

The Visual Information System¹

Merlyn J. Paulson^{2/}

Abstract: This paper outlines a project level process (V.I.S.) which utilizes very accurate and flexible computer algorithms in combination with contemporary site analysis and design techniques for visual evaluation, design and management. The process provides logical direction and connecting bridges through problem identification, information collection and verification, visual evaluation, design development, management prescription development and periodic review. V.I.S. introduces sophisticated new algorithms for data verification and visibility, view quality, and topographic and visual slope and aspect determinations; a logical procedure for user and expert preference and sensitivity testing, and a graphic analysis system for the identification of form, line, color and texture related anomaly detection and mitigation design criteria at a site scale.

INTRODUCTION

Visual quality analysis and design processes have evolved as creativity, new technology and common sense have merged to provide the means to challenge and improve them. Few disciplines are caused to cover a similar range of the interactions of the sciences and the arts. A detailed assessment of the interworkings of the socio-economic-physical environment must be followed by applications of interactive principles of art, design implementation and management to form the necessary complete process. Dynamic and iterative analysis/design systems have created opportunities for flexible and efficient evaluative procedures which are defensible to the public and beneficial to the designer. It has remained an important goal during the development of the Visual Information System to embody these important segments in a holistic rather than atomistic manner.

THE V.I.S. PROCESS^{3/}

The V.I.S. process is diagrammed in figure 1.0. It consists of five general phases, each of which contains a number of specific procedures. The entire process is initiated by a proposal for physical change, in which it is assumed that a visual evaluation, design or management prescription is a requirement.

Phase I: Overview

Phase one consists of the project overview. The assumptions under which the project is undertaken are identified and the proposed changes documented and defined in terms of time and space. The administrative coordination of the project, the project schedule and information sources are established and verified.

^{1/}Submitted to the National Conference on Applied Techniques for Analysis and Management of the Visual Resources, Incline Village, Nevada, April 23-25, 1979.

^{2/}Merlyn J. Paulson is Assistant Professor of Landscape Architecture, Colorado State University and President of MJP ASSOCIATES, INC. of Fort Collins, Colorado.

^{3/}The Visual Information System process has been developed in visual quality analysis research and professional work conducted by Merlyn J. Paulson, with original conceptual guidance from Carl F. Steinitz, Harvard University, and the later assistance of Daniel Oetting, John Schock and many students of Landscape Architecture at Colorado State University.

Phase II: Data

Phase two involves the identification of the project study area and the collection of information relevant to the project. The project study area encompasses all of the proposed physical changes and geographic areas which can, at this stage, be identified as exerting or receiving visual influence.

Two "grid maps" of information are required for the computer-aided evaluations of visibility, view quality, slope, aspect, duration and view impact. These include: 1) the topography, in multiples of feet, as shown in figures 2.0 and 2.1; and 2) the visual surface pattern, as shown in figure 2.2.

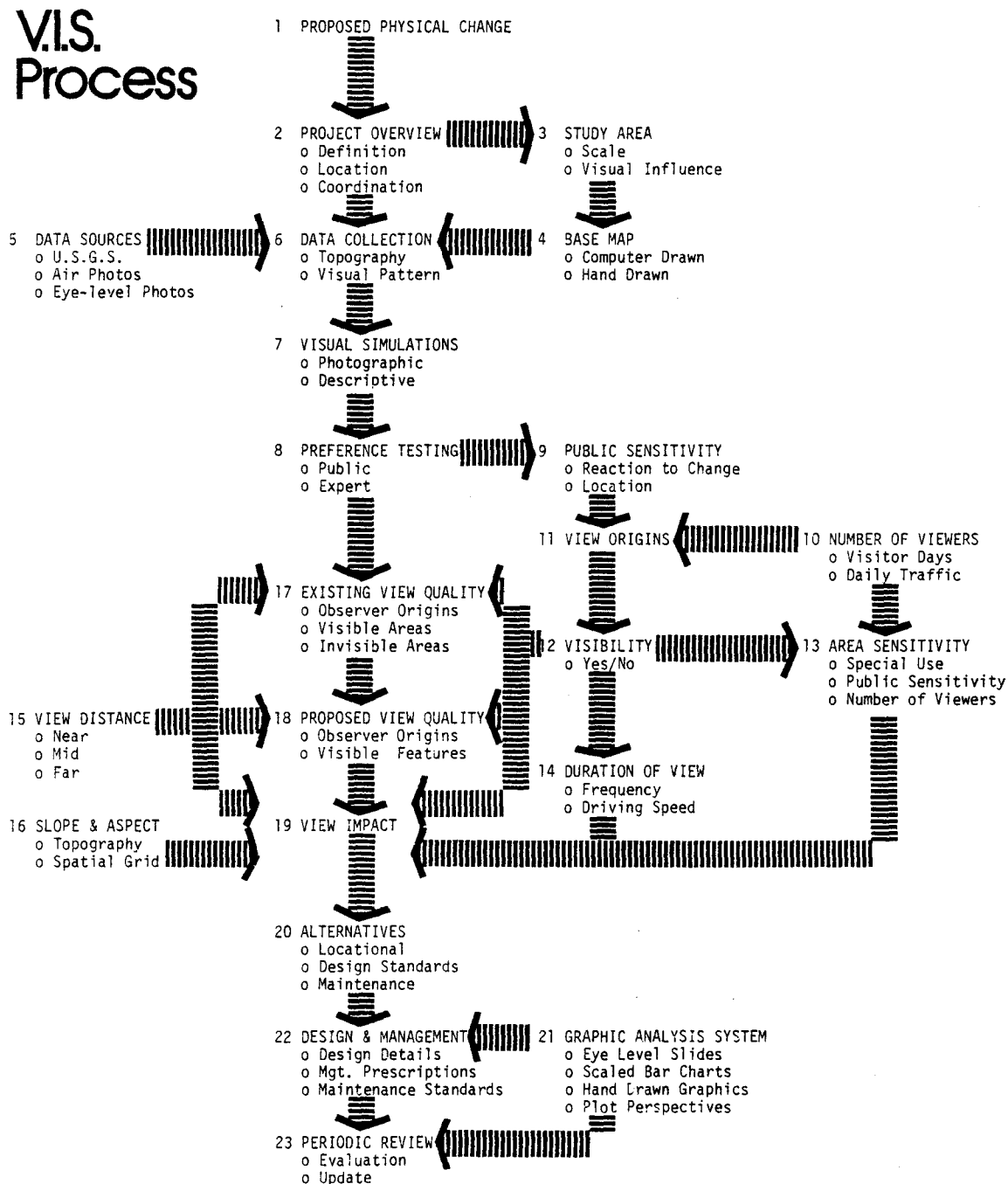


Figure 1.0--The V.I.S. process diagram.

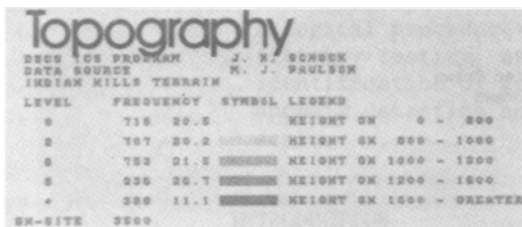
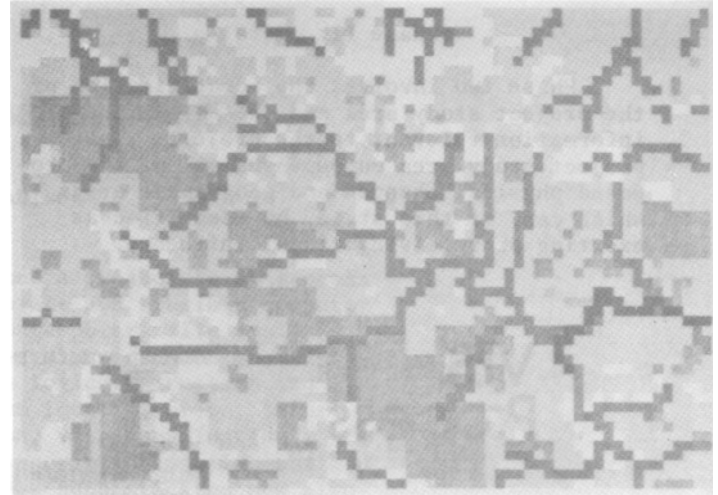
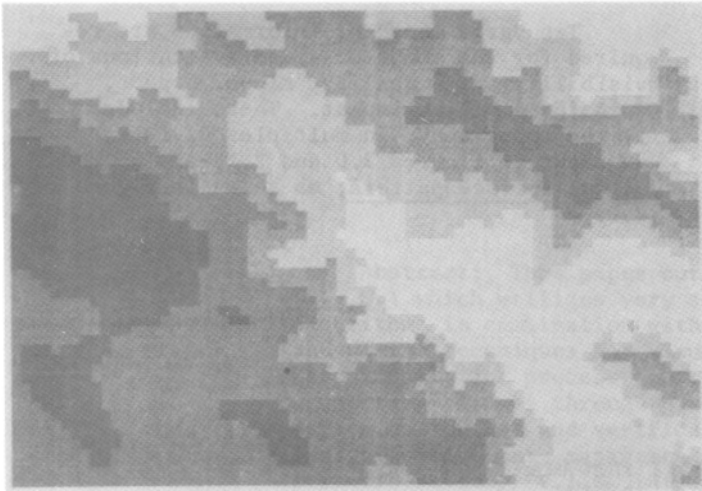


Figure 2.0--Topographic Elevation: where darker areas represent higher elevations.

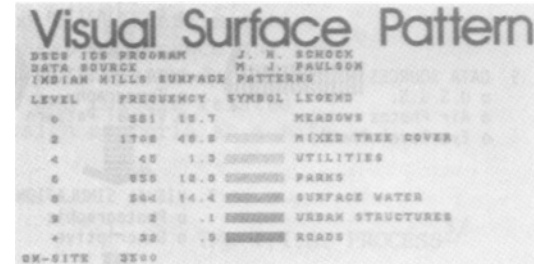


Figure 2.2--Visual Surface Pattern: where thirty-one visual features are aggregated into six basic visual classes.

addition, photographs are taken of representative visual features in the region. These regional photographs are used as a standard of comparison for preference determinations in the project study area. Colored photographic simulations are produced to demonstrate the appearance of the proposed physical changes in appropriate locations in the study area. The V.I.S. preference testing procedure^{4/} (Paulson 1979) insures the use of both public and expert judgments regarding critically important visual quality indices.

User sensitivity information is developed within the preference testing procedure and applied with visibility and number of viewers data to form the area sensitivity evaluation.

An information verification algorithm entitled "DSCS-DATAVER" (Schock 1978) allows the verification and correction of grid cell maps.

^{4/} The preference test procedure was developed in visual quality research conducted through the Landscape Architecture Research Office, Colorado State University, 1975-79.

Figure 2.1--Topographic Surface: where lines represent boundaries of grid cells. (Schock 1978)

The visual surface pattern map is derived simply by dividing the study area environment into homogenous visual parts. Examples include: trees, meadows, roads, houses, lakes, streams, transmission lines, etc.

Preference testing information in the form of colored slides and prints is collected for each different visual surface pattern feature and/or combination of features in the project study area. In

Phase III: Evaluation

The third phase of the process involves the detailed evaluation of the interrelationships between viewers, the proposed physical changes and the visual environment. Qualitative and quantitative analyses, using computer-aided manual procedures, provide visibility, area sensitivity, duration, view quality, slope, aspect and view impact information in map, photographic, numeric and written form.

The topographic slope and aspect (fig. 2.4 and 2.5) and visual slope and aspect calculation algorithms are entitled "DSCS-SLOPE & ASPECT" (Schock 1978). These algorithms are based upon a unique 'warping' concept which utilizes the four corners, plus the center point, of each cell in the critically important slope and aspect identification procedures.

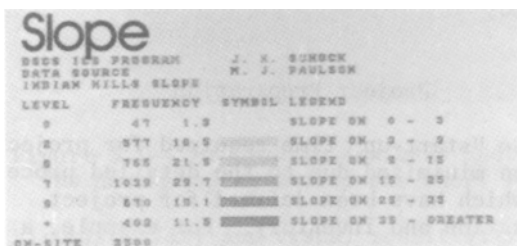
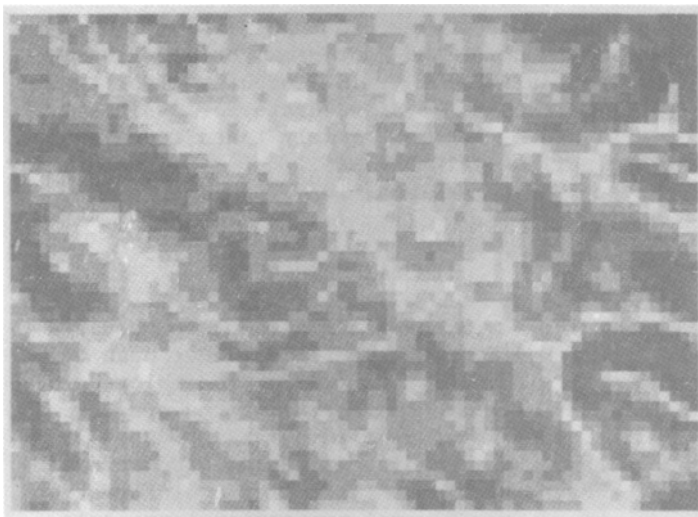
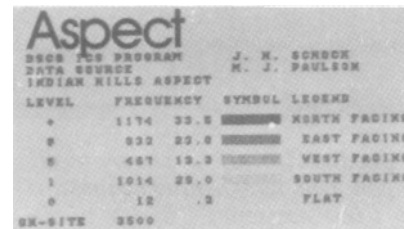
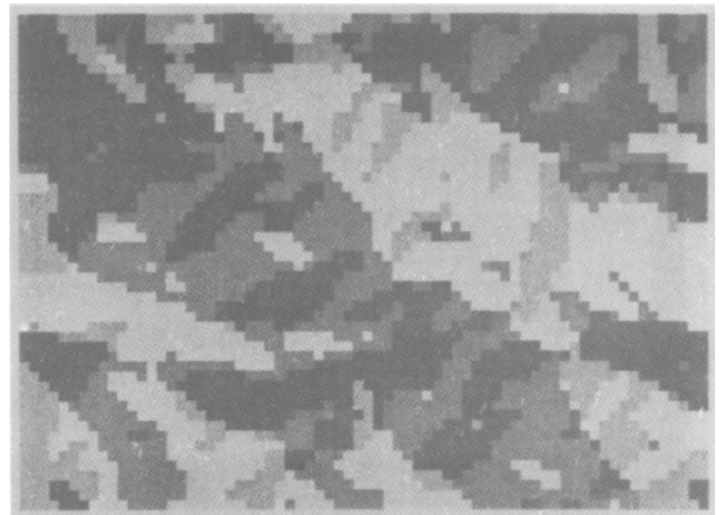


Figure 2.4--Topographic Slope: where darker areas represent steeper slopes.

The visibility, sensitivity and quality related analyses are developed with the assistance of the computer algorithms entitled "OCTVIEW & VISQUAL" (Paulson 1978). The author's conception of the visibility algorithm is shown in figures 2.6 and 2.7.

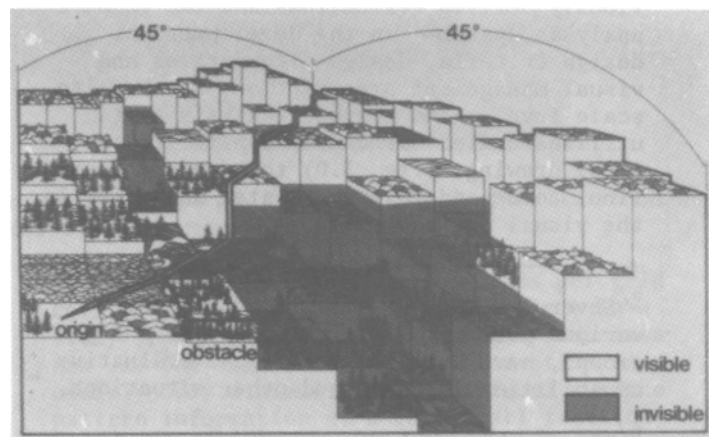


Figure 2.6--Topography and the Visual Surface Pattern: the three-dimensional concept for the north-northeast and east-northeast views.

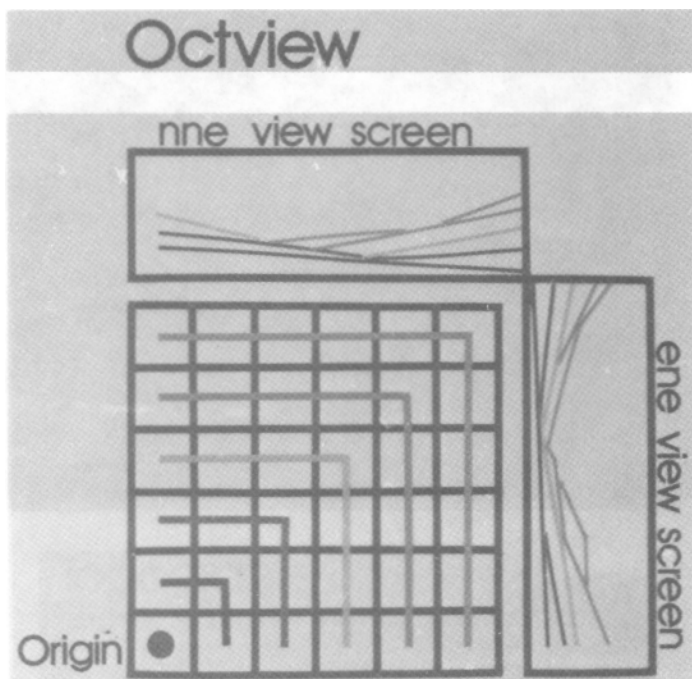


Figure 2.7--The projection of a theoretical grid pattern upon the north-northeast and east-northeast view screens. Lines visible on the view screens represent visible areas.

The V.I.S. evaluative capability is particularly useful in providing defensible answers for facility siting studies, environmental assessment studies and mined land visual design studies^{5/} Paulson 1975).

Phase IV: Design and Management

Phase four involves the use of previously derived evaluations and the graphic analysis system^{6/} in the development of design criteria, design alternatives and visual management prescriptions at the site scale level. The graphic analysis system utilizes scaled bar charts applied to eye level drawings (fig. 3.0) to identify form, line, color and texture related anomalies in the visual environment.

^{5/} Several visual studies, conducted by various public and private agencies-and groups, have utilized the V.I.S. evaluative capabilities in these and other situations.

^{6/} The graphic analysis system was developed for three limestone quarry reclamation and visual design projects near Colorado Springs, Colorado, which were undertaken by MJP ASSOCIATES, INC.

Phase V: Periodic Review

An important fifth phase of the process is the periodic review of the study area to determine the level of success, and/or possible revisions, of the original designs and management prescriptions. This is accomplished through the application of the graphic analysis system to eye level slides or photographs of the project area.

APPLICABILITY

Experience by many groups in professional work, research and teaching has shown the Visual Information System to be flexible, easy to use, and defensible to the layperson and public. Projects have ranged in scale from 3000 hectares to 140,000 hectares; in complexity from very flat arid deserts to densely vegetated mountainous areas; in viewing distance from 100 meters to 29 kilometers; and in content from mined land reclamation studies, to transmission line siting studies and geothermal energy visual assessments. The V.I.S. computer algorithms have proven to be as accurate for visibility analysis as the most finely tuned topographic and surface pattern data . . . and economically competitive (Paulson 1978).

TIME AND EXPENSE

The levels of time and expense required to use V.I.S. are directly dependent upon the segments of the system which are employed, and the size and complexity of the project. It is thus impossible to portray adequately in this paper absolute time and expense data for every problem. The following information is based upon several professional projects in which various segments of the system were employed.

Project Preparation

The "start-up" time required for projects has been minimized due to the detailed procedures which have been defined for project organization and inventory. For example, a staff of four people can collect, verify and begin to analyze topographic and surface pattern information for 50,000 grid cells in about two weeks.

Barring changes in proposed actions and/or project requirements, the computer can then analyze visibility, view duration, visual absorption, topographic slope and aspect, and visual slope and aspect in an afternoon.

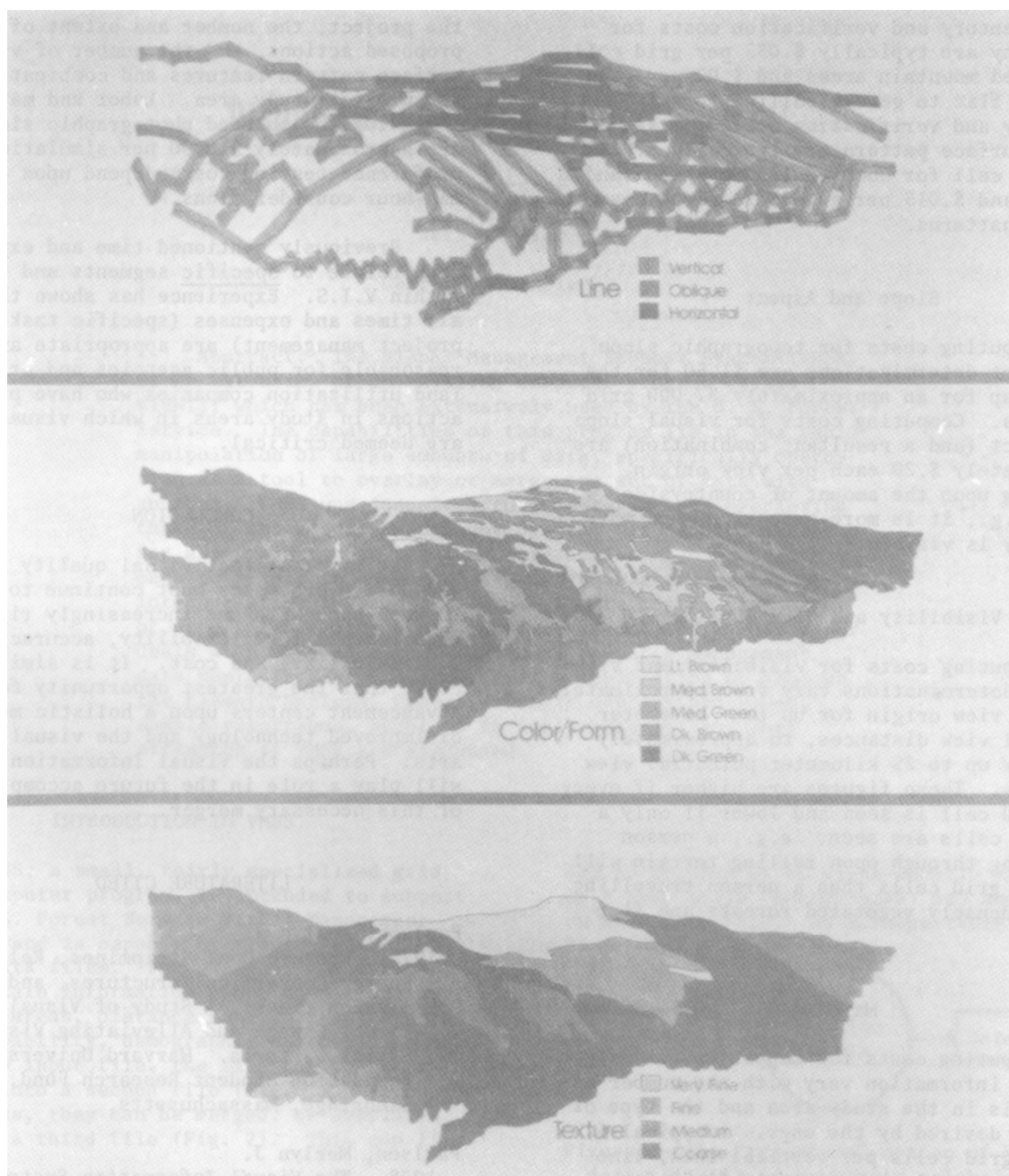


Figure 3.0--The Graphic Analysis System: values adjacent within the sketches and further apart on the accompanying scaled bar chart represent greater visual contrast and impact.

Visual quality and visual sensitivity assessments, which depend upon photography and public meetings (time variable), can also be accomplished by the computer in less than a man-day.

Inventory

Manually collected information, such as topography and the visual surface pattern,

requires approximately 25 man-seconds per grid cell to inventory for the first project in a study area. Future projects in the same area can use the same topographic information and usually only minimally changed visual surface pattern information at a very small fraction of the original cost. The 25 man-second figure typically decreases for larger study areas (approximately 100,000 grid cells) and increases for smaller study areas (approximately 10,000 grid cells).

Inventory and verification costs for topography are typically \$.035 per grid cell for rugged mountain areas and \$.02 per grid cell for flat to gently rolling terrain. Inventory and verification costs for the visual surface pattern are typically \$.025 per grid cell for complex land use and landscapes, and \$.015 per grid cell for homogenous surface patterns.

Slope and Aspect

Computing costs for topographic slope and aspect determinations are \$1.50 for the entire map for an approximately 37,000 grid cell area. Computing costs for visual slope and aspect (and a resultant combination) are approximately \$.20 each per view origin, depending upon the amount of countryside seen, e.g., it is more expensive when more territory is visible.

Visibility and View Quality

Computing costs for visibility and view quality determinations vary from approximately \$.10 per view origin for up to 7 kilometer potential view distances, to approximately \$1.20 for up to 29 kilometer potential view distances. These figures are higher if every last grid cell is seen and lower if only a few grid cells are seen, e.g., a person travelling through open rolling terrain will see more grid cells than a person travelling through densely vegetated forests and flat terrain.

Mapping

Computing costs for mapping previously computed information vary with the number of grid cells in the study area and the type of graphics desired by the user. A typical 6, 8 or 10 grid cells per vertical inch, line print map, costs approximately \$1.50 for 10,000 cell study areas. A newer gray shaded (looks like zip-a-tone and always comes out report sized) dot matrix map produced by an electrostatic printer/plotter costs 30-50% more for the same sized study areas. A newer yet color/shaded (four colors--five shades of each) map sandwich, produced first in separates, and then in a layer of color for each separate, costs slightly less than five times more than a gray shaded map.

Preference Testing

Public and expert preference testing costs vary with the level of complexity of

the project, the number and extent of the proposed actions, and the number of visual surface pattern features and combinations in the project study area. Labor and materials costs for the colored photographic simulations are approximately \$10.00 per simulation. Other preference testing costs depend upon travel and man-hour considerations.

Previously mentioned time and expense data relate to specific segments and tasks within V.I.S. Experience has shown that over-all times and expenses (specific tasks plus project management) are appropriate and reasonable for public agencies and private land utilization companies who have proposed actions in study areas in which visual issues are deemed critical.

CONCLUSION

It is clear that visual quality analysis and design processes must continue to improve to keep pace with the increasingly rigorous requirements for flexibility, accuracy (defensibility) and cost. It is similarly clear that the greatest opportunity for advancement centers upon a holistic merger of improved technology and the visual design arts. Perhaps the Visual Information System will play a role in the future accomplishment of this necessary merger.

LITERATURE CITED

- Paulson, Merlyn J.
1975. Western Coal Stripmines, Related Energy Conversion Structures, and Transmission Lines: A Study of Visual Quality, Visual Change and Alleviating Visual Siting Criteria. Harvard University/Ford Foundation Student Research Fund. Cambridge, Massachusetts.
- Paulson, Merlyn J.
1978. The Visual Information System. Land-scale Architecture Magazine 68(3):233-235.
- Paulson, Merlyn J., Inc., and Harmon, O'Donnell & Henninger Associates, Inc.
1979. Outer Continent Shelf Visual Resource Management Methodology Study, Alaska OCS Socioeconomics Studies Program. U.S.D.I. Bureau of Land Management. Available through the National Technical Information Service.
- Schock, John H.
1978. FORDYM-Information Classification System Programs. Dynamic Systems Consulting Service, 710 Remington Street, Suite One, Fort Collins, Colorado.