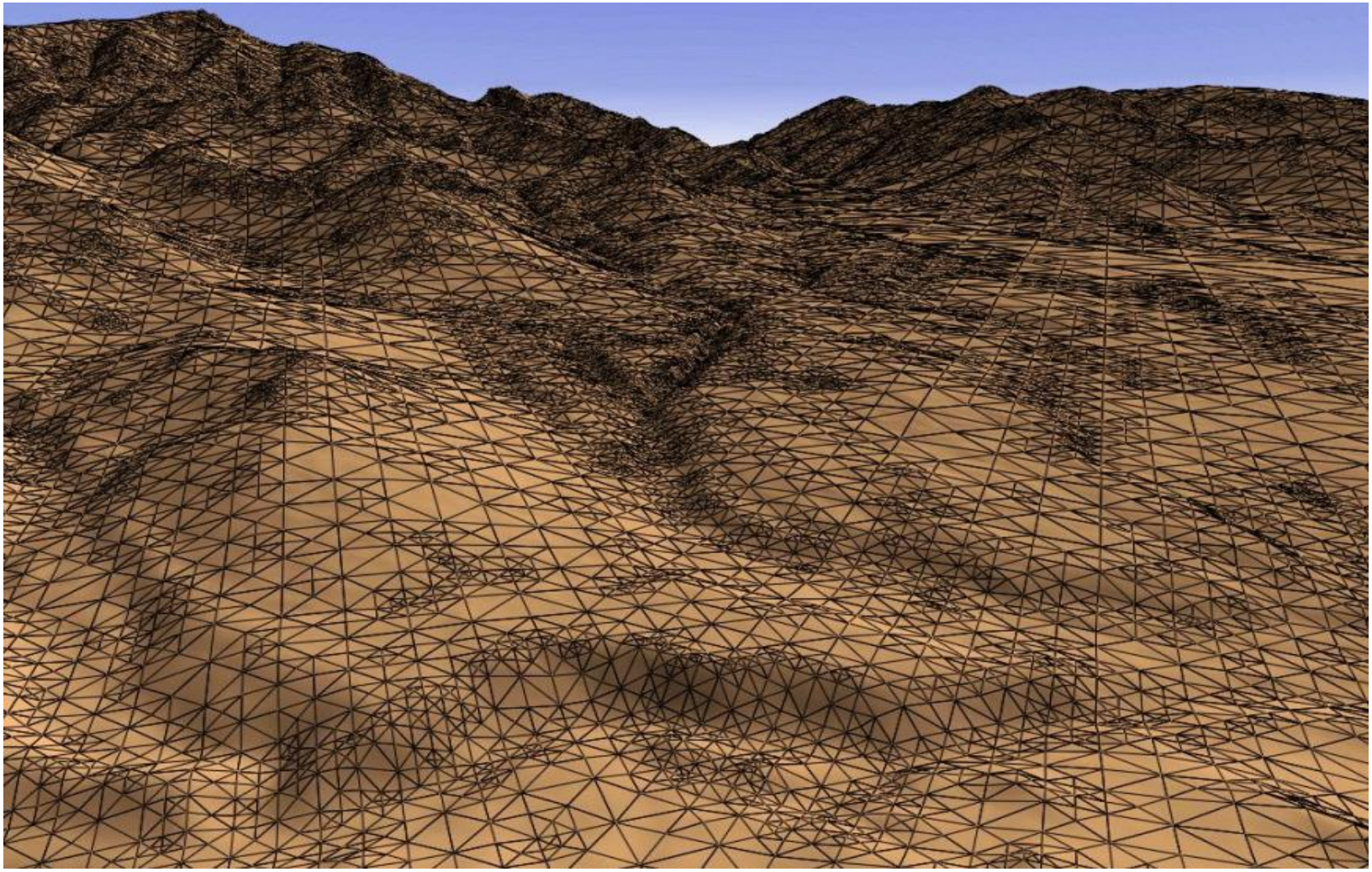


537 triangles

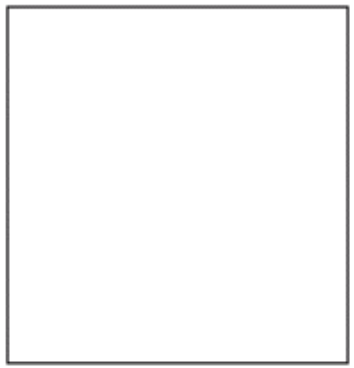
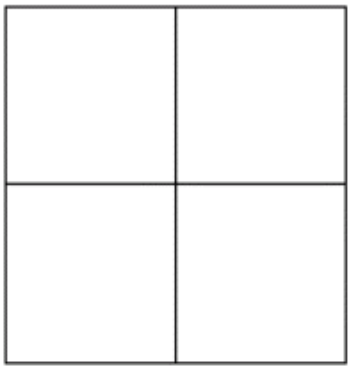
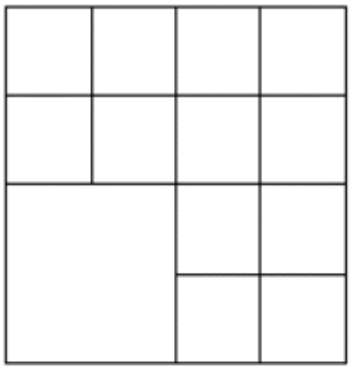
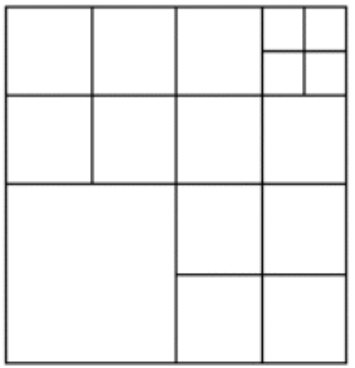
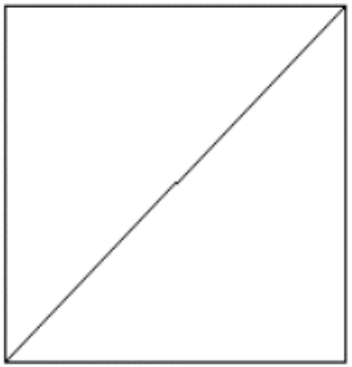
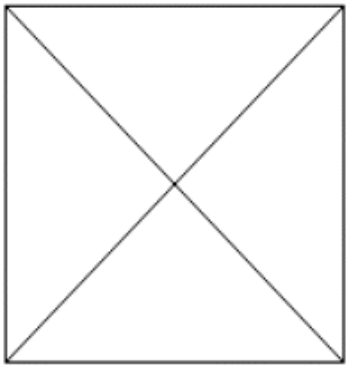
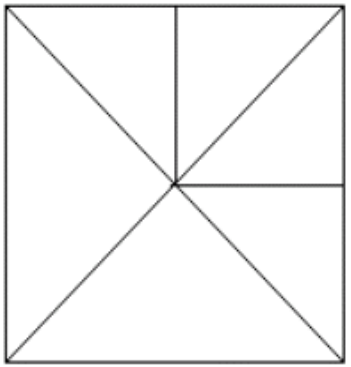
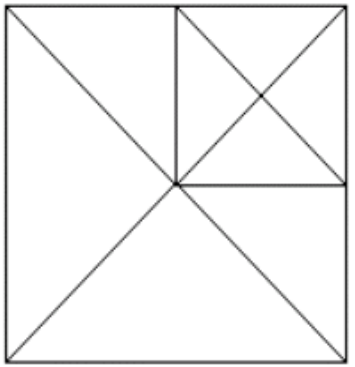
특징기반 LOD



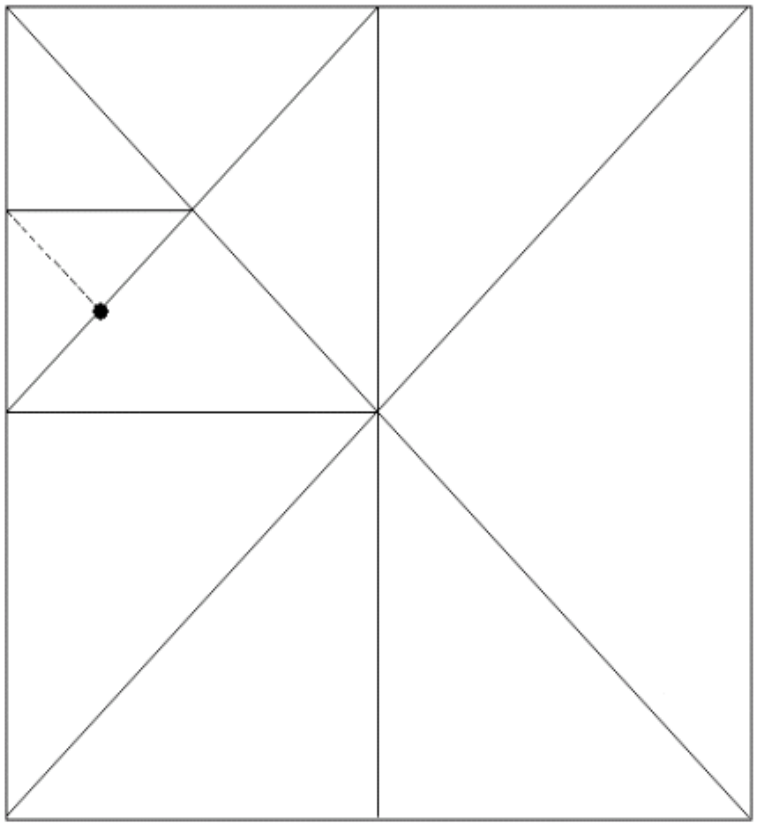
지형의 LOD

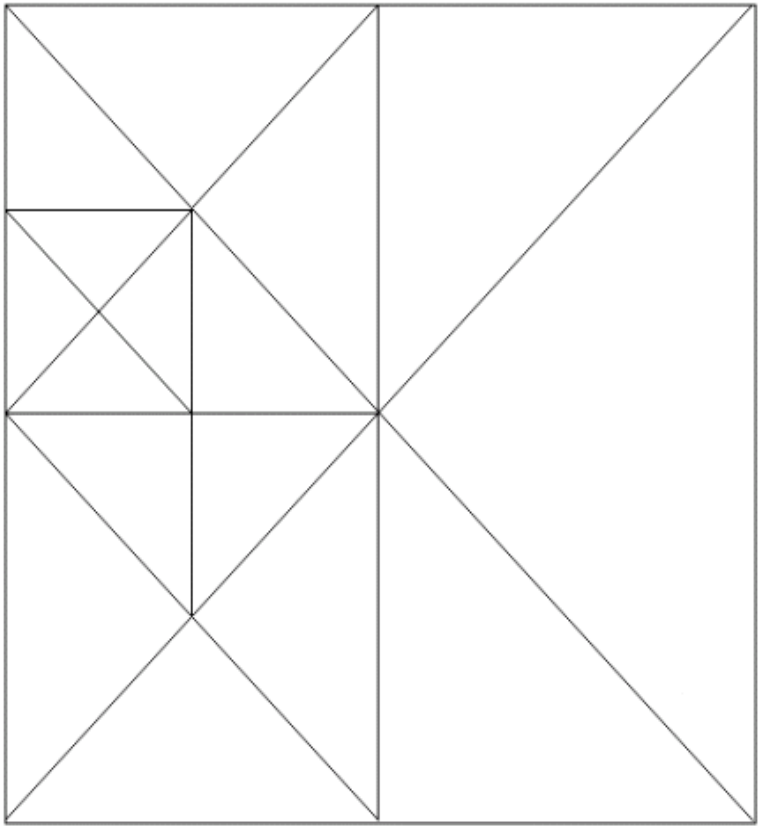


Quadtree and Bintree

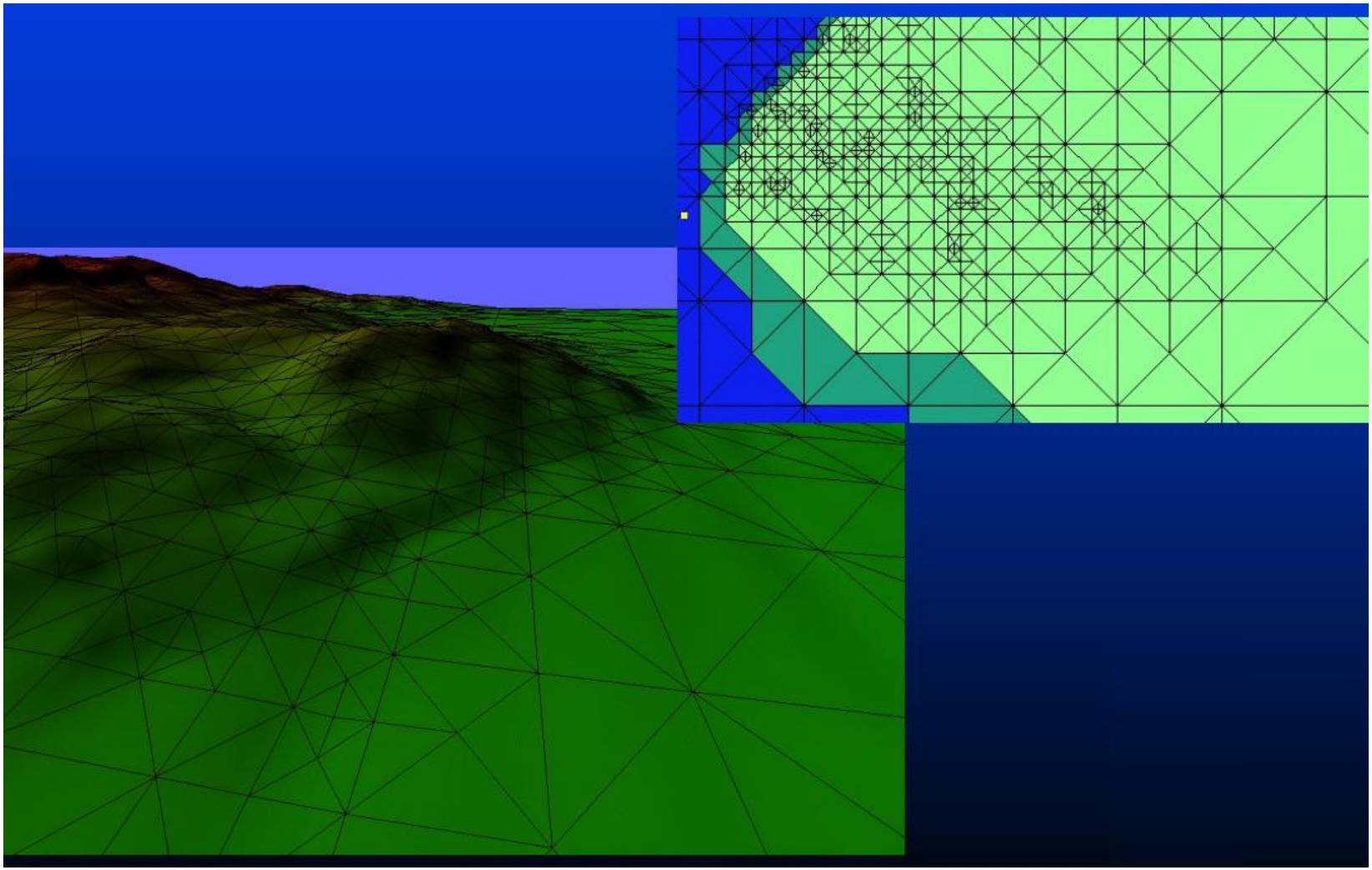









T-Junction 처리

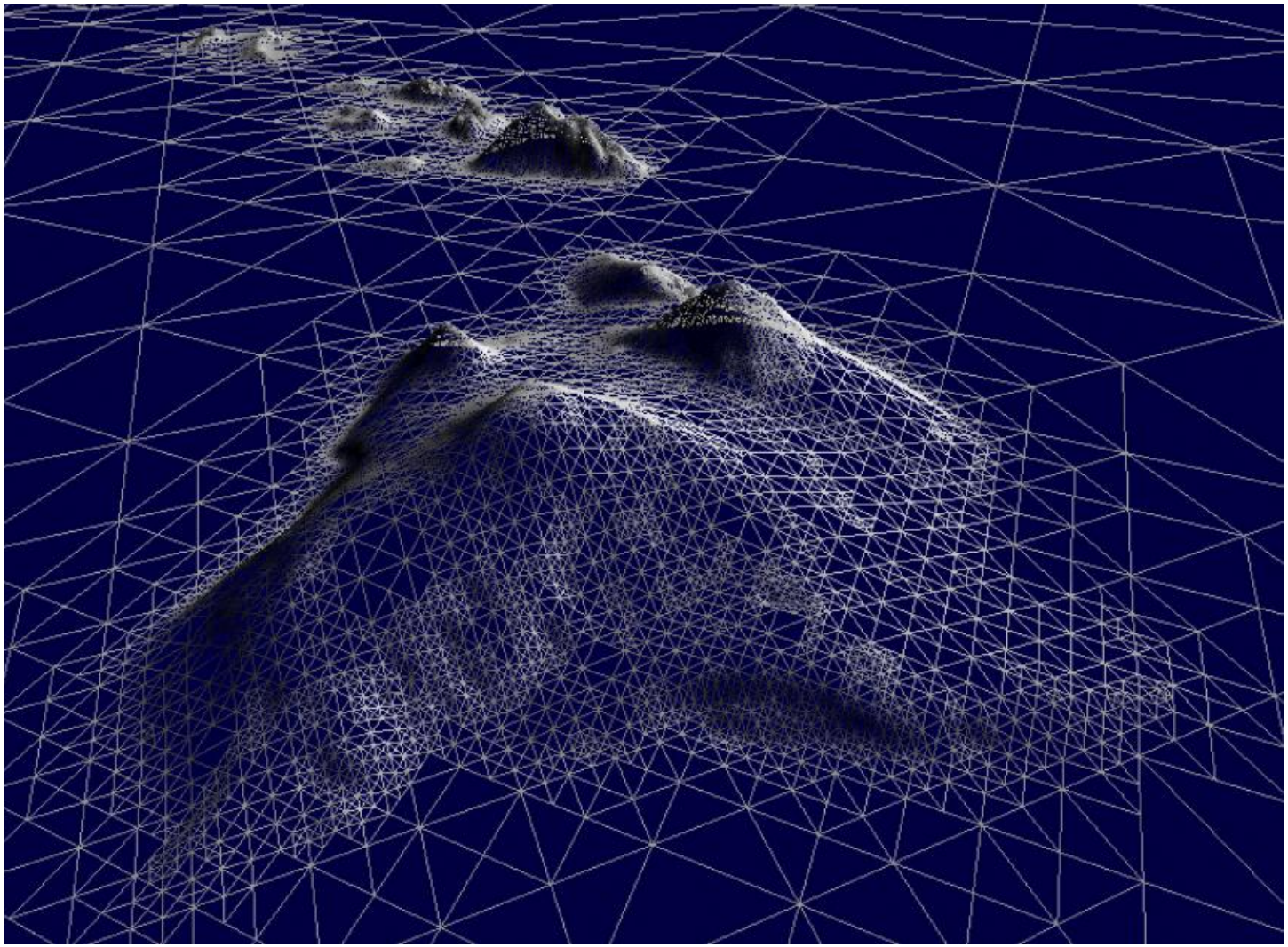




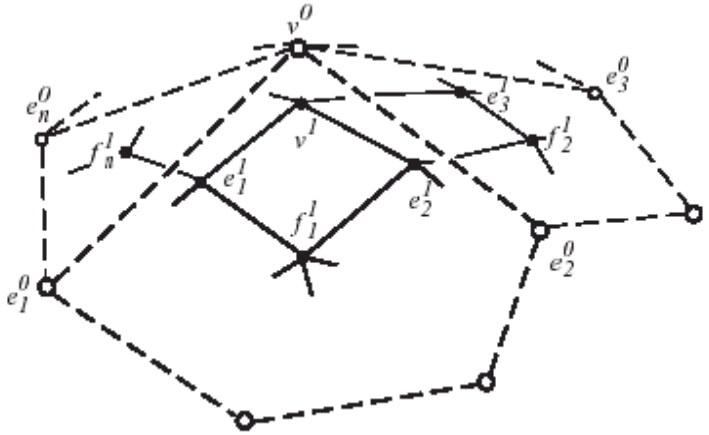
지형의 LOD

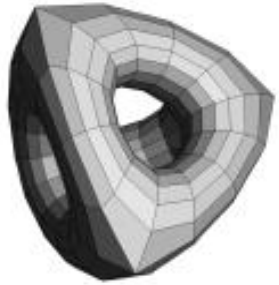


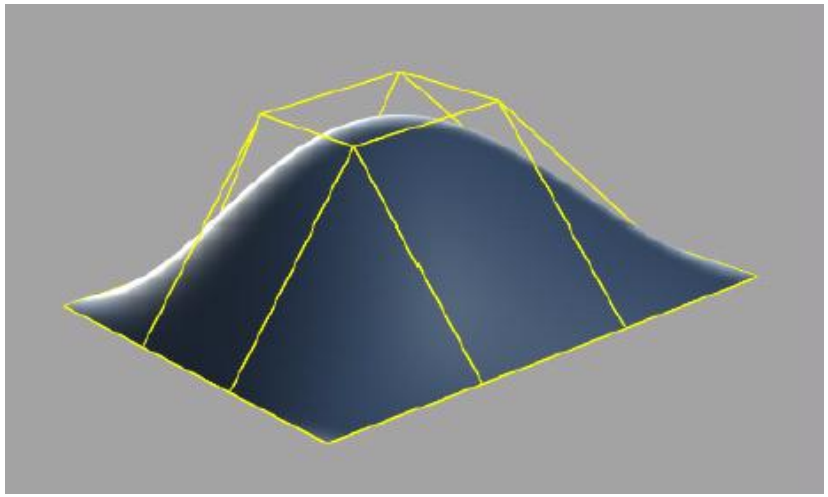
지형의 LOD



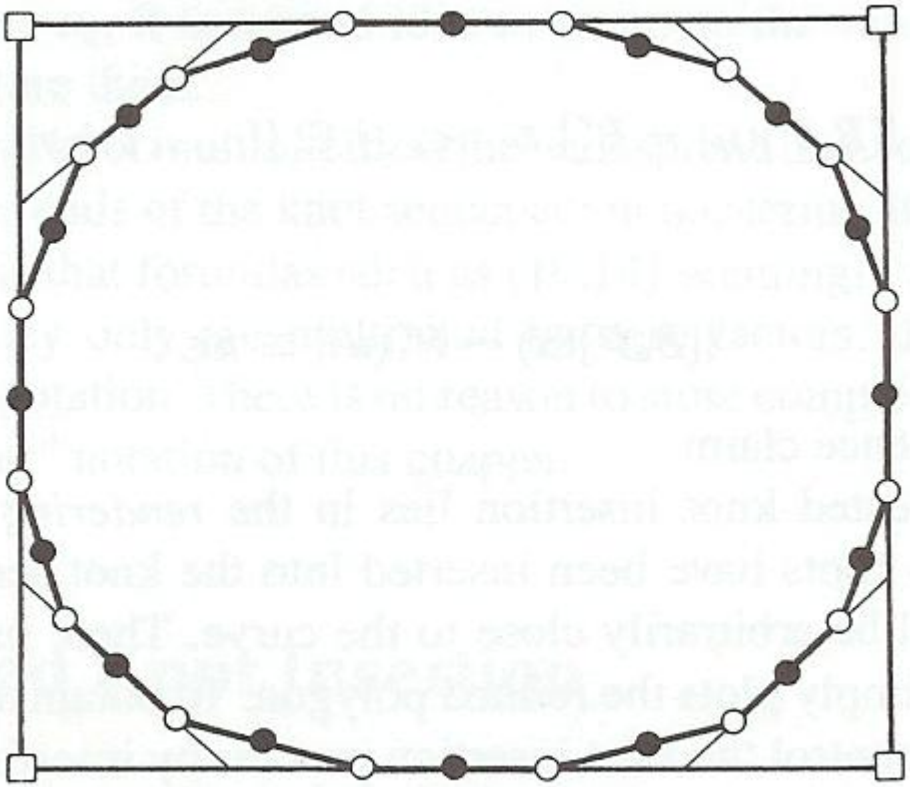
Subdivision 곡면



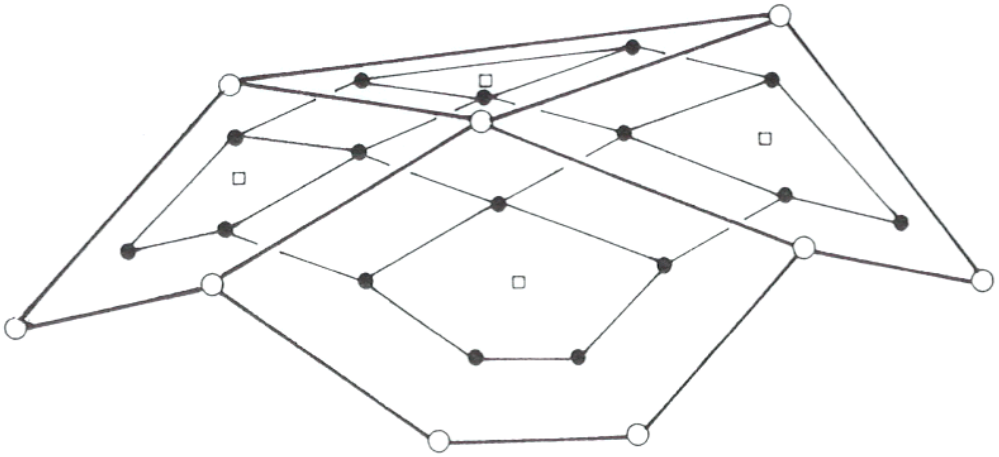


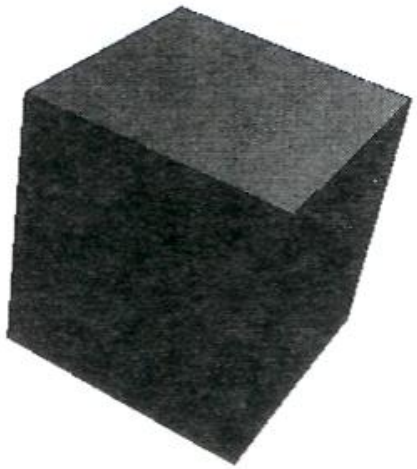


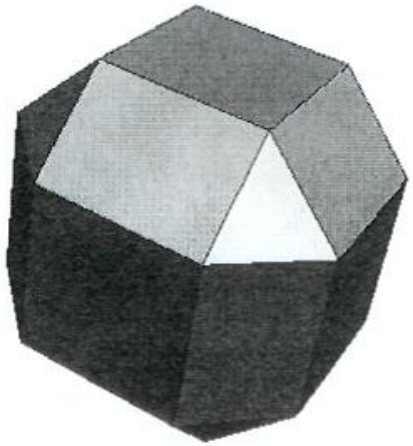
Chaikin의 알고리즘 (1974)

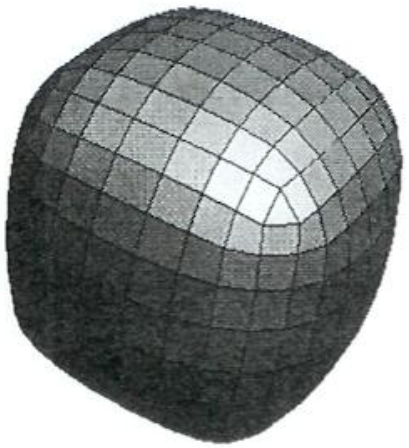


Doo-Sabin 알고리즘

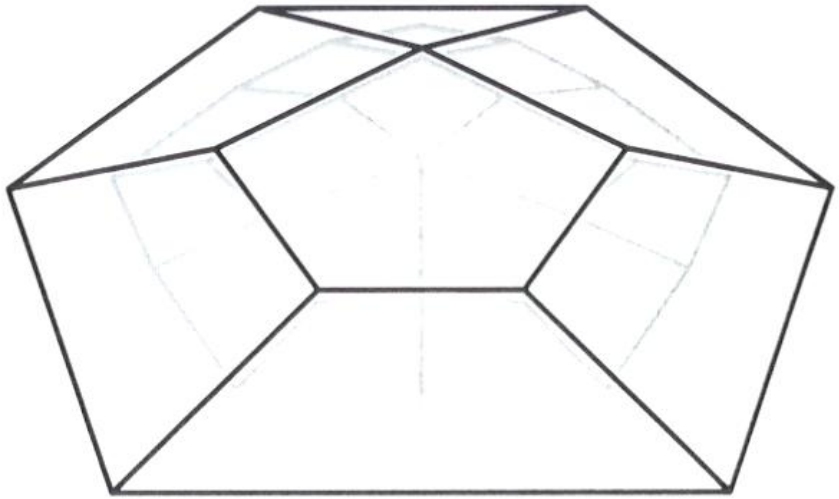


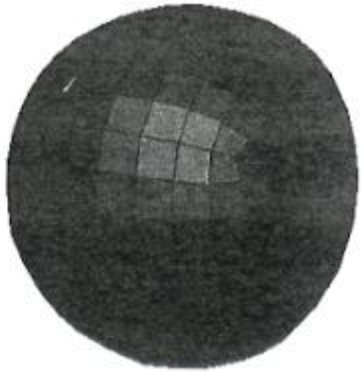




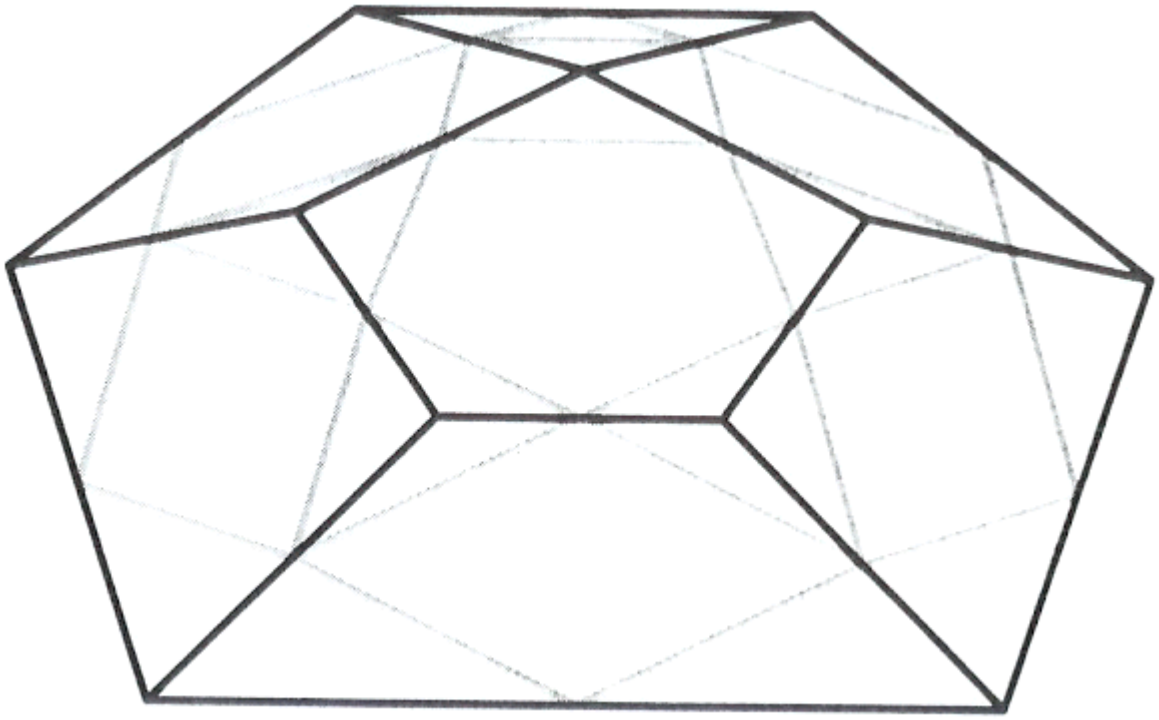


Catmull-Clark 알고리즘





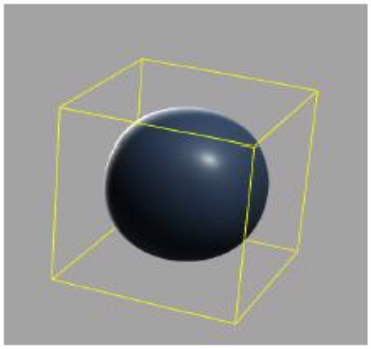
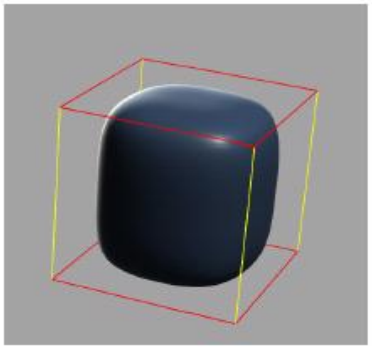
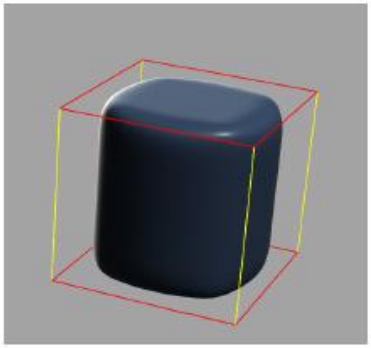
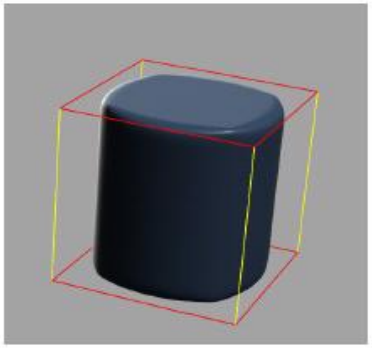
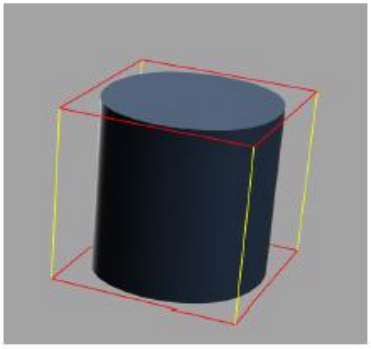
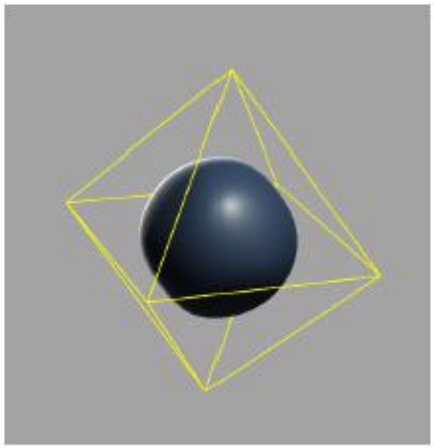
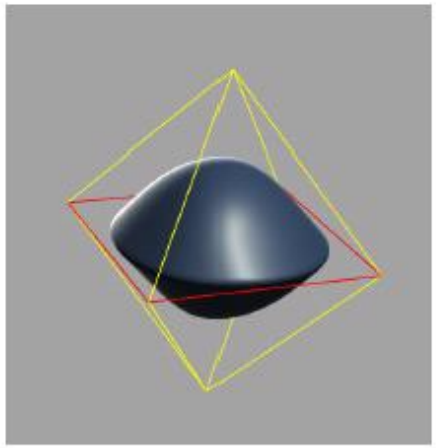
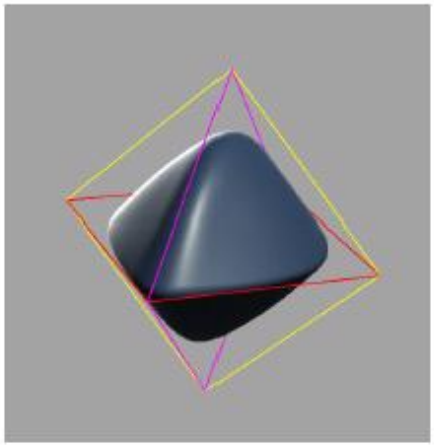
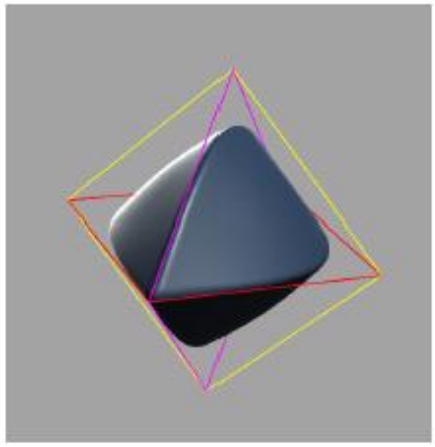
중간점 분할 알고리즘



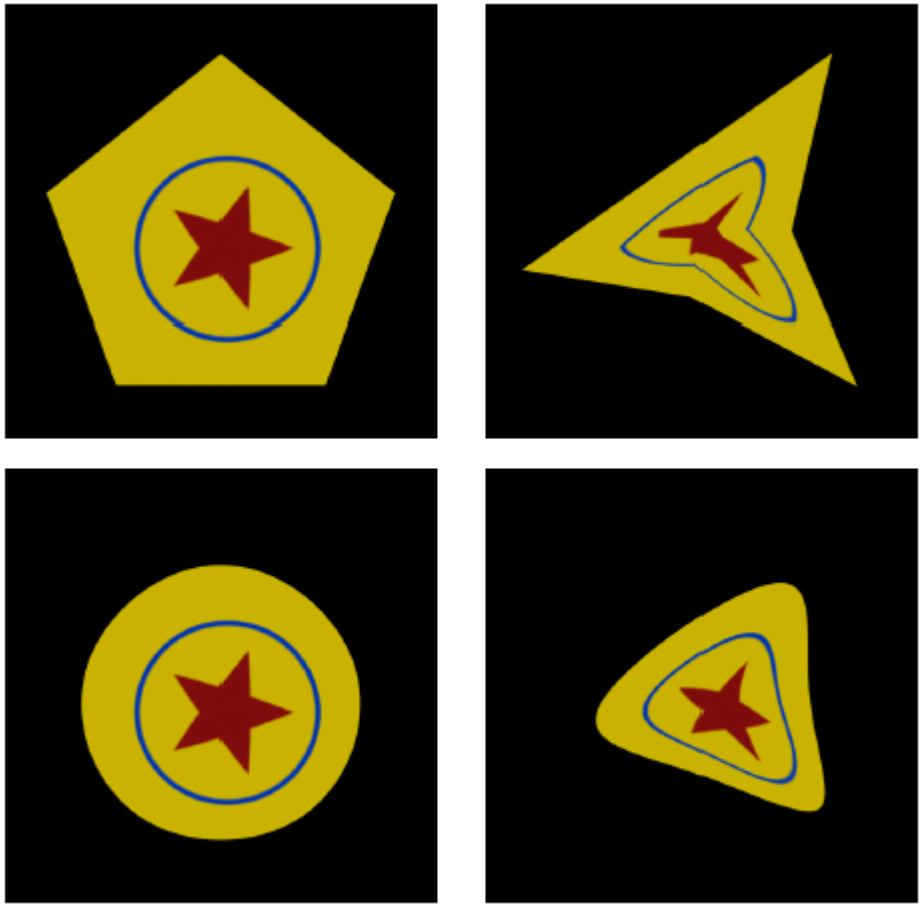
Geri's Game: Pixar Animation

Subdivision 곡면 모델링의 예

Sharpness 제어

텍스처 매핑



5개의 삼각형으로
이루어진 다각형에
대한 텍스처 매핑

Subdivision
곡면으로 모델링된
경우의 텍스처 매핑