"LANDFORM" LAND ANALYSIS AND DISPLAY FOR MINING

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Landform - A Computer-Aided Planning and Design Process

What is landform?

Landform is an acrononym for Gathering and Organizing, Displaying, and Processing data to assist the planner and designer in doing a thorough job and reaching timely decisions which are based on more facts.

The process was developed under the Forest Service Surface Environment and Mining program and is being demonstrated in a cooperative effort with J. R. Simplot Company in the phosphate area of southern Idaho.

The Surface Environment and Mining (SEAM) program was a special Research, Development, and Application program established by the Forest Service. The program got underway in 1974 and was given a five-year charter to examine the potential environmental effects of surface mining in the west. This entailed doing the necessary research and developing technology to minimize any adverse effects or to hopefully enhance the environment. This entire effort, of course, was underscored by the need to get the knowledge used or applied to the problems. The program is closing down at the end of September, in about a week, with the objectives initially established met. The cooperation and assistance by the minerals industry has been tremendous, is appreciated, and we would like to take this opportunity to say thanks.

Why landform?

In recent years, there has been a significant public awareness and concern for environmental conditions and especially possible environmental degradation. This environmental concern, as well as legal and economic constraints, has made minerals development expensive. Ways of handling the necessary planning and design have become quite sophisticated.

In examining the ways minerals development was being planned, it seemed there was a real need for a more comprehensive approach to minerals development. For example, a few years ago reclamation was considered the action that was taken after mining was completed. Now, I believe, most people in the business realize that proper development includes adequate consideration of all phases of mining, from exploration through post reclamation.

At the same time that there was recognition of the need for more comprehensive planning, it was also recognized there was a need for better methods and tools to do the job. There were a number of computer programs in use both inside and outside the Forest Service which could be applied to the task of doing a better planning and design job. Landform is the result of the effort to bring existing and new computer programs into a system that can be applied to minerals development, planning, and decision. It brings together digital modeling, information display techniques, and engineering design programs into a single, integrated process.

Over the past few years, technology has advanced significantly, and methods have now been developed to collect both surface and subsurface data in digital form so that, with the aid of computers, it can be rapidly manipulated and displayed. In addition, program and processes have been developed to use digital data for planning and designing many different types of landform changes, including those resulting from such activities as surface mining, timber harvest, transportation facilities construction, and ski area development. Visual display and simulation capabilities have been developed, which can be used to depict what a proposed development will look like before any land is actually disturbed.

How is landform organized?

Landform is divided into three primary phases. These are:

(1) Data Gathering and Organizing

(2) Information Display

(3) Design and Plans

I would like to discuss each of the three phases.

Data gathering and organizing.

In the first phase, Data Gathering and Organizing, we are collecting data sufficient to define the surface of the ground, the subsurface geology, man-made improvements, and other information needed for planning.

Any point, line, or surface can be described in a numerical way by coordinates so computers can be used to manipulate the data. This digitized data in an XYZ coordinate system can be gathered in a number of ways. It may be collected from aerial photography using what we call the Mahan Breakline Method. With this procedure, a digitizer-equipped stereo plotter such as a KERN PG2 or TOPOCART is used to digitize the drainage bottoms and ridge lines. If the terrain is uniform, this is the minimum amount of data that will adequately describe it. However, the ground is seldom uniform or seldom has a constant slope between the ridges and drains. Therefore, additional data is collected along what we call "form lines" to define additional breaks in the terrain. This method is designed to allow the definition of the terrain within specified limits of accuracy with a minimum amount of data.

Recently, it has become possible in certain areas to get terrain data tapes from the U. S. Geological Survey. These data tapes are collected as a byproduct of their normal process of developing orthophotos and mapping. We have tested the data to a very limited extent and have found that a 40-foot contour level of resolution is reasonable. This would be very suitable data which could provide useful information for broad area planning.

Terrain data can also be collected by digitizing the XYZ coordinate data from contour maps. In some cases, suitable data can be obtained from on-the-ground surveys.

We believe that use of the Mahan Method is efficient and effective, and it does allow the user to statistically evaluate the accuracy of the terrain data. We believe this is important, because it tells one how closely the terrain model represents the actual ground.

Subsurface data can be developed using drill hole logs, information from seismic or resistivity surveys, or other valid geologic data sources. I would like to point out that the geologist or mining engineer must specify and systematically identify the encoded information. The subsurface data will normally be much sparcer than the surface data. The system is developed so that machine extrapolation beyond known data is not allowed. We have found that considerable interaction between the user (geologist or mining engineer) and the system is necessary to properly develop subsurface information.

Other resource information is also needed to do an adequate job of planning. Such information as property boundaries, existing transportation facilities, vegetative types, and wildlife habitats can be incorporated into the system by using either an XY digitizer, or a stereo digitizer. The information can be taken from maps, photos, or surveys.

The Landform system is designed to operate on mini computers as well as large systems. Therefore, organizing the data takes on special significance. First, all data is oriented or tied to a uniform coordinate system. All data is sorted by location in a series of grid blocks. These blocks of data are addressed and can be selectively retrieved. In that way, the entire file does not have to be searched in order to call out some specific data.

The data is stored in either a random or gridded format so that advantage can be taken of either or both, as appropriate. As was mentioned earlier, the data is compartmentalized so that it is useable on small systems which will support random access files and where core storage is limited. All programs are written in Fortran language so they can be more universally applied.

The system as it presently exists is organized in a matrix with nine programs. There are an average of about six (6) subprograms in each program. The system is modularized, and we foresee the addition of other programs and subprograms in the future. Many of the programs have been developed on an IBM 1130 mini computer, but also operate on the large Univac 1100 system. Some of the programs have also been put on the Data General Eclipse and Nova mini computers in our office. The rest of the programs are currently being put on the Eclipse system.

Information displays.

One of the advantages of having a digital data bank that a computer can use with a machine plotter is that contour intervals, scales, and perspective views can be rapidly changed to meet the user's needs. It also allows the overlaying of the different information layers.

The initial output of the Landform process is the production of a number of displays or plots of the existing conditions. These displays are useful to the planner or designer, because it provides a visual representation and enhances understanding of the site. They can also be used for actual planning and designing activities such as laying out road grade lines using topographic plots. Examples of plots which can be produced using surface data are: perspective views of topography, perspective fishnet grids, slope and aspect, or profiles at any location selected by the user. These plots can be registered to vertical or oblique photography as desired.

The subsurface data can also be represented in various ways. In addition to the drill hole locations, structural contours or cross-sections showing the various strata or layers can be plotted. These can also be turned and viewed in perspective from any position. We believe, for example, that perspective plots of the underground surfaces are very useful in locating and analyzing faults or other discontinuities.

These informational displays can be supplemented and overlayed with any number of other resource or physical feature plots, such as property boundaries or existing roads.

Designs and plans.

Computations - With the above information available and easily accessible, the designer has products which he can use. To further assist the designer, the system includes programs which provide compuation of plan areas, such as the area disturbed and needing revegetation. Cross-sectional areas and the volumes of overburden and ore, for example, can also be computed. These computations are all provided in a systematic tabular format. Once the location and volume of material is known, haul quantities and costs can be computed. Road design processes are included so that the geometry, such as the centerline alignment, is calculated and tabulated. Cross-sections and profiles are plotted and areas and earthwork volumes computed.

Plans - Finally, the result of the design process needs to be represented as plans with drawings and/or models. Again, using the display capabilities of the system and alternative designs of the transportation system, pit or waste disposal areas can be produced in plan views, perspective views, or as cross-sectional views. These plots can be used by themselves or registered to vertical or oblique photography to accurately depict what the proposed development will look like. With a minimum of artistic enhancement, the proposed development can be accurately portrayed. This gives both the designer and the public a better understanding of just what the proposed development will look like before any ground is disturbed.

Applications.

Development and assembly of the system has been undertaken during the past year in cooperation with the J. R. Simplot Company and the Forest Service Regional Office in Ogden, Utah. The system, as it presently exists, is documented in a draft User's Manual. The Forest Service will continue testing and application of the system at the regional headquarters in Ogden. The programs will be available at reproduction costs to those who want them. These will be provided within the constraints of the time available by the two-man project staff.