Intersecting surfaces and solids

Solid and surface intersection is an integral part of the mine planning and design process. This article will discuss the tools that MineSight 3D (MS3D) offers for surface and solid intersection, as well as verification of input and output data. Verification of surfaces, solids, and the results of their intersections is crucial, as issues in a surface or solid can affect reserve calculations and become increasingly difficult to fix as edits are made. So verify input surfaces before either intersection tool is used and output surfaces following the execution of either operation.

The MS3D **Verify Tool** can be used to check for and repair self-intersecting faces, duplicate faces, and openings. This tool can also check for non-orientable (Mobius) surfaces, which cannot be automatically repaired, but are vital to be aware of and must be fixed. Any of these defects can cause surface tools to produce invalid results, and can also cause reserve calculations and coding to be inaccurate. Once the **Verify Tool** is run on a surface or solid without issues, that surface or solid is ready to be used with other MS3D tools.

The **Intersect Surfaces Tool** can produce surfaces and solids from the intersection of input surfaces. One common surface intersection performed in open pit mining is the intersection of a pit or dump design with the original topography to obtain the topography at that particular phase of mining and/or dumping. Obtain this surface by using the Cut or Fill Surface (union) operation under Merged Surfaces. Another common product of surface intersection is a solid that represents the material that must be mined out or dumped to achieve this topography. Obtain this solid using the Cut or Fill Solid operations under Solids in this tool.

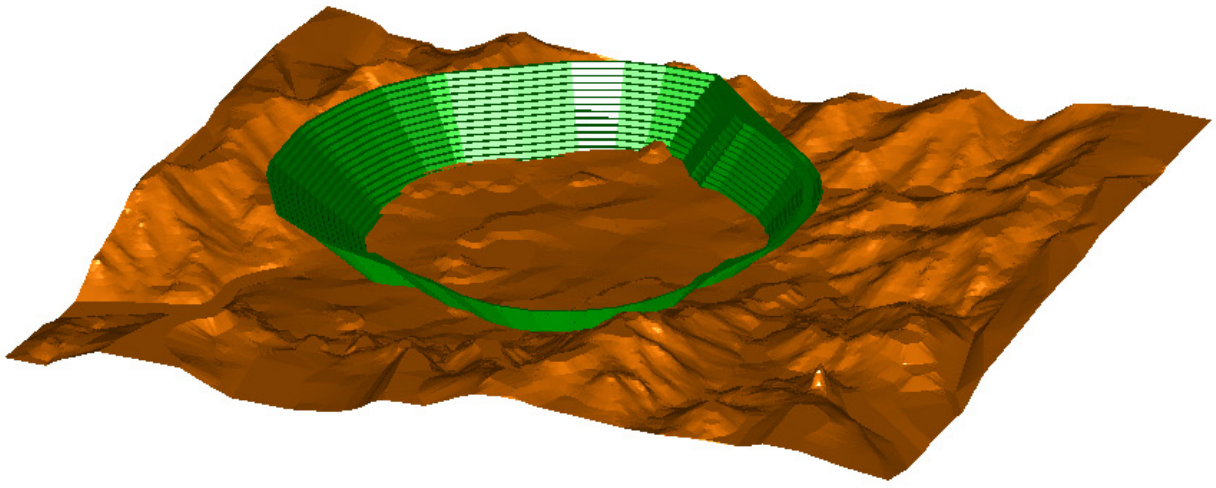

Fig 1a) *A pit surface that extends through topography.*

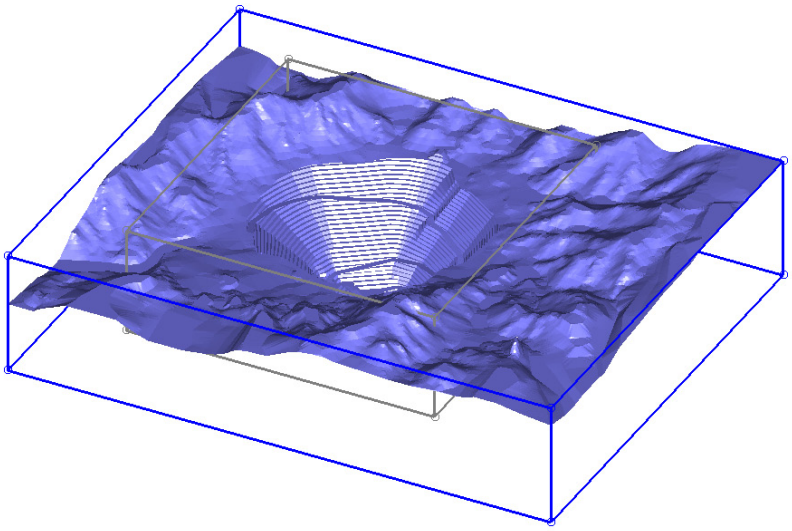

Fig 1b) *The results of merging the topography and pit design surfaces using the Cut Surface (union) operation under Merged Surfaces.*

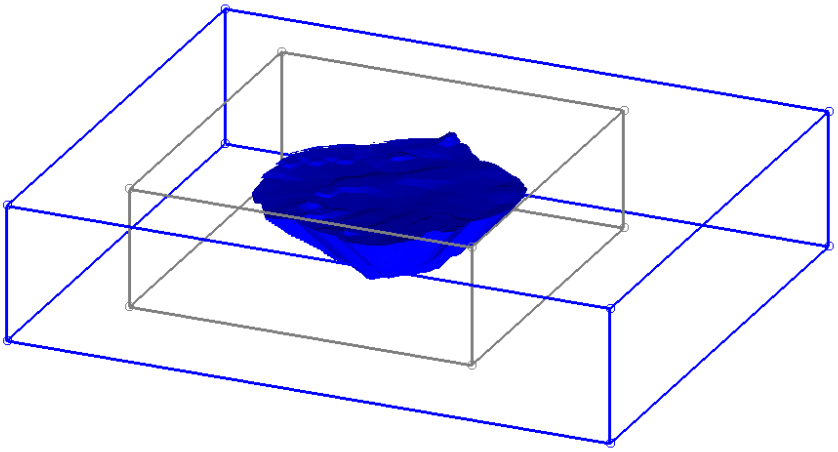

Fig 1c) *The resulting solid from using the Cut Solid operation under Solids.*

Results can be limited by a polygon; limiting here can prevent the need to clip surfaces in a later step. The preview button is useful to test the operation and to see what area or volume will be contained in the resulting element.

The **Intersect Solids Tool** uses two groups (defined A and B) as inputs, each of which can contain one or more solid(s). This tool has six unique outputs, described below.

	Function Name	Result
	Return Intersection of Solids	Returns a solid of the overlapping volumes of the two groups.
	Return Union of Solids	Performs the union of all members of both groups into one solid element.
	Return B-A	Returns solid B less the portion also occupied by A.
	Return A-B	Returns solid A less the portion also occupied by B.
	Return All Components	Similar to the Union option shown above, but instead, the result is split at the lines of intersections into separate surfaces.
	Return Lines of Intersection	Returns the lines of intersection between Solid A and Solid B.

When designing a pushback for a new mining phase, the new pit may intersect with a previous pushback design. The Return B-A operation of the **Intersect Solids Tool** will produce a solid representing the material within the new pushback, assuming that the material from the previous pushback has been mined. Once this solid is verified to have no surface defects, accurate volume and reserve calculations can be successfully obtained. This process is outlined below in Figures 2a and 2b.

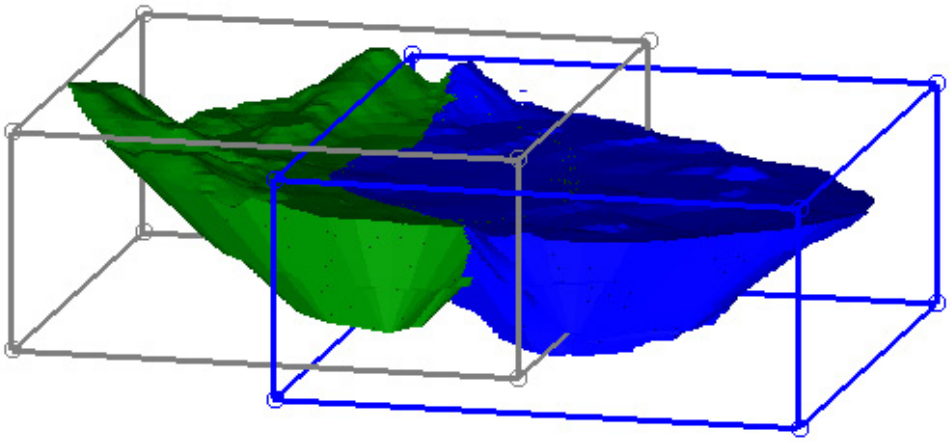

Fig 2a) Two overlapping pushback design solids clipped at topo. The blue pushback was selected as Group A and the green pushback as Group B.

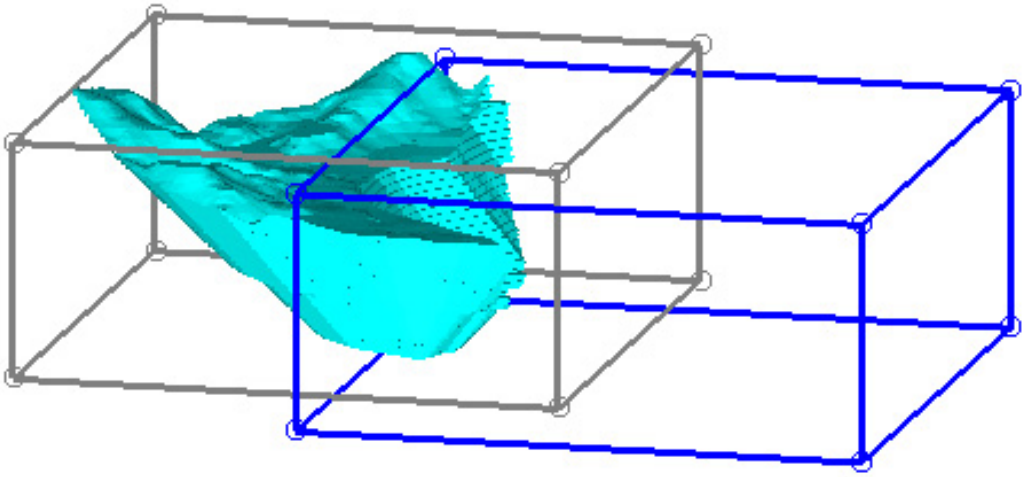

Fig 2b) Results from Return B-A; a solid representing the volume of the green pushback less the volume also occupied by the blue pushback.

The **Verify Tool** will inform you of whether self intersections, duplicate faces, openings, or mobius surfaces exist within a surface element. However, if a solid contains interior walls without self-intersecting or duplicate faces, the **Verify Tool** will not identify or repair these. To ensure accurate coding and reserve reporting from solids it is good practice to manually check these solids with **Volume Clipping** after successful verification with the **Verify Tool**.

One example of a function that may produce interior faces is the Return All Components operation in the **Intersect Solids Tool**. The difference between the result of this operation and the result of Return Union of Solids is best seen using **Volume Clipping**. The results of this examination can be viewed below in Figures 3a and 3b.

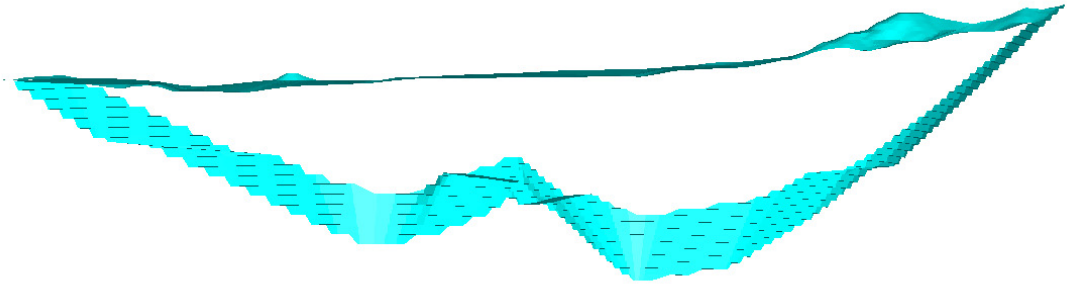

Fig 3a) *An EW cross-section with volume clipping on of the solid from Return Union of Solids.*

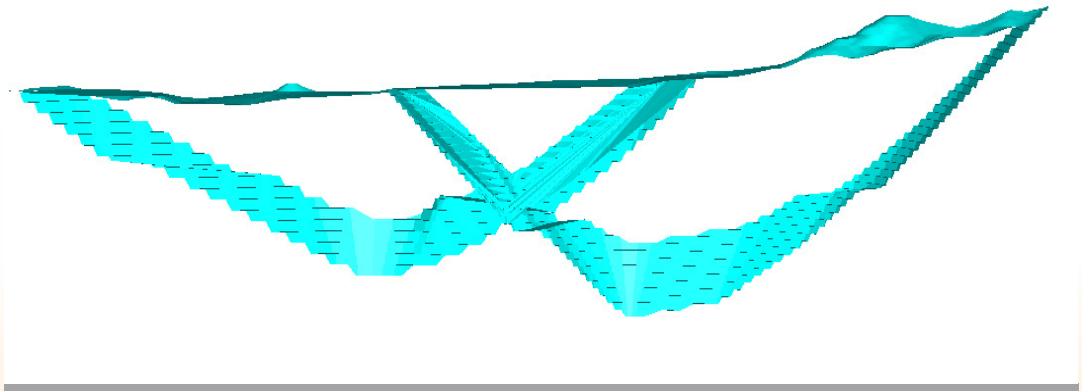

Fig 3b) *Same cross-sectional area of the solid from Return All Components.*

With **Volume Clipping** on, it is clear that the solid shown in Fig 3b contains interior walls, which can negatively affect coding and reserve reporting. The **Objects Contents Browser** will also show the difference in the number of elements for each object. The solid in Fig 3a consists of one surface, while the solid in Fig 3b is made up of 7,732 individual surface elements.

MS3D's intersection tools can be extremely useful in the mine planning and design process. However, without proper verification of all surfaces and solids used, issues can be encountered that make the resulting surfaces and solids difficult to work with. Use of the **Verify Tool** before and after the use of either the **Intersect Surfaces Tool** or the **Intersect Solids Tool** will ensure the validity of surfaces and solids produced in MS3D.