GEM4D Visualisation background knowledge

The following background knowledge is required for many procedures and discussed separately to shorten explanations and duplication in procedures. This document will be updated and expanded in the future; the current version discusses:

1) Polygon Orientation.
2) Camera Perspective and Parallel Views.

1. Polygon Orientation

Although visualisation software displayed polygons as double-sided, a polygon has only one visible orientation side. When a polygon is viewed from the visible side, the polygon will look as usual. But, when a polygon is viewed from the other side, the polygon should be invisible. As this creates issues to users, visualisation software nearly always displays polygons as double-sided.

The polygon orientation is defined by the polygon normal, which is a perpendicular vector that indicates the orientation of the visible polygon side. As the polygon orientation is not important for most mine design applications, these packages often create polygons with inconsistent normals. In many geological applications, the polygon orientation is important, and the reason Leapfrog shows the different sides of a polygon in different colours. Figure 1 shows the design and CMS of a stope adjacent to one another, with the normals of the left image showing outwards (away from the void), and inwards on the right image (towards the void). The left image is the "normal" way in which triangulations are perceived. The right image displays the inside of the stope, as the polygons of the nearest walls show away from the observer and thus invisible.
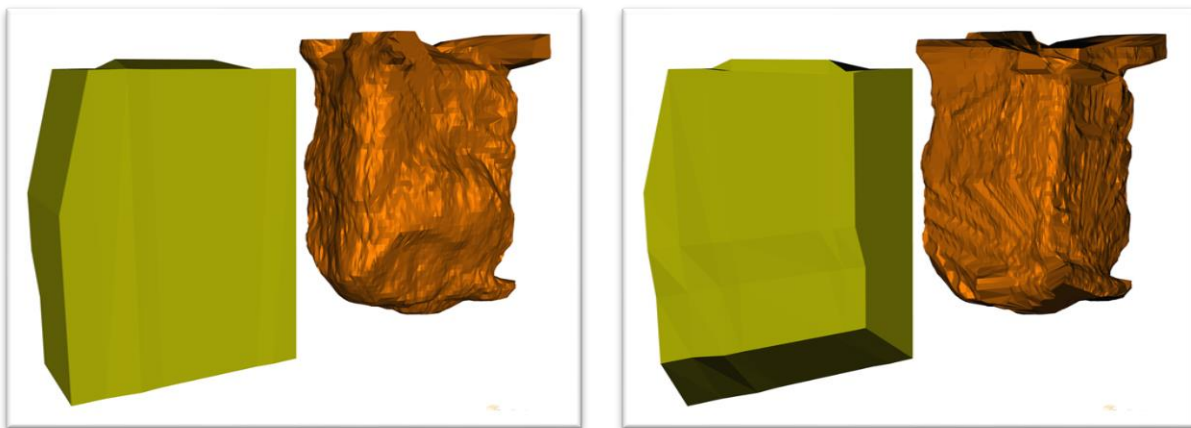

Figure 1 The same underground stope with polygon normals showing away from the void (left), and towards the void (right)

Polygon orientations are of crucial importance when using triangulations in numerical models such as Trajec3D and Map3D. Figure 2 shows a typical result from mine design software where the left image shows the stope design as perceived in software, and the right image shows the polygon back faces as invisible (culled).
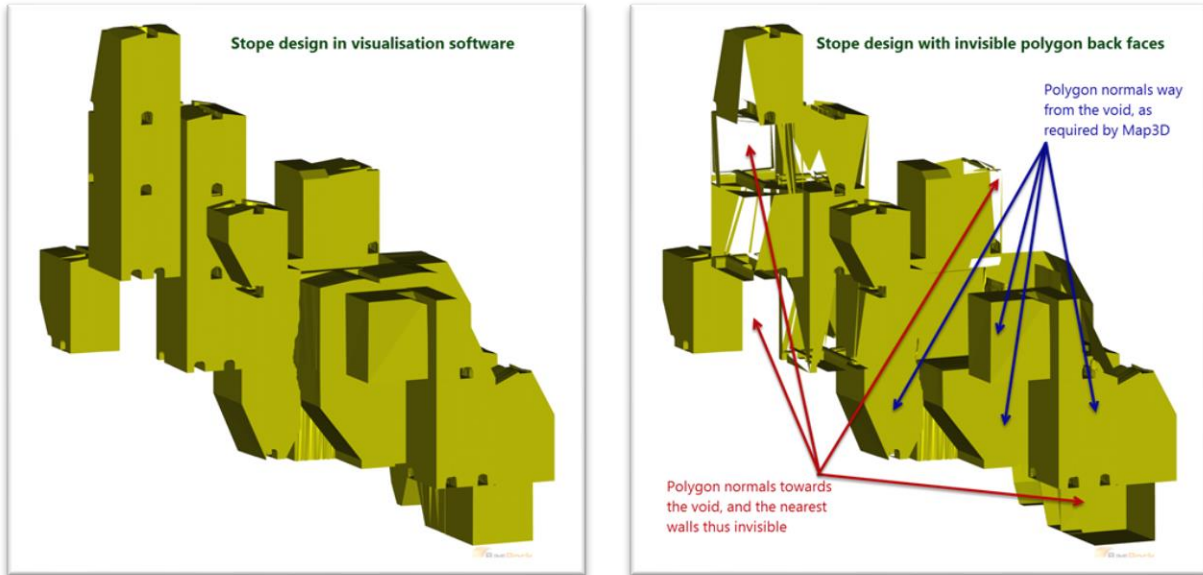
Figure 2 Polygon normals from mined design software are nearly always inconsistent

These designs are suitable to load into Map3D for many reasons:

1) Inconsistent polygon normal orientations.
2) Dividing polygons inside stope shapes.
3) Triangulation shapes are often not mathematically closed.
4) Duplicate and overlapping polygons.
5) Inconsistent polygon vertice density.
6) Polygon shapes that could cause stability issues (distorted polygons).
7) The polygon vertice number is not optimal for numerical modelling.

The steps in the procedure below automatically correct all the above issues.

2. Camera Perspective and Parallel Views

Visualisation software uses the same naming convention as movie sets. The display area is called the "scene", and the viewpoint is the "camera", the objects in the scene are "actors", light sources are "lights" etc. The camera can be defined as perspective or parallel, and the differences between these camera modes are important when selecting (picking) actors or polygons in the scene.

In perspective view, actors that are further away are scaled to a smaller size, as reality is perceived in real life. In a parallel view, actors are not scaled base on their distance from the camera, and actors are thus the same size irrespective of their distance from the observer. Figure 3 illustrates the difference by showing the same scene in perspective (left) and parallel (right) views.

Figure 3 Camera with a perspective view (left) and parallel view (right)

The perspective view reflects reality and it is easier to interpret, but accurate picking in the scene troublesome due to the uncertainty about the picking depth plane. For pixel-perfect picking in the scene, a parallel view is required. Some picking functions in GEM4D thus automatically changes the scene to a parallel view, which could be reset to perspective view in three locations, as shown in Figure 4. Not many functions are duplicated in GEM4D; the camera view toggle is an exception due to the importance in many functions.
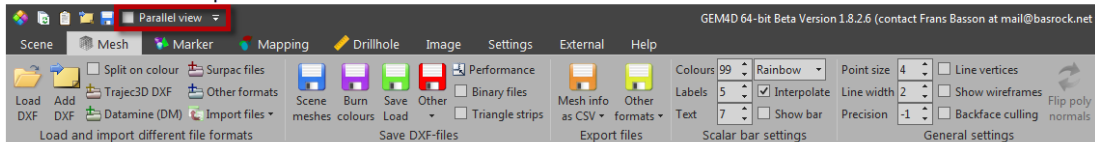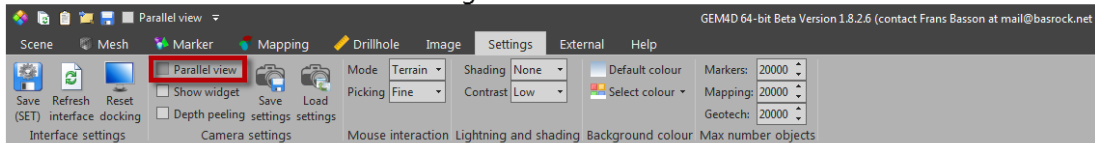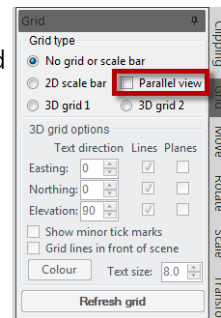

Figure 4 Toggle camera parallel view ON and OFF in one of three locations in GEM4D