The benefits of a well-designed mine are extraordinary, ranging from operational advantages, such as shorter haul distances and less waste handling, to economic gains for the operator. Without proper planning, reserves may be sterilized unnecessarily and it may be difficult to meet certain product grade requirements. A block model is one of the tools used by Skelly and Loy in mine planning when site geology and product grade are variable. Within the context of a mining operation, a “block model” refers to a three-dimensional graphical representation of the physical and chemical properties of the mineral resource.
The block model consists of a series or collection of cubes of a given dimension which traverse the reserve both laterally and vertically. Each cube has unique quantity and quality characteristics and, collectively, the blocks model the entire reserve area. A block model allows the detailed characterization of a reserve in increments across a site, which may ultimately result in optimization of a mine plan. Depending on the site-specific needs of the operation (and various quality parameters that must be met for the saleable products), the block model can be as detailed or as generalized as so desired by the operator. The process for creating a block model begins with a drilling and sampling program and is followed by data analysis, and then input into appropriate computer software that generates the three-dimensional block model.

Carlson 2009 (CAD-based software) is the most widely used design and mapping software in the mining industry. In the summer of 2008, Skelly and Loy worked closely with Carlson representatives to revamp the software’s block modeling capabilities to meet or exceed current mining industry standards. This issue of the Portal discusses the procedures that Skelly and Loy follows to generate a block model for a mineral reserve.

**Data Analysis and Input**

Typically drill hole data is provided to Skelly and Loy in one of two formats: hard copy (hand-written driller’s logs) and/or in an electronic spreadsheet format. If the data is provided in hard copy, Skelly and Loy must transcribe the data into a spreadsheet format and then import the drill hole information. If the data is provided in an electronic format, it is randomly spot-checked against driller’s logs for accuracy. Each entry in the geologic database contains multiple data points (coordinates, elevations, and quality characteristics) for the ore body. The database includes, but is not limited to, drill hole collar elevation, down hole stratigraphic descriptions, and quality data for the reserve. Before importing the drill hole data into Carlson, Skelly and Loy must define the drill hole dimension (sample size), symbolism (circle, square, triangle, etc), and stratigraphic type (limestone, shale, dolomite, etc.). Once the parameters are defined, the drill hole and stratigraphic data are imported via the custom import formatter that is capable of handling the drill hole text files created in the spreadsheet. After the drill holes have been imported, Skelly and Loy uses the “drawing inspector” feature to confirm the reported drill hole top elevations as compared to the mapped surface contour elevations.

The results of the drilling and sampling program are used to define the subsurface geologic structure and stratigraphy of the site. Data collected from the program typically includes the hole identification number, coordinates, surface elevation, stratigraphy data (elevation and thickness of the stratigraphy), and quality data by parameter, all of which is entered into a geologic database. This information becomes the cornerstone of the model. Often the drilling and sampling program is completed by the operator prior to engaging Skelly and Loy for engineering services. However, Skelly and Loy geologists and mining engineers can also work together to design a suitable drilling and sampling program for its clients.
The next step is to define the geologic units as “key” (limestone, dolomite, etc.) or “non-key” (overburden, waste rock, etc.) and define the color, hatch, scale, and density of each unit encountered. Defining the geologic unit is important because these data are used to draw geologic columns and fence diagrams. These figures are then used by Skelly and Loy’s geologists to correlate strata within the reserve. The geologic units are also used by macros within Carlson to color and display the 3D block model. The strata are then organized into beds or layers (horizontal or inclined) and named for block modeling identification. Once the drill hole data have been correctly imported (and verified), geologic units defined, and QA/QC measures completed, Skelly and Loy begins to create the 3D block model.

**Creation of the Block Model**

Block modeling can be accomplished by various interpolation techniques, including inverse distance, Kriging, or discrete routines. Skelly and Loy analyzes the ore body in a series or cluster of blocks or cells. These cells are of a given dimension, depending on the drill spacing and other factors, and may be of practically any size but generally range somewhere in the neighborhood of 50 to 100 feet in each dimension (length, width, and height, all of the same dimension). After the 3D block model has been generated, we employ the AutoCAD 3D viewer function that allows the drill hole lithology and downhole data to be displayed and analyzed from any desired viewpoint. We also have the capability to view the block model in a 3D “fence diagram” or “profile” view for further analyses.

After the block model has been created, Skelly and Loy can complete geostatistical analyses on a grid basis for each block within each “lift” in order to characterize the unique quantity and quality parameters of each. Isopleth maps can be prepared from the block model to reflect various quality parameters. The software has the capability to analyze each block (or cube) and report the volume, tonnage, and quality of each material type and quality parameter sampled and contained in the block. It can also produce an overall quality average for any area defined (individual block, multiple blocks, entire lift, entire reserve, etc.). The software allows the user to select complex inclusion perimeters and exclusion perimeters (i.e., mined out areas) using advanced polyline logic.

The block model is then used by Skelly and Loy in the creation of a mine plan that maximizes mineral extraction while minimizing waste handling. In other words, it presents the opportunity to blend waste into product, thus maximizing recovery. These designs may include detailed material blending and handling plans to meet unique product specifications and grades. Skelly and Loy can develop layouts for a broad range of client’s planning needs, including complex annual and life-of-mine scenarios.

If you would like more information about block modeling in mine planning, or if you have questions about one of our other many expert services, please feel free to contact Don Polly at 800-892-6532 or 717-232-0593 or dpolly@skellyloy.com.