A Computerized System for Portrayal of Landscape Alterations[1]

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Abstract: The growing public awareness of and participation in the visual resource decision process has stimulated interest to find improved means of accurately and realistically displaying proposed alterations. The traditional artist renderings often lack the accuracy and objectivity needed for critical decisions. One approach, using computer graphics, led to the MOSAIC system which is a special adaptation of photomontage techniques capable of meeting most of the requirements for realism, accuracy and cost.

This paper briefly covers some of the early development and explains some of the more innovative concepts of the system. The development and demonstration phases were conducted using actual landscape alteration problems. Key steps involved in field measurement, photography, computer input and output, artist enhancement, documentation and training materials are described.

Finally, capabilities and limitations are discussed in terms of the applications of the system. Specific issues will include costs, data requirements, ranges and scales, terrain characteristics and skill needs.

MOSAIC

Introduction

MOSAIC is a low cost computergraphic system for producing accurate portrayals of proposed landscape alterations -- with realism. The system was developed expressly for the typical problems encountered by landscape architects and land use planners. It has been demonstrated, installed, and checked out on the USDA computer located in Ft. Collins, Colorado. User and programmer documentation has been prepared. A training course has been documented and applied to develop a National Training Team.

This paper describes the development of the MOSAIC system which was a joint effort of specialists in The Aerospace Corporation and the Forest Service. The use and capabilities of the system are briefly discussed. Finally, it describes solutions to some problems encountered while achieving the functioning system.

Early Work

When initial work was begun in 1970, we believed the concept of using computergraphics to draw the landscape and proposed alterations was a novel idea. Later we would discover that others were also exploring the same area. We were aware of the existence of software which could draw perspective views of terrain using digitized contour elevation data. In fact, we were using just such a program to test the quality of terrain data processed for a Forest Fire Model being developed for the Forest Service. It occurred to us that such a system might also be used to portray landscape alterations. We contacted Dr. Gary Eisner of the Forest Service and he confirmed that if such a model could be developed, it might become a useful tool for landscape architects. We were to learn that developing such a computer system was somewhat more complex than we first envisioned. We did appreciate that our early efforts might have a high probability of nonapplicability or even failure and, therefore, elected to do a substantial

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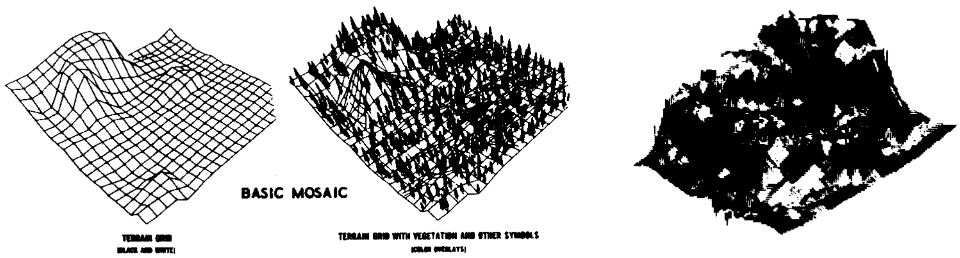

Figure 1--Light intensity algorithms for the front face of the Santa Barbara Mountains.

Figure 2--Southeast view of Pansy Creek area proposed timber cuts--black and white pen plot.

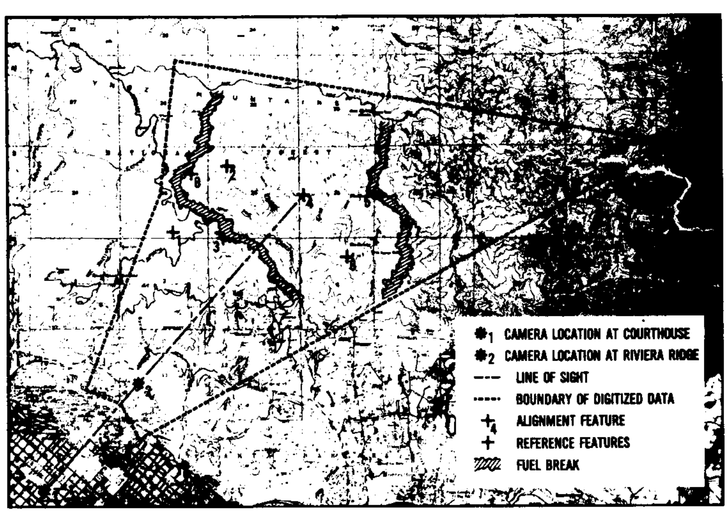

Figure 3--Map used in MOSAIC photomontage of Santa Ynez fuel breaks.

portion of the initial development with corporate funds. As the system began to achieve the demonstrated capabilities, the Forest Service provided increased funding to the program.

The corporate funds were being used to support experimental research of computergraphic techniques. The Forest Service funds were directed toward a literature search of the current state of the art in computergraphics equipment and software. It was felt that the findings of this research could have direct application in producing displays of proposed landscape alterations. The results of the search by A. E. Stevenson, et al. (1973) provided a broad foundation upon which to build the final system. A greater appreciation for the limitations and costs of existing systems was also achieved.

The early experimental work at Aerospace consisted of finding an efficient computer program to convert terrain data into plot data. This program contained a hidden-line removal subroutine which eliminates those portions of both terrain and landscape alterations that would naturally be hidden by the foreground. As time progressed, symbols for trees and other objects were added to the basic graphic capability. Experiments were made to incorporate color and shadows. Light intensity algorithms were developed and a series of drawings were produced (Fig. 1) for the front face of the Santa Barbara mountains and a demonstration area at Pansy Creek in Oregon. In spite of great effort and many innovative techniques, it eventually became apparent (Fig. 2) that this capability would not yield the required realism within practical cost boundaries.

The Photomontage Concept

The inability of these early computergraphic techniques to achieve the needed realism was truly discouraging; however, it was decided to again review the techniques uncovered in our original survey of computergraphic art. One method that was particularly appealing was the photomontage concept. It had the potential of combining the realism of photography with the accuracy of the computer-generated graphics and artist enhancement. The literature revealed, however, a serious difficulty in aligning the computergraphic origin with the camera origin and view orientation. The experimenters in the literature had used theodolites to achieve camera alignment and ground survey data to determine position. The photographs were made on glass plates with measurements made by manually operated, optically accurate comparators. The equipment and techniques were far too complicated, time consuming and expensive for the field applications we envisioned. A method for achieving the needed registration was developed by Aerospace and is described in a paper by J. Carey et al. (1975).

The method devised to locate the camera origin and determine its orientation was one of selecting a number of reference features (four or more) which could be readily recognized and accurately measured on both the photograph and on the area map. The reference points or alteration location are limited to distances of ¼ to ½ mile or greater from the camera origin. These requirements place some restrictions upon the type of terrain where MOSAIC can be easily applied.

With the measurements of the reference points as input, a computer software program (Carey, et al. 1976) is then able to solve for the most likely camera position and orientation (fig.3) . Initial estimates of camera location are input; however, these can be rough guesses, with errors of several thousand feet in position and angle errors are great as 10 degrees. These inputs merely provide a starting point for the computer program.

Now that the camera position and orientation angles have become known, the computer is now able to portray the landscape alteration when required inputs are supplied. On unfamiliar terrain we have found it useful to draw the terrain itself and overlay it on the photograph for an initial terrain registration check (fig. 4). This step will reveal errors in the digitized data as well as errors in camera position and orientation angles. While this step is not essential, we have found its inclusion avoids many problems further downstream.

The computer now contains the origin and field of view which gives the best match of graphic overlay with the photographed terrain. It also contains a data set for the digitized terrain which is without major errors. The remaining step is to define and input the proposed landscape alteration to be displayed. There is a substantial library (Fig. 5,6) of graphic options within the computer software. We will examine these as classes and show some example of each.

The first class of alterations are those which change the shape of the terrain. These include surface mine pits and spoil banks, dams and lakes, and roadbeds for highways and railroads. There are some special subroutines within MOSAIC which assist in preparing input changes to the terrain data, i.e., the computer input for surface mines is able to use the pit dimensions to also define the spoil bank configuration. It does, however, require some additional input data, i.e., the angle of repose, and the expansion of the overburden. The roadbed input is based on cross section dimensions and center line locations. Dams are similar to roadbeds and lakes are a large fill with a single elevation dimension.

The second class of graphics are those which are superimposed on the surface of the terrain. These include revegetated areas, fuel breaks, timber cuts, ski runs, trails and boundaries. The inputs

Figure 4--Terrain registration.

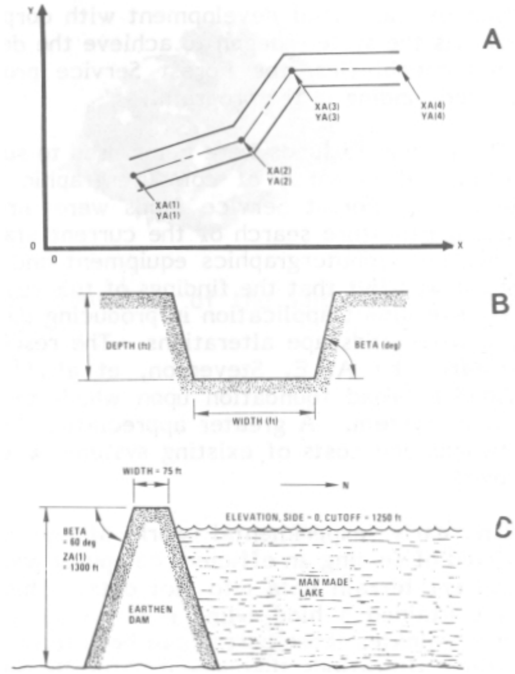

Figure 5--(a) Plan view of surface mine, (b) cross section view of surface mine looking from point 1 to point 2, (c) cross section of earthen dam and man-made lake.

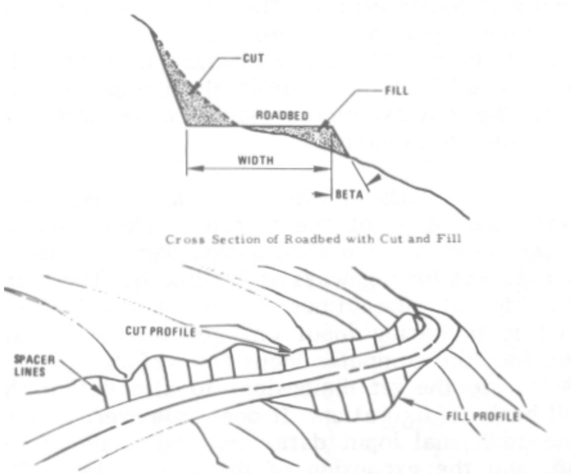

Figure 6--Prospective view of roadbed.

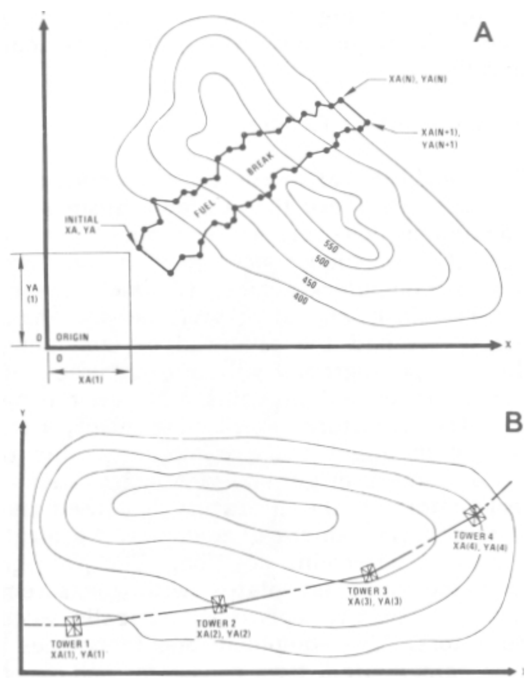

Figure 7--(a) Fuel break superimposed on contour map, (b) plan view of power line system.

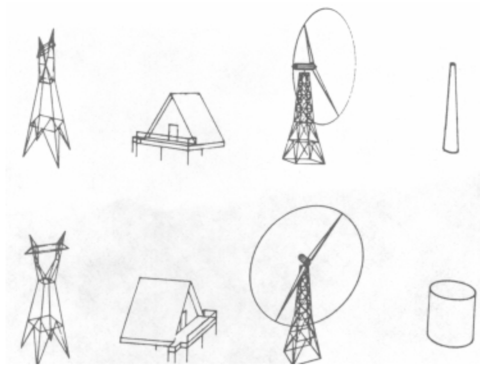

Figure 8--Structures.

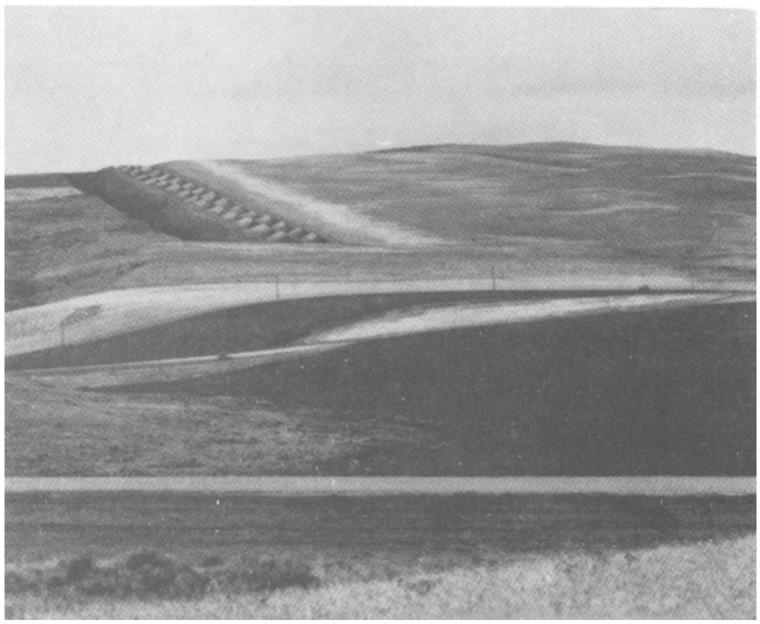

Figure 9--MOSAIC portrayal of surface mines.

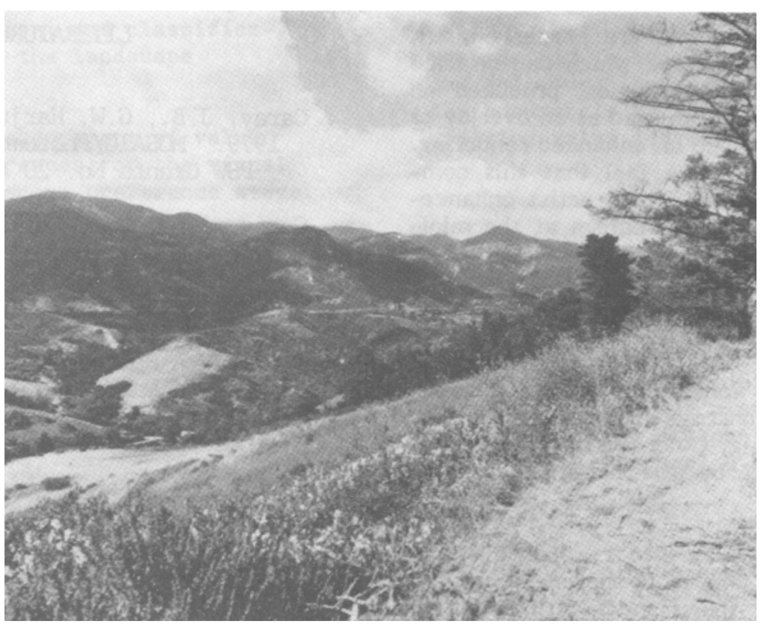

Figure 10--Original mountainous terrain.

Figure 11--Terrain with lake superimposed by MOSAIC methods.

here consist of an ordered set of map measurements (x,y) which define the outline of the alteration (Fig. 7).

The third class of graphics are structures which may be found in the wildland area. There are subroutines for A-frame cabins, tanks, smokestacks, powerline towers and large power windmills (Fig. 8). When proper position measurements, desired structure sizes and azimuthal orientation parameters are supplied as input to the computer program, the system will locate, draw the structures to scale, and provide the appropriate terrain concealment.

When these measurements are properly input, the system will produce a tape which can be used to drive a plotter. The graphics, produced on mylar by this plotter are then used as an overlay to assist the artist to produce an enhanced rendering. Based on our experience, we feel that this combination of computergraphics and artist enhancement produces the maximum realism at the minimum cost.

Let us briefly examine some examples of the computer output.

An example of the artist enhancement is shown on Figure 9 for a demonstration project of surface mines planned for Craig, Colorado. The computer outlines were colored by the artist to provide realism.

Another example is a view of a proposed lake in mountainous country. Figure 10 shows the original terrain and Figure 11 shows the terrain with the lake superimposed.

The brevity of this paper prevents the detailed explanation of the mechanics of applying the system or its internal workings; however, these are covered in the programmer's handbook and user manuals (Carey et al. 1976, 1979).

The project represents a total program which includes landscape architecture research, engineering and computer techniques. It also represents an example of cooperation between a governmental agency and a nonprofit corporation in a creative research program.

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