

# Solid building

Emilio González Montaña (egoeht69@hotmail.com)  
at <http://emiliogonzalez.sytes.net>

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## Abstract

The aim of this document is to study the different techniques to build solid objects. We will discuss these methods: building solid geometry, mathematic generation and mesh edition. To illustrate the methods we will introduce some scenes generated in 3DS.

## 1 Introduction

This work will explain the different methods to build 3D objects, we will talk about the three main methods, illustrating each of them with 3DS scenes.

We will do this for every method:

- Explain the method.
- Use a 3DS scene to illustrate it.

## 2 Constructive solid geometry

This object building method uses the concatenation of one or more of these simple operations:

- Union.
- Intersection.
- Substraction.

All these methods use the plane intersection calculation (although finally they use the information for unions, intersections or subtractions).

This could be a typical procedure to calculate intersections:

```
FOR-EVERY object IN objectList
  FOR-EVERY polygon IN object.polygons
    FOR-EVERY otherObject IN objectList AND NOT IN usedObjectList
      IF object <> otherObject
        FOR-EVERY otherPolygon IN otherObject.polygons
          IF AreIntersected (polygon, otherPolygon)
            intersection = CalculateIntersection (polygon, otherPolygon)
            AddIntersection (intersections, intersection)
```

```

        END-IF
      END-FOR
    END-IF
  END-FOR
  AddObjet (usedObjectList, object)
END-FOR

```

Finally in the intersections variable, we have the list with the intersections of all the polygons of all the objects; with these intersections (grouped as we need), we can calculate the new polygons of the new object (based on the operation type of the composition that we need).

## 2.1 Example

To achieve a complex object (figure 2) using this method, we need to concat several operations, this has been illustrated into figure 1. We can see a hierarchy of operations, where the top element is the final object, and the leaves are the basic primitives used to achieve the result, the intermediate operations are the ones saw in the previous section.

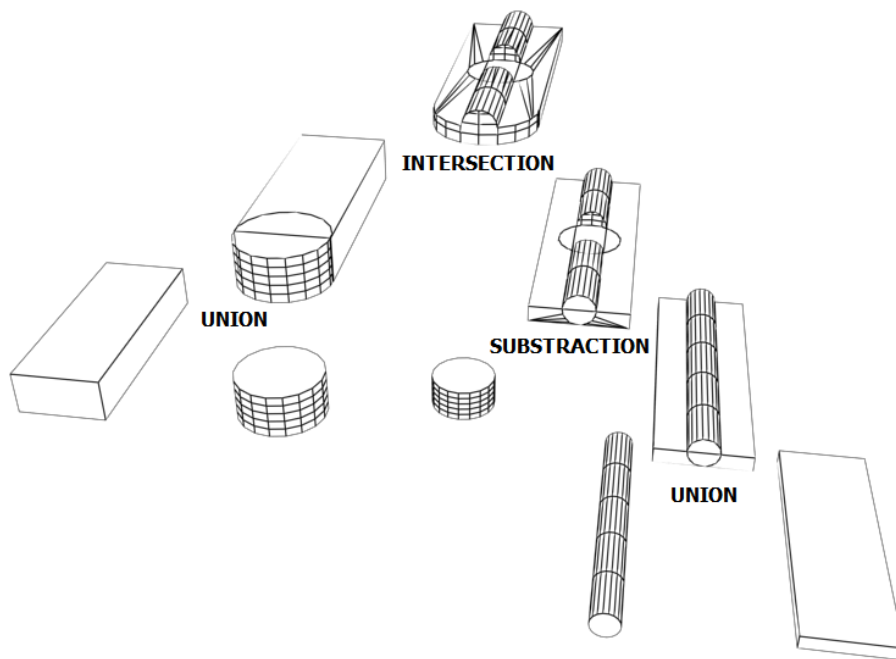


Figure 1: Tree of operations to achieve a new object

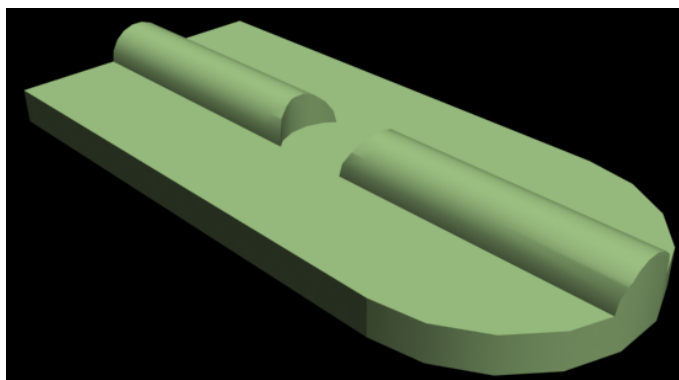


Figure 2: Object achieved by Solid Geometry method

## 2.2 Intersection calculation troubleshooting

We must analyze how is formed a polygon face, previous to the intersection calculation algorithm.

Usually we see a face like this:

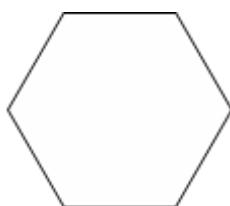


Figure 3: A normal polygon

But the real inside is that the face is triangulated to something similar to this:

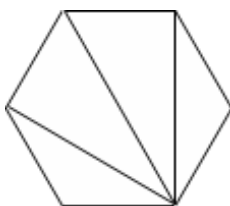


Figure 4: The triangles inside a normal polygon

This is done in this way to make easier the model calculation (a three point polygon is much easier to manage that a bigger one, and we get all the polygons homogenized).

### 2.2.1 Example

To illustrate this we have composed a simple object that it is the subtraction of two boxes (figure 5), the image has been coloured to distinguish between the

triangles of the faces.

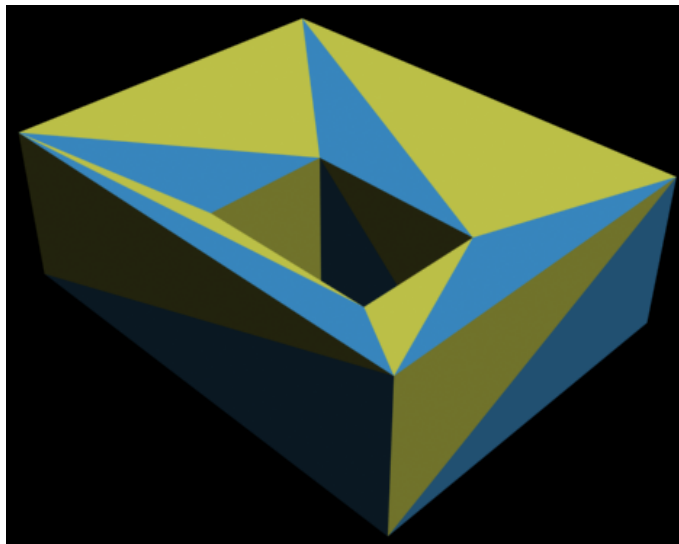


Figure 5: Triangulation example of an object faces

### 3 Procedural

The procedural method is a way of applying mathematical functions to primitives we can achieve complex objects.

There are a several operations to apply to a shape:

- Revolution of a plane figure a certain angle number (like in the figure 7).
- Extrude of a plane figure along a path (this is similar to the previous if we use a circumference as path).
- Extrude of different plane figures along a path (we choose the figure to extrude in the points of the path).

#### 3.1 Example

For instance if we use this shape (figure 6):



Figure 6: Simple shape

And we apply a rotation to it, we get this (figure 7):



Figure 7: Object generated by procedural method

## 4 Mesh edition

This method is based into the edition of the 3D object mesh; we can change several parts of the object:

- Point.
- Edge.
- Polygon.

The idea is start from a relatively simple object (like a box) and extruding it to achieve the expected figure.

### 4.1 Example

In the figure 8 we have started from a box, and after making modifications in its subelements we achieve the final result.

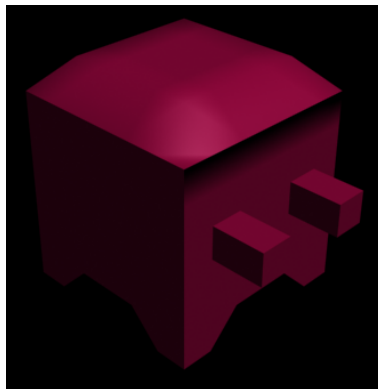


Figure 8: Object generated by mesh edition

## References

- [1] David Escudero Mancebo: *Fundamentos de informática gráfica*, Ceysa, 2003.
- [2] Alan Watt: *3D Computer Graphics* (third edition), Addison-Wesley, 2000.
- [3] 3D Studio Max Reference: *Autodesk*.