BASIC SURFACES FOR ENGINEERING

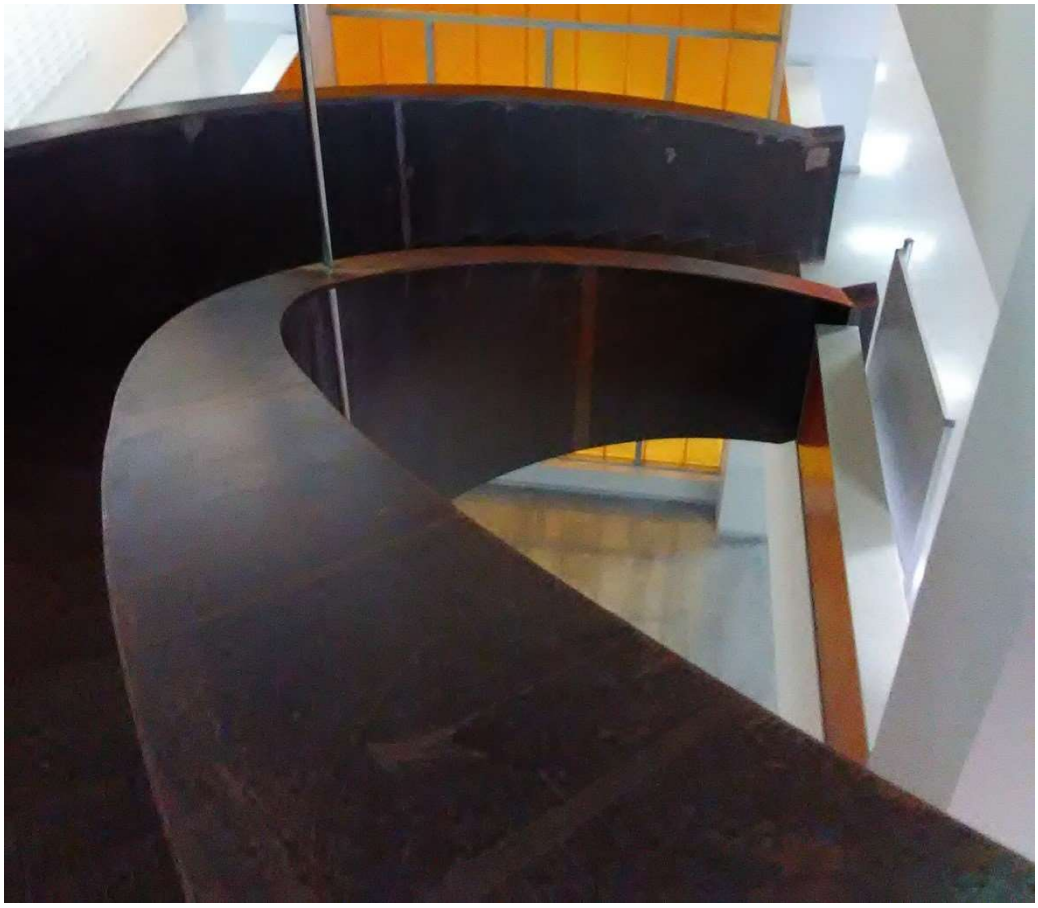

Figure 00. Main stairs of Engineering School of Bilbao II. Picture made by the authors, 2018.

5. Surfaces intersection

Content

5. SURFACES INTERSECTION

At the end of this topic, students are expected to be able to:

- To anticipate the geometric shape of the line that will result from the intersection of two surfaces.
- To determinate the view that allows obtaining the simplest or most immediate geometric solution.
- To identify the remarkable points of the intersection.
- To select the most suitable planes to find an intersection.
- To develop graphic operability in geometric problems where surfaces intervene.

For an adequate follow-up of this topic, it is necessary to have previously achieved the learning results of the topics:

- Surfaces: Representation and flat sections.
- Dihedral System: Single and double plane changes.

Figure 5.1. Convention Center Dublin. http://irishamerica.com/2012/03/kevin-roche-americas-irish-architect/

The study of the subject has influenced, above all, the concepts of surfaces intersection. The examples shown and the exercises proposed are intended to clarify the concepts without the complications of laborious layouts. Computer aided drawing applications have the ability to do those tedious delineate jobs.

5.1 GEOMETRIC FORM OF THE INTERSECTION LINE OF TWO SURFACES

The intersection of two surfaces is composed of one or two lines that belong to both surfaces.

The number and type of the intersection lines depend on the relative position of the surfaces and the kind of surfaces involved.

5.1.1 Number of lines of the intersection of two surfaces

The number of lines of the intersection of two surfaces depends on the relative position of the surfaces.

Bite:

It is named this way when on both surfaces there are generatrices that do not intersect with the other surface. Figure 5.2.

The intersection is a unique closed line.

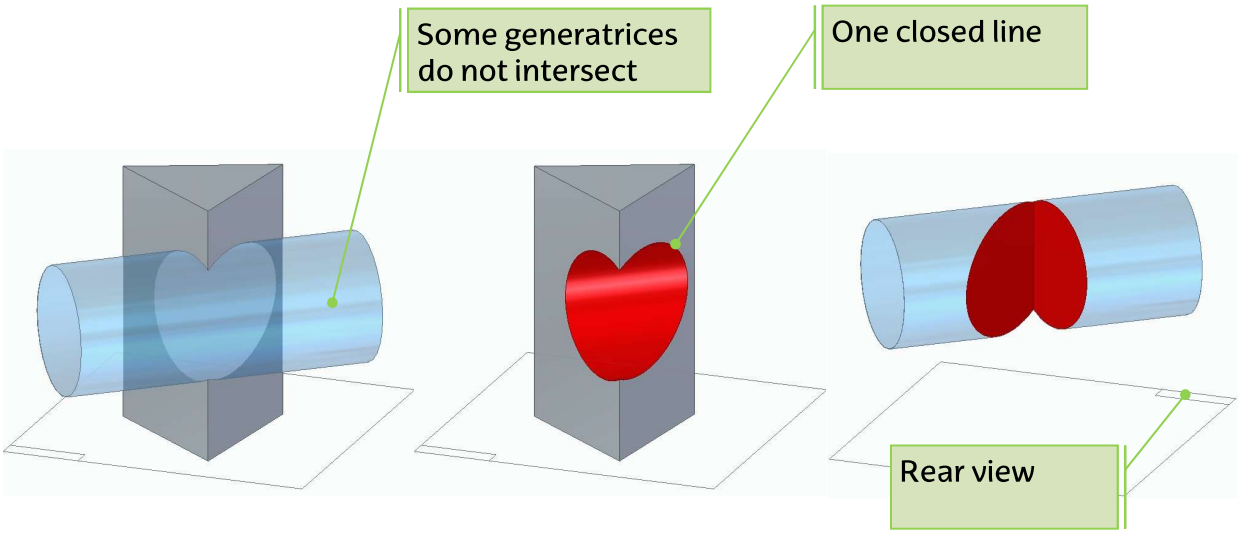

Figure 5.2. Intersection of surfaces in bite (Image made with Solid Edge)

Penetration

It is named this way when all the generatrices of one of the surfaces intersect with the other surface. Figure 5.3.

Generally, the intersection consists of two closed lines independent of each other.

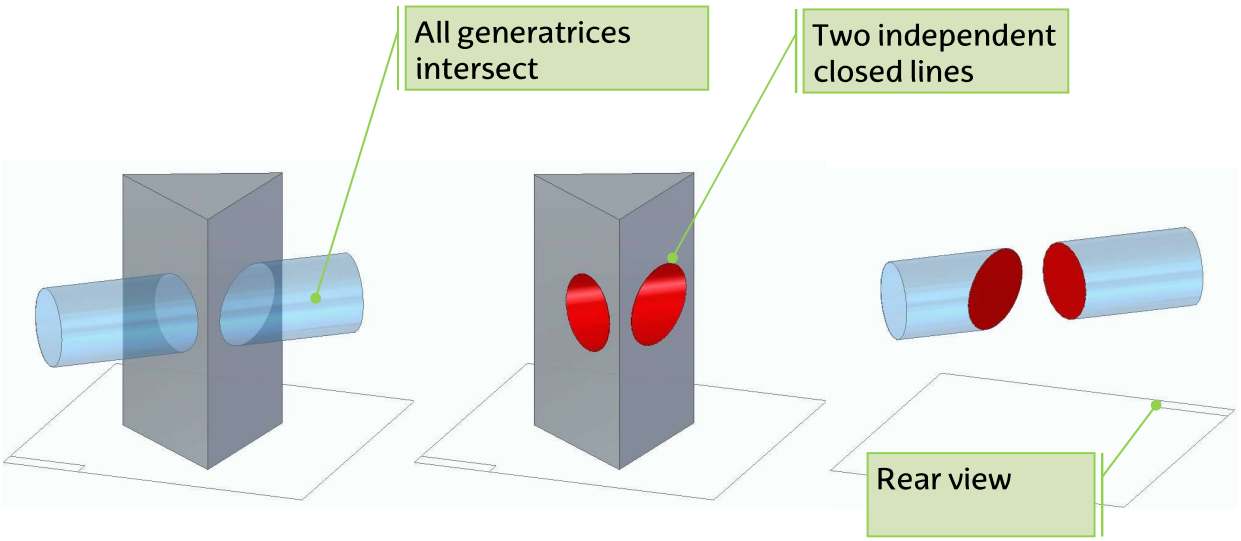

Figure 5.3. Intersection of surfaces in penetration (Image made with Solid Edge)

Simple tangential penetration

It is the particular case of penetration in which both surfaces are tangent to the same plane. Figure 5.4.

The intersection consists of two closed lines that have a point in common.

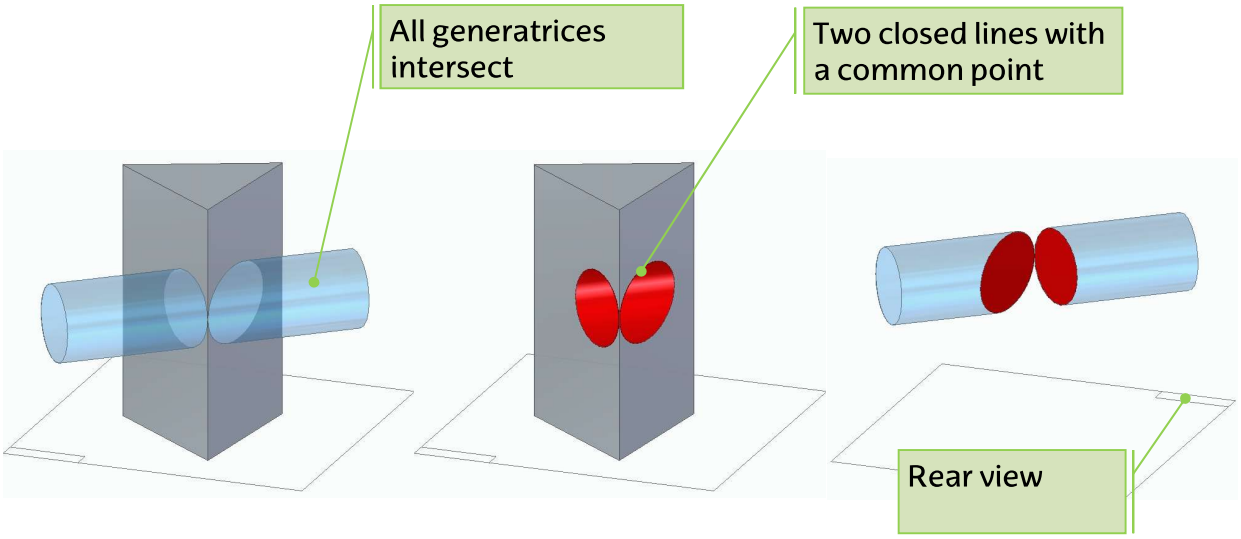

Figure 5.4. Intersection of surfaces in simple tangential penetration (Image made with Solid Edge)

Double tangential penetration

This is the particular case of a penetration in which both surfaces are tangent to two planes at the same time. It is also called maximum penetration or mutual penetration. Figure 5.5.

The intersection consists of two closed lines that have two points in common.

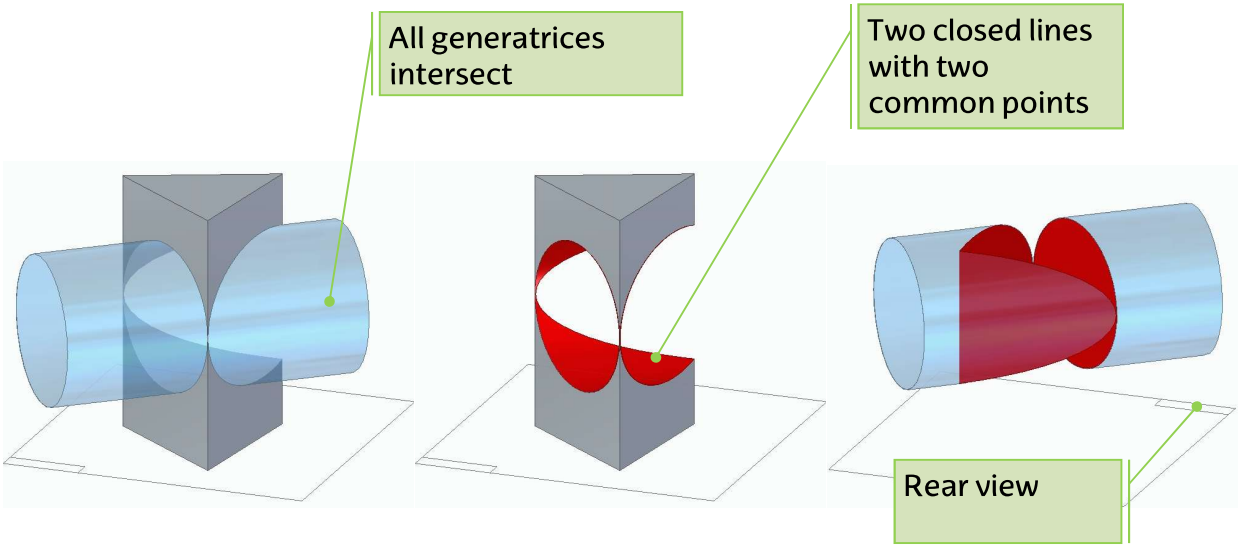

Figure 5.5. Intersection of surfaces in double tangential penetration (Image made with Solid Edge)

5.1.2 Type of the intersection lines of two surfaces

The type of line or lines of the intersection of two surfaces depends on the kind of surfaces involved.

In case both surfaces are pyramidal or prismatic, the intersection line is polygonal. The polygon can be flat or warped. The vertices of the polygon are on the lateral edges of the surfaces. Figure 5.6.

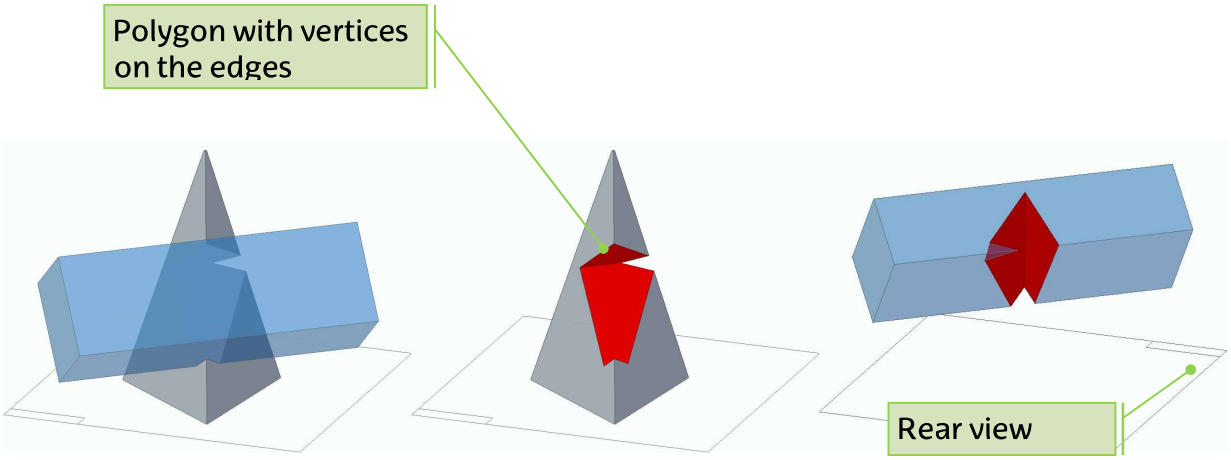

Figure 5.6. Polygonal intersection line (Image made with Solid Edge)

In case that one surface is pyramidal or prismatic and the other surface is conical or cylindrical, the intersection line consists of conical curves (see section 3.4.4). Each of the curves is the result of a flat section to a cone or cylinder. Figure 5.7.

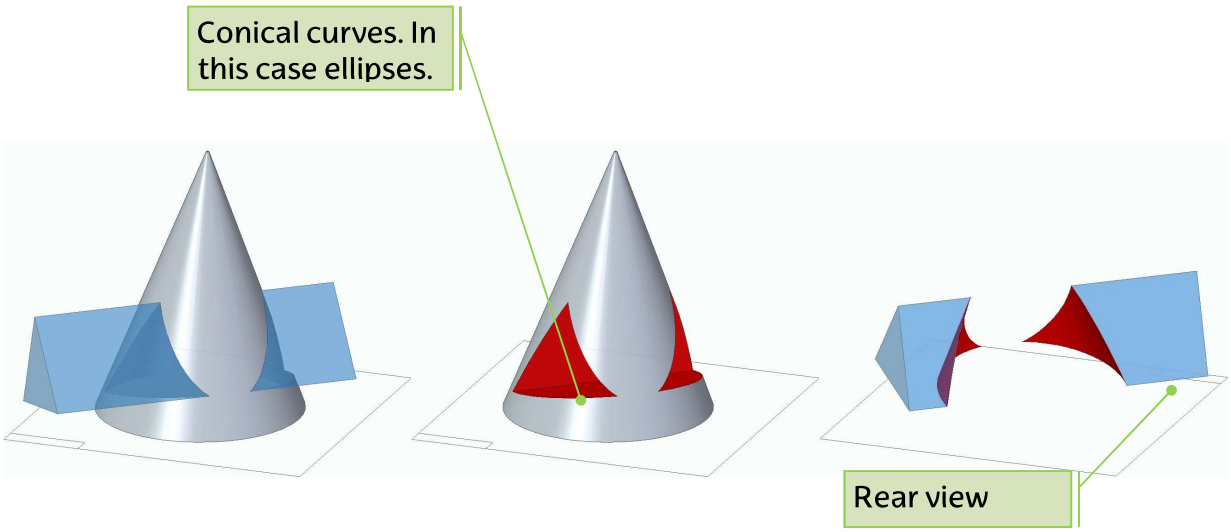

Figure 5.7. Intersection line consists of conical curves (Image made with Solid Edge)

In case that one surface is pyramidal or prismatic and the other surface is a sphere, the intersection line consists of flat circumferences (see section 3.1). Each of the circumferences is the result of a flat section to a sphere. Figure 5.8.

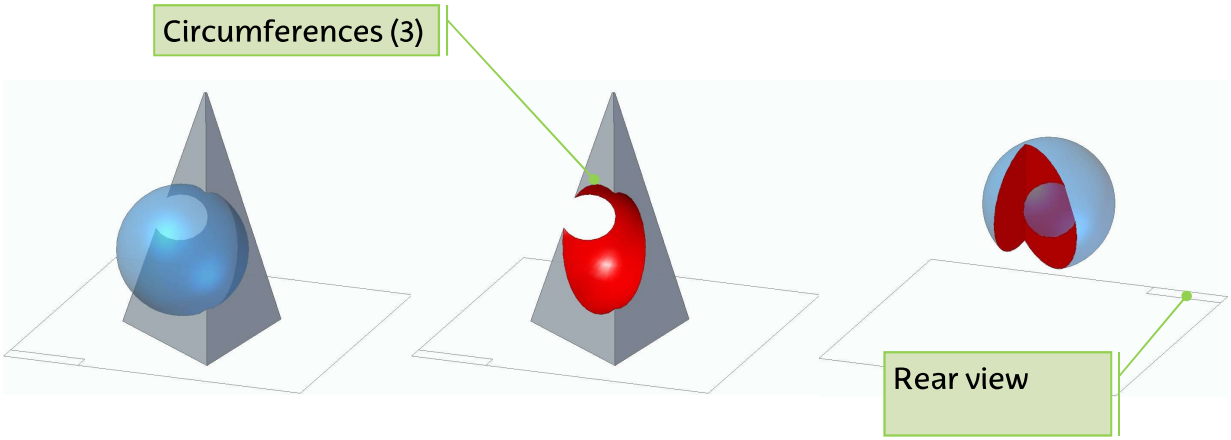

Figure 5.8. Intersection line consists of circumferences (Image made with Solid Edge)

In case both surfaces are conical or cylindrical and / or spherical, the intersection line is curved. The curve can be flat or warped. Figure 5.9.

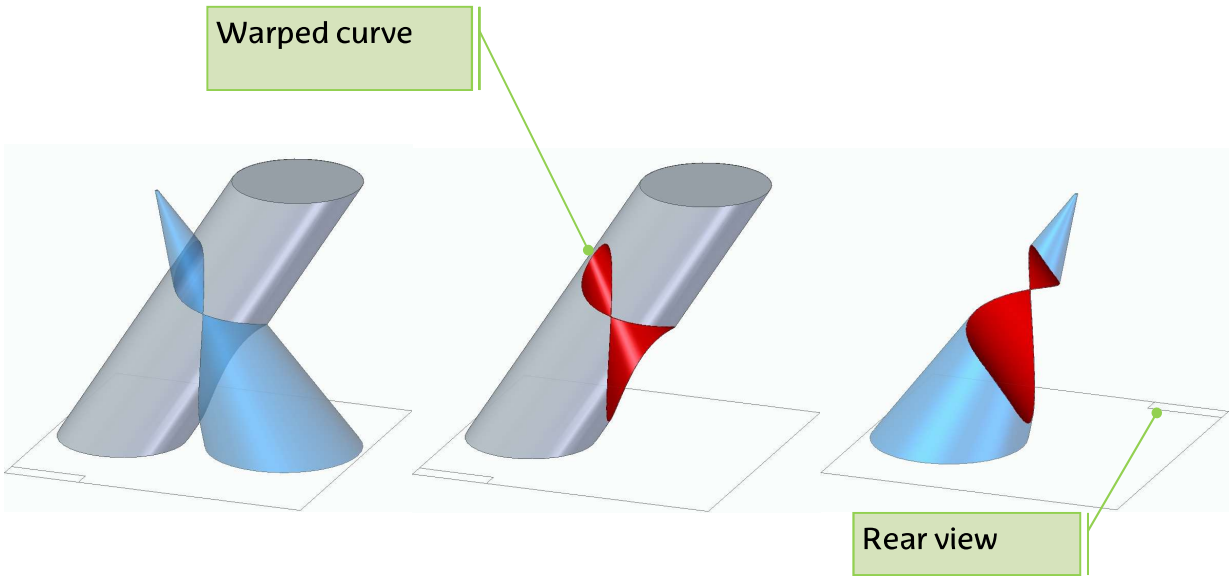

Figure 5.9. Intersection line consists of warped curves (Image made with Solid Edge)

5.2 GENERAL METHOD FOR FINDING INTERSECTION OF SURFACES

The general procedure to obtain the intersection of two surfaces is to find the flat section (see topic 3) that produces a plane to both surfaces. The common points of the two flat sections belong to the two surfaces and, therefore, are points of the intersection. This process is repeated taking several planes. Figures 5.10 y 5.11.

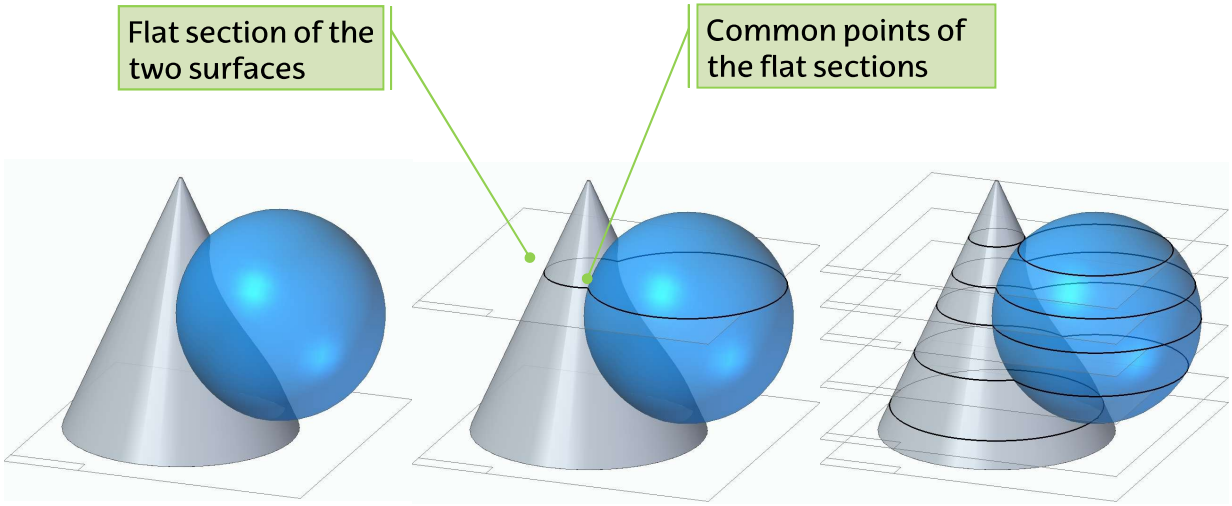

Figure 5.10. Surfaces intersection (Image made with Solid Edge)

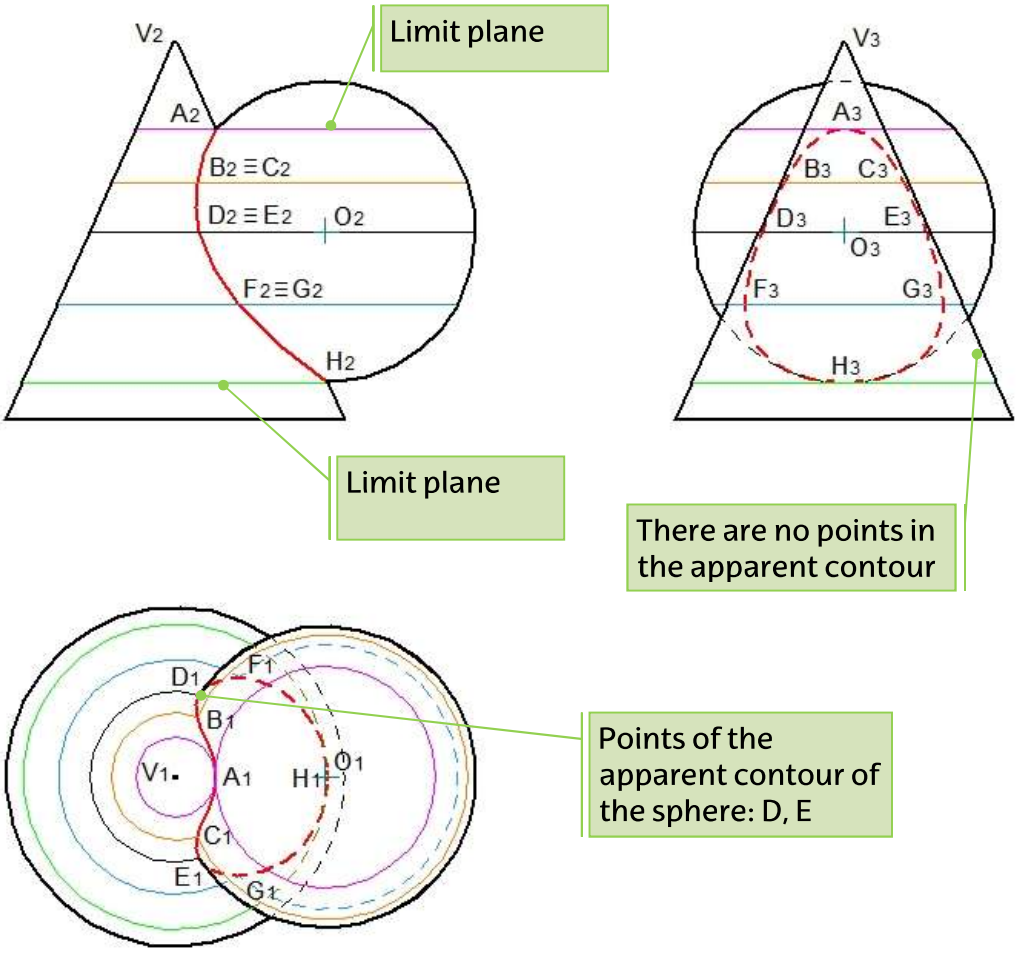

Figure 5.11. Surfaces intersection (Image made with Solid Edge)

Logically, planes will be chosen that offer a favorable situation or that produces a flat section of easy layout (see sections 3.2 and 3.4).

5.3 NOTABLE POINTS OF A SURFACES INTERSECTION

Notable points of a surfaces intersection are those that provide key information for the layout of the intersection line.

In general, the notable points of an intersection of surfaces are the limit points, which are the points found in the limit planes. The limit planes set the zone of the secant planes that cut the two surfaces. Figure 5.12.

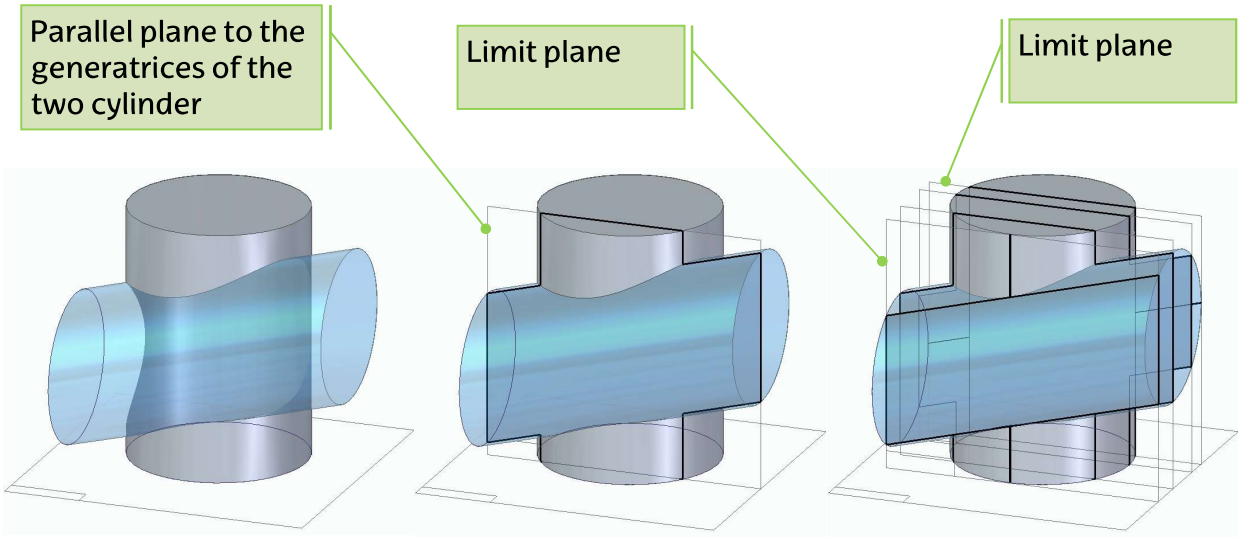

Figure 5.12. Notable points of a surfaces intersection (Image made with Solid Edge)

Also are notable points those found in the apparent contour generatrices, because they delimit the seen part of the intersection line in each of the views. At these apparent contour points the intersection line is tangent to the apparent contour generatrix. Figure 5.13.

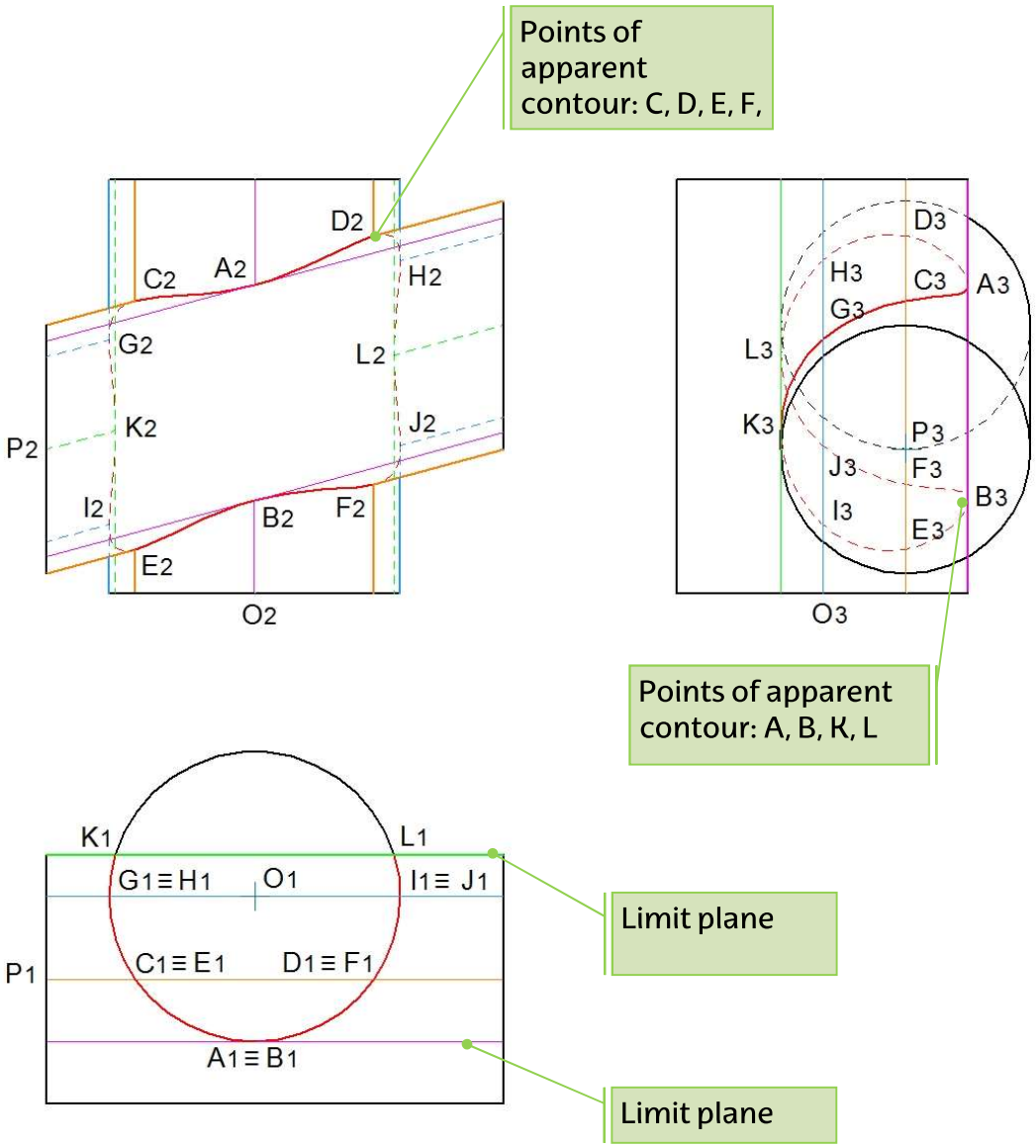

Figure 5.13. Notable points of the surfaces intersection (Image made with Solid Edge)

In case that one of the surfaces is pyramidal or prismatic, also notable points of the intersection are at the edges of the surface, since they are vertices of the intersection line. Figure 5.14.

5.4 PARTICULAR CASES

The solution is immediate in the event that one of the surfaces is prismatic or cylindrical.

The most favorable position is when the generatrices of the prismatic or cylindrical surface are perpendicular to one of the projection planes. In this case, the intersection of these generatrices with the other surface is obtained directly. Figures 5.12 y 5.13.

When the generatrices of the prismatic or cylindrical surface are not perpendicular to one of the projection planes, the favorable situation can be reached by plane changes. This method is less laborious than the general method, and more advisable the greater the number of generatrices taken to find the intersection. Figure 5.14. See Figure 5.7.

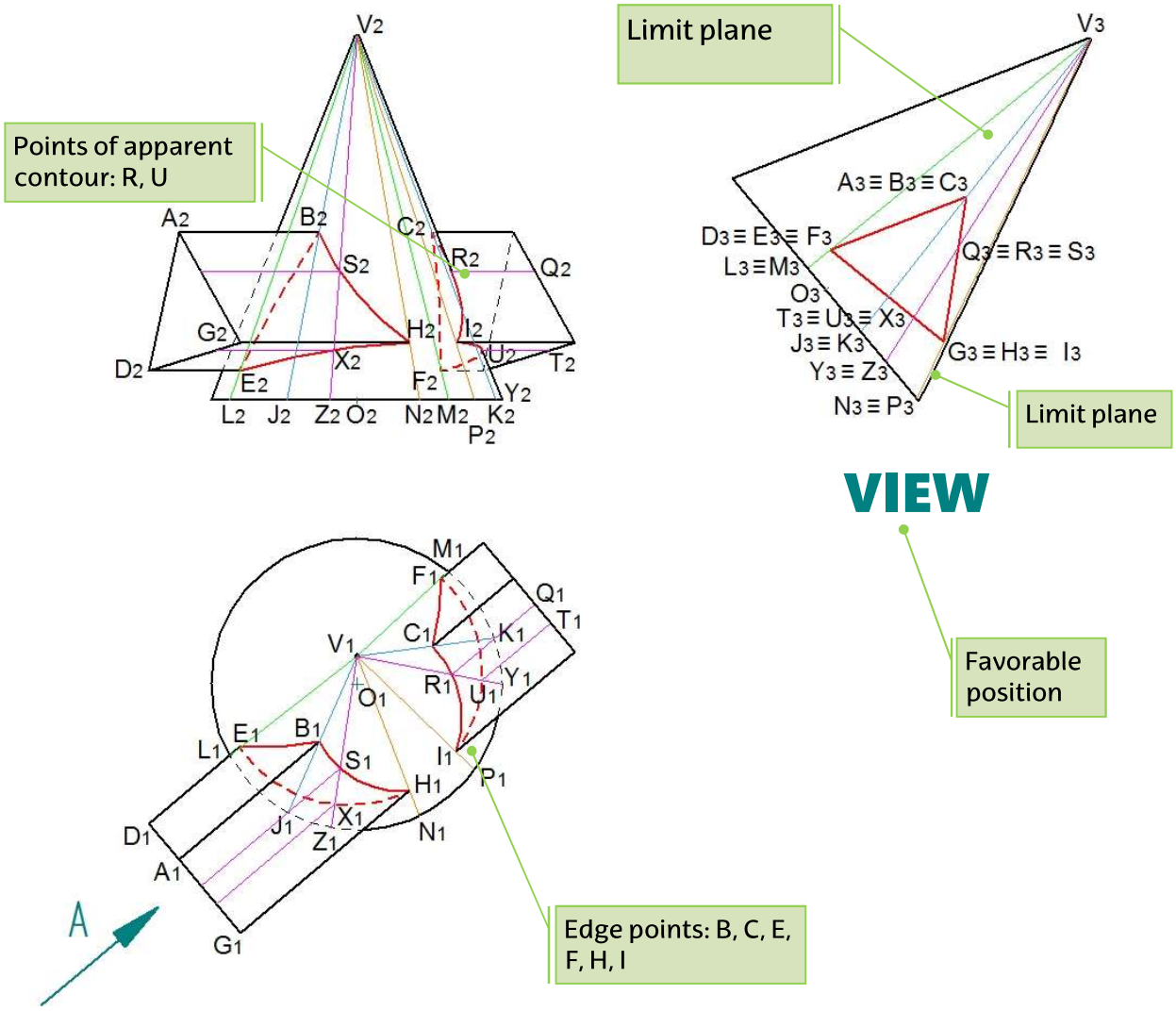

Figure 5.14. Favorable position at surfaces intersection (Image made with Solid Edge)

If two cylindrical surfaces of revolution are tangent to a same sphere, the intersection consists of two flat conics. The axes of both surfaces intersect and double tangential penetration occurs. Figure 5.15.

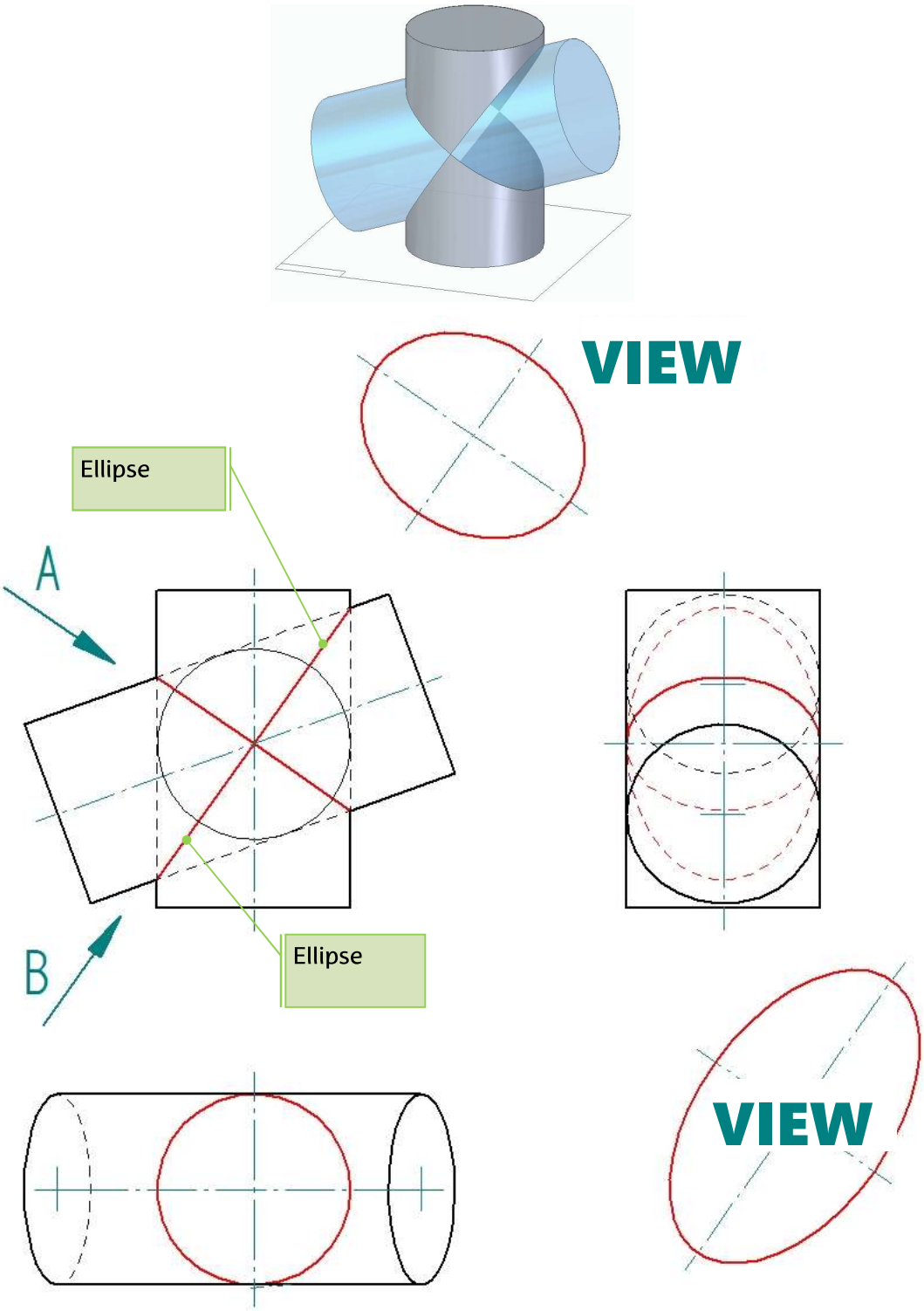

Figure 5.15. Intersection of tangent surfaces to a sphere (Image made with Solid Edge)

In the same way, if two conical surfaces of revolution are tangent to a same sphere, the intersection consists of two flat conics. The axes of both surfaces intersect and double tangential penetration occurs. Figure 5.16.

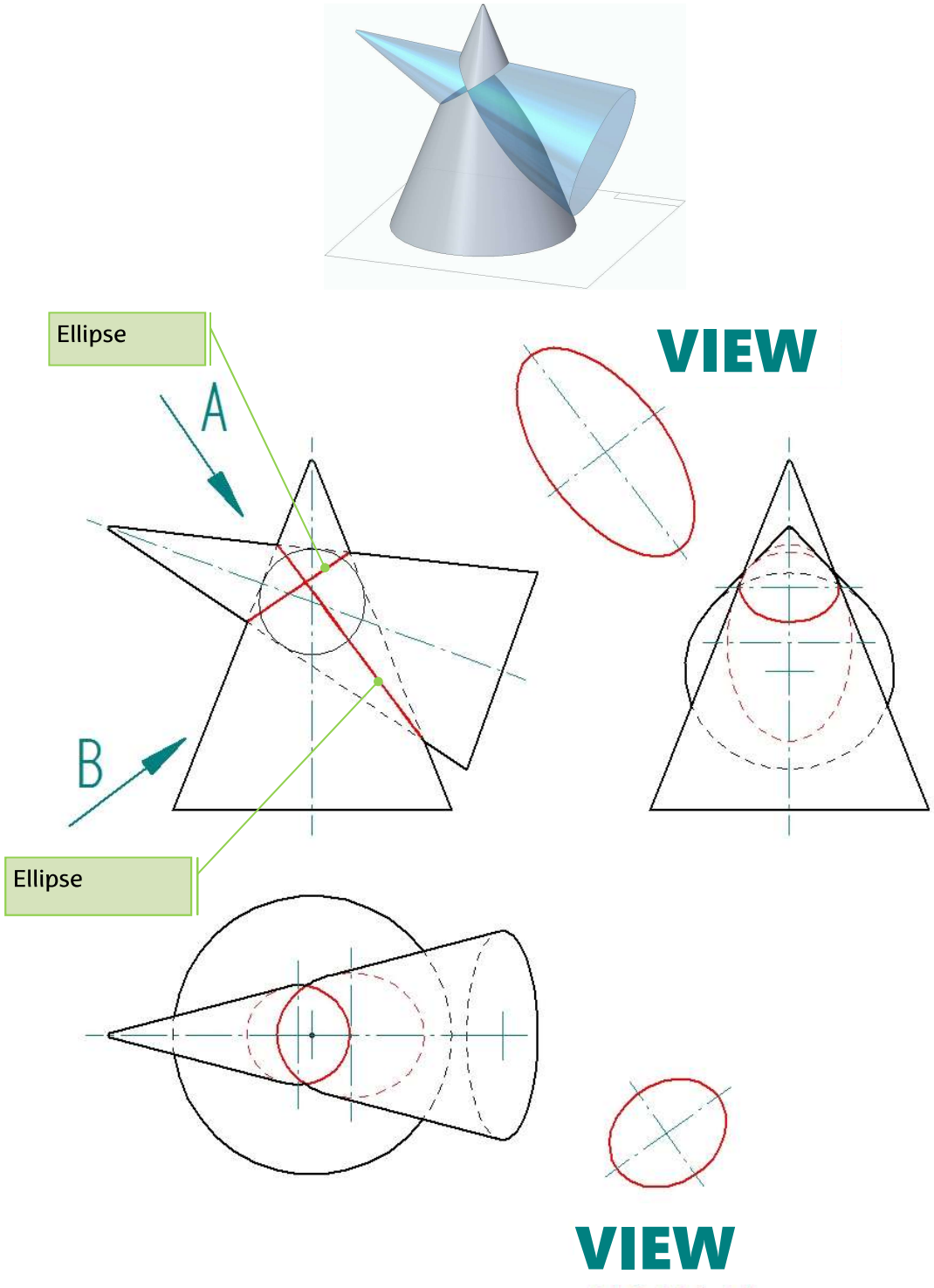

Figure 5.16. Intersection of tangent surfaces to a sphere (Image made with Solid Edge)

And also, if a conical surface and a cylindrical surface, both of revolution, are tangent to a same sphere, the intersection consists of two flat conics. The axes of both surfaces intersect and double tangential penetration occurs. See exercise 5.5.

At the intersection of a spherical surface with a cylindrical surface, if one of the intersecting lines is a plane circumference, the other is also a plane circumference. Figure 5.17.

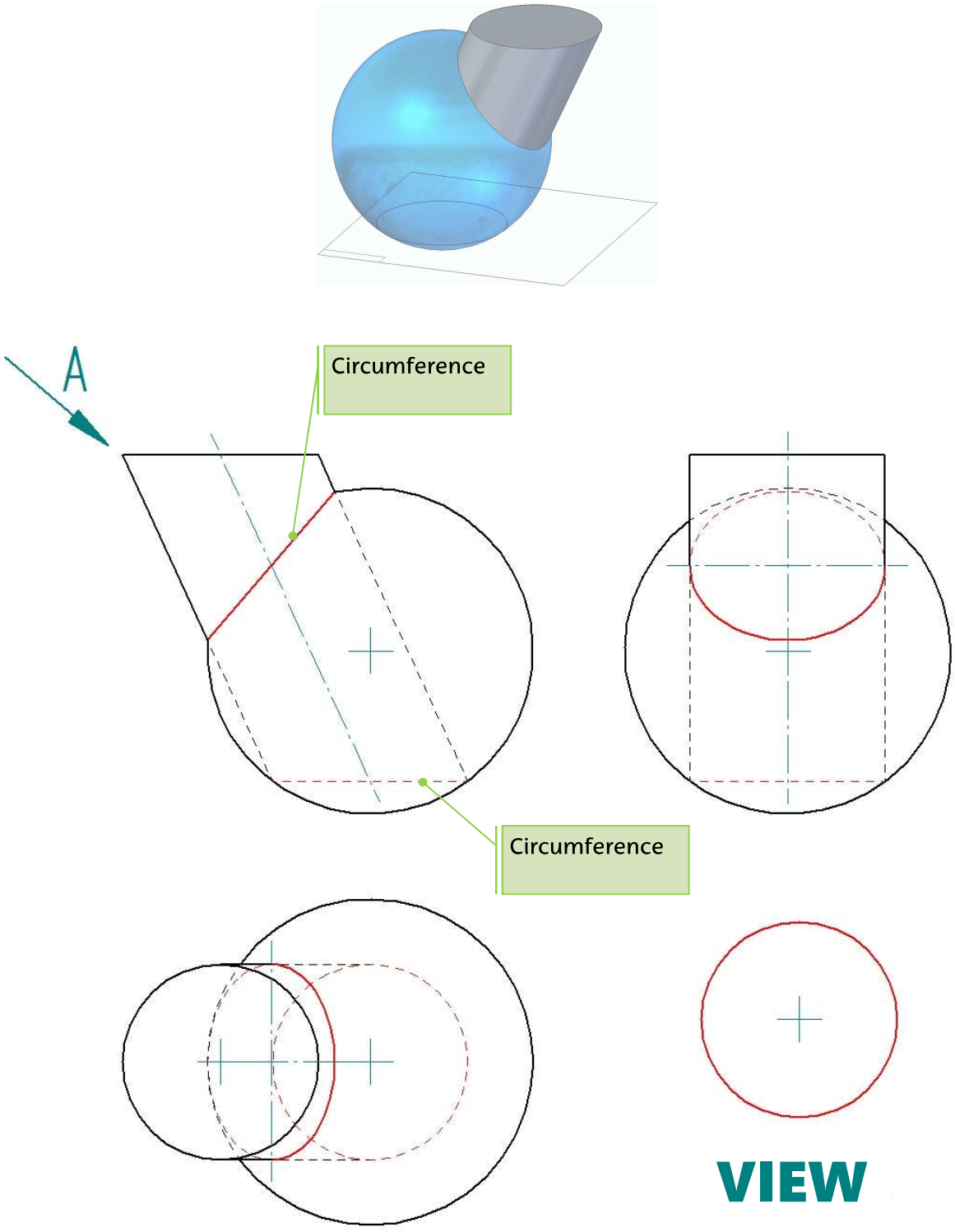

Figure 5.17. Particular case of intersection between cylinder and sphere (Image made with Solid Edge)

In the same way, at the intersection of a spherical surface with a conic surface, if one of the intersection lines is a plane circumference, the other is also a plane circumference. Figure 5.18.

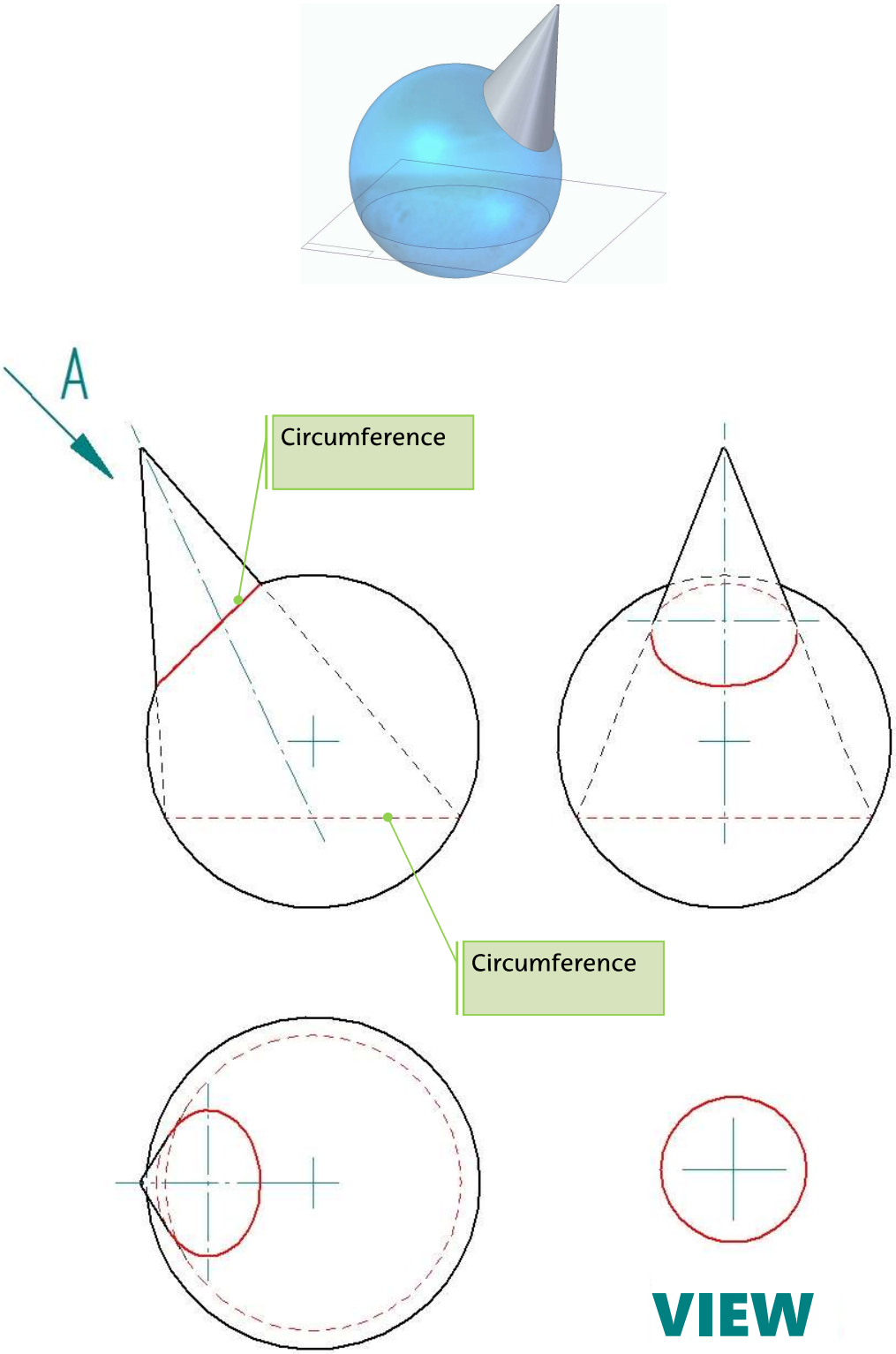

Figure 5.18. Particular case of cone and sphere intersection (Image made with Solid Edge)

The intersection of two spherical surfaces is a flat circumference. Figure 5.19.

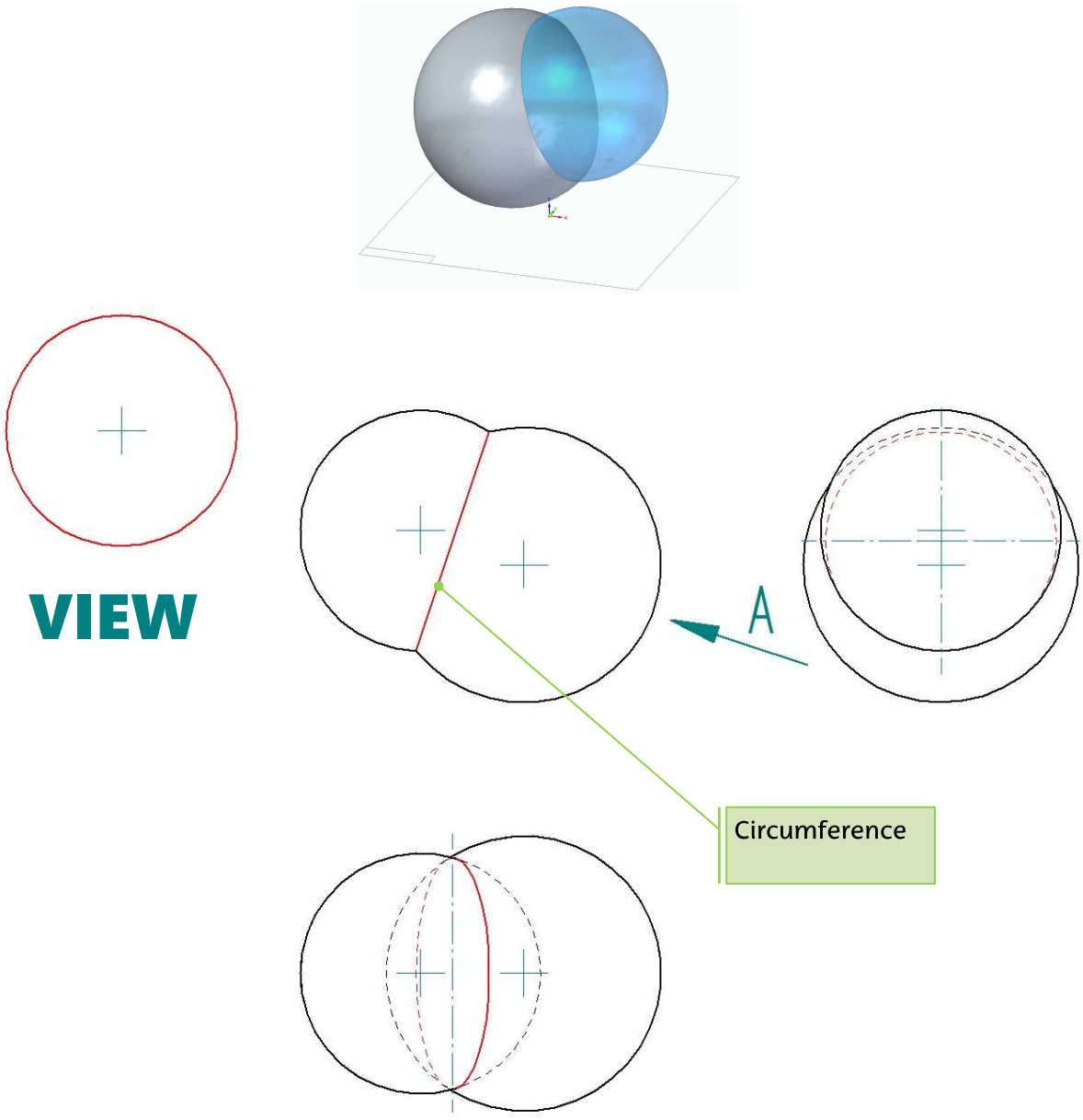

Figure 5.19. Spheres intersection (Image made with Solid Edge)