



Subject:CG

Sem : III

Class: SEDS

Sweep representation and CSG

Sweep representations are used to construct 3D object from 2D shape that have some kind of symmetry.

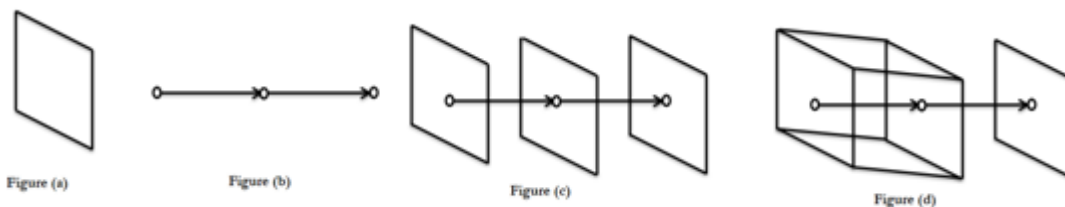
For example, a prism can be generated using a translational sweep and rotational sweeps can be used to create curved surfaces like an ellipsoid or a torus.

In both cases, you start with a cross-section and generate more vertices by applying the appropriate transformation.

More complex objects can be formed by using more complex transformations. Also, we can define a path for a sweep that allows you to create more interesting shapes.

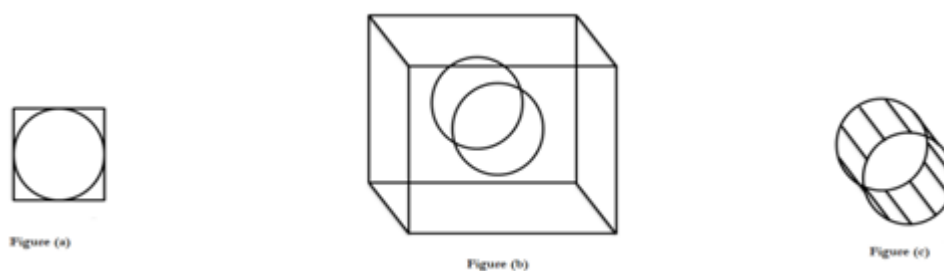
Translational sweep:

- Define a shape as a polygon vertex table as shown in figure 33 (a).
- Define a sweep path as a sequence of translation vectors figure 33 (b).
- Translate the shape; continue building a vertex table figure 33 (c).
- Define a surface table figure 33 (d).



Rotational sweep:

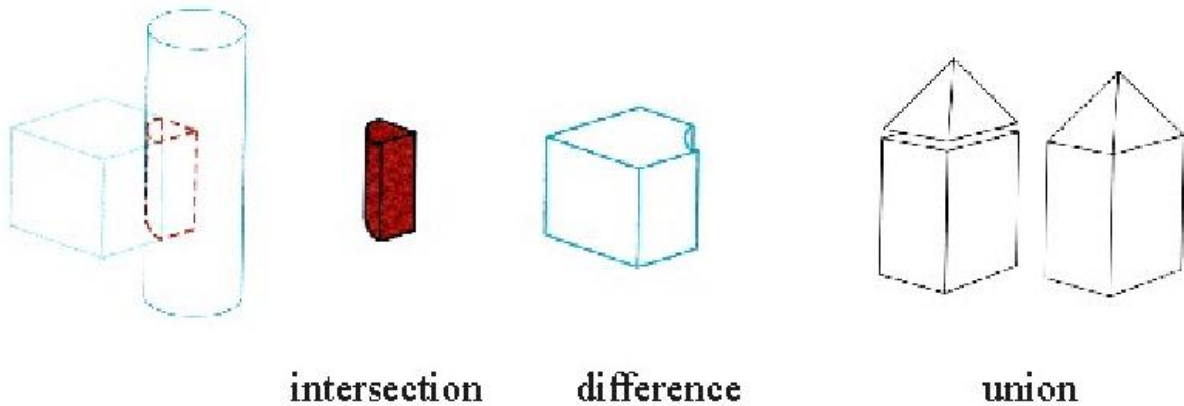
- Define a shape as a polygon vertex table as shown in figure 34 (a).
- Define a sweep path as a sequence of rotations.
- Rotate the shape; continue building a vertex table as shown in figure 34 (b).
- Define a surface table as shown in figure 34 (c).



Constructive models represent a solid as a combination of primitive solids. (CSG)

This modeling technique combine the volumes occupied by overlapping 3D shapes using set boolean operations.

This creates a new volume by applying the union, intersection, or difference operation to two volumes.



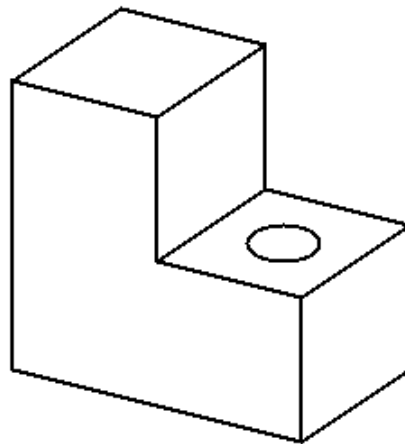
Each primitive is defined as a combination of half-spaces.

Typical standard primitives are:

cone, cylinder, sphere, torus, block, closed spline surface, right angular wedge.

swept solids (a revolution or linear sweep of a planar face which may contain holes).

The method of Constructive Solid Geometry arose from the observation that many industrial components derive from combinations of various simple geometric shapes such as spheres, cones, cylinders and rectangular solids. In fact the whole design process often started with a simple block which might have simple shapes cut out of it, perhaps other shapes added on etc. in producing the final design. For example consider the simple solid below:



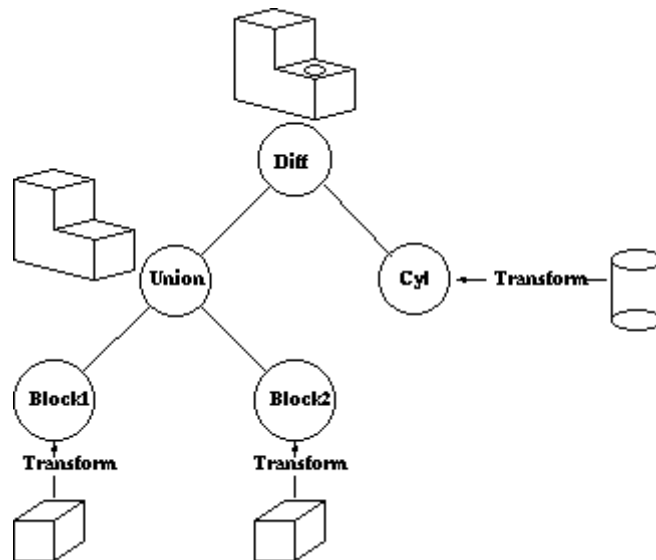
This simple component could be produced by gluing two rectangular blocks together and then drilling the hole. Or in CSG terms the the union of two blocks would be taken and then the difference of the resultant solid and a cylinder would be taken. In carrying out these operations the basic primitive objects, the blocks and the cylinder, would have to be scaled to the correct size, possibly oriented and then placed in the correct relative positions to each other before carrying out the logical operations.

The Boolean Set Operators used are:

- union - $A + B$ is the set of points that are in A or B.
- intersection - $A.B$ is the set of points that belong to A and B.
- difference - $A - B$ is the set of points that belong to A but not to B.

Note that the above definitions are not rigorous and have to be refined to define the Regularised Boolean Set Operations to avoid impossible solids being generated.

A CSG model is then held as a tree structure whose terminal nodes are primitive objects together with an appropriate transformation and whose other nodes are Boolean Set Operations. This is illustrated below for the object above which is constructed using cube and cylinder primitives.



CSG methods are useful both as a method of representation and as a user interface technique. A user can be supplied with a set of primitive solids and can combine them interactively using the boolean set operators to produce more complex objects. Editing a CSG representation is also easy, for example changing the diameter of the hole in the example above is merely a case of changing the diameter of the cylinder.

However it is slow to produce a rendered image of a model from a CSG tree. This is because most rendering pipelines work on B-reps and the CSG representation has to be converted to this form before rendering. Hence some solid modellers use a B-rep but the user interface is based on the CSG representation.

