Computers and the Landscape[1]

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Abstract: Computers can analyze and help to plan the visual aspects of large wildland landscapes. This paper categorizes and explains current computer methods available. It also contains a futuristic dialogue between a landscape architect and a computer.

INTRODUCTION

Computers can do routine things, such as balance checkbooks, calculate transportation costs, and send you bills. How can a computer possibly assist in the challenging, esthetic area of landscape planning? This paper discusses the current role of computers in landscape planning and suggests possibilities for the future.

Size of the Job

If we consider that wildlands constitute 1.6 billion acres of the United States or approximately 66 percent of our land area, then it follows that landscape planning for this area is a big job. As we have heard from R. Burton Litton, the largest public land management agencies have recommended approaches for planning the large areas they administer. But the actual job of landscape analysis and planning usually is done by one or two people on each administrative unit. For the Forest Service this typically means that these people have the job of analyzing about a million acres of land. And for the Bureau of Land Management it typically means several million acres for one or two people. Other agencies, private industry, and States often have a job of equal or greater magnitude.

To illustrate the size of one million acres, assume the area is square. If you started on a walk to visit each acre and walked continuously at the rate of 4 miles per hour, it would take you 1 year, 1 month and 17 days.

ROLE OF COMPUTERS IN VISUAL LANDSCAPE ANALYSIS

The implication of the above discussion for landscape analysis is that any problem requiring an area to be consistently analyzed will usually require a lot of field work, or a lot of data collection, or both, and will result in masses of data. Often the field work can be minimized through wise sampling, but usually data on the visual properties must be maintained and analyzed to make tradeoffs with other uses. The result: a computer robot may be a helpful friend.

Consider an example of determining scenic complexity. The analyst suggests that several variables must be considered and that these variables working together, determine scenic complexity. Furthermore, he knows some specific sites--control points--that are highly complex and some that are uniform. A simple approach to analyzing the entire area would be to prepare a map for each of the basic variables and combine these in various ways until the resulting map produced complexity indices matching those of the known control points.

Now consider how a computer can handle the mechanical and bookkeeping aspects of this job. Suppose a transect of known values has been determined and the basic variables for the transect and the remainder of the area have been mapped. The computer may

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combine such variables as topographic complexity, vegetation complexity, and accessibility with different weightings until it reproduces the known transect. Then the computer can use the same formula to determine automatically the scenic complexity for the remainder of the 1 million acres and prepare maps of the entire area.

Grid and Polygon Overlay Mapping

Computers can perform two types of overlay mapping. One general type is called grid mapping; another type is called polygon mapping. These types can be combined; for example, input data is in grid form and the printout appears as a line-drawn polygon map; or, data is input by digitizing polygons and the printout consists of overlays in grid form and polygon maps.

Overlay mapping is a valuable tool in dealing with the many variables involved in landscape analysis as well as in incorporating these results into the total job of land-use planning.

Psychometric and Social Science Analyses

Any type of observer-based analysis concerning landscape preferences will generate large amounts of basic data. Both questionnaire and interview approaches typically gather subjective data from several hundred people on from 10 to 100 points of investigation. For a typical study this will amount to from 1000 to more than 10,000 separate pieces of data to be considered. To save time, computers are used extensively, in analyzing this data. The methods include factor analysis, Chi-square tests, and other approaches to testing hypotheses as well as an array of methods for summarizing the data and generalizing results.

In addition to the psychometric methods, computers are used extensively in many social science methods. The objectives of these studies range from testing a simple hypothesis to developing a complex prediction or simulation model of landscape preferences, enjoyment, or many other aspects of the landscape environment.

Seen Area Analyses

Because the "landscape" is often defined as that area which is visible, it is frequently necessary to prepare a map of the "seen areas." For a single proposed development the map simply shows from which areas the development could be seen or not seen. It is usually one irregular contiguous area around the proposed development site with seen area "islands" scattered about; for examples, mountain tops.

For more complex situations--for example, a proposed roadway or an aerial tram--the computer can determine the seen area from the multitude of points that comprise the route. The computer can easily overlay each of these separate analyses to produce an intensity map of seen areas, a map that is frequently referred to as a times-seen map. This more complicated analysis is particularly useful in deciding where to allocate the most design effort and where to locate landscape control points. It can also be used to help answer many more complex questions; for example, comparing one route with another on the basis of diversity of scenery and viewing (Travis and others 1975).

ROLE OF COMPUTERS IN VISUAL LANDSCAPE PORTRAYAL

Suppose a manager asks the landscape architect to show him how a proposed microwave relay station will appear from six developed campgrounds, four major intersections, three staging areas for hiking trails, and a planned residential area. The manager insists that he wants accurate portrayals. From some of the fourteen viewpoints only part of the relay station will be visible and from others it will be totally visible. It will always be a different apparent size, however, because each of the 14 viewing points is a different viewing distance from the proposed station. Available computer programs can determine visibility and prepare an accurate, scaled drawing of the relay station from each of the 14 points. The computer can easily repeat the process if a differently designed station is proposed later or if the location of the station has been shifted.

When developments, rehabilitations, or other activities are planned, managers and public often want to see how they will appear before they decide to take action. For the wildland situation we are usually talking about "simulating" a scene that may have a vista of 20 miles or more. At this distance both the earth's curvature and light refractions become significant problems in preparing an accurate portrayal. Computers can take these two variables into account automatically and can also automatically draw the correct relative size of the proposed change and determine what portions of the change will be visible.

Two computerized approaches are: (a) scenes drawn totally by computer, and (b) modifications only drawn by computer and overlaid on color photographs. Either approach typically requires considerable elapsed time in putting together all the data that represent the topography, the vegetation, and the planned modification, and making the first accurate picture. After the first picture has been made, it is usually easy and quick to change viewing locations or the design of the modification, or both, and produce additional simulated pictures. One often chooses to use a computerized portrayal technique when examining many views or many designs or when an area is subject to frequent developmental pressures of all types.

The approach of drawing the scene totally by computer has the ability to portray topography, vegetation, and modifications, but may need to have color added by an artist to make the scene appear realistic and not abstract. Using the computer to draw only the modification, and then overlaying and drawing the modification accurately on a color photograph, has the advantages of maintaining the accuracy of the computer rendition and the realistic qualities of the color photography.

The previous discussion has defined various roles for computers in the area of landscape planning. Specifically, the discussion has highlighted several categories within the areas of visual landscape analysis and portrayal (fig.1). All of the applications in this discussion are presently in use by a relatively small group of specialists and are available for use by a wider audience.

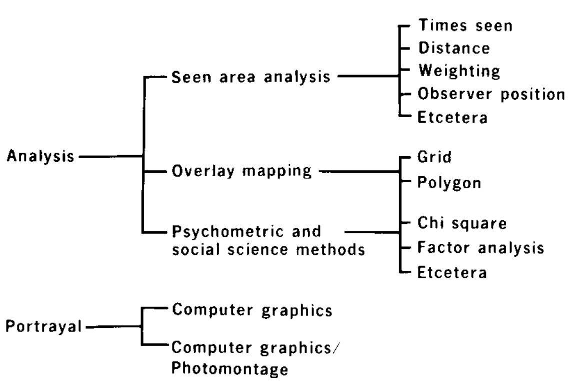

Figure 1--Computer applications in landscape planning

A FUTURE SCENARIO:
LANDSCAPE ARCHITECT AND COMPUTER DIALOGUE

I believe that the <u>extent</u> to which computers are used in landscape planning will increase dramatically in the next 5 years and that the usefulness will surpass most all of our current expectations. The following fictional dialogue between a future landscape architect and his friendly computer suggests several potential uses and implies priorities for research and development.

<u>Landscape Architect</u>: "What's the status of the landscape this morning?"

<u>Computer</u>: "Generally things are in pretty good shape. The blowdown we've been predicting for the last several days has occurred. Strong winds were accompanying the rainstorm we were having. It's over in both quadrants, 23F and 24F. The extent of the blowdown is about 30 acres. I detected it this morning about 12:35 a.m. from satellite reconnaissance. The visual impact of the blowdown does not seem to be too significant. I've calculated the visibility and it's not visible from any major road or any section of the trail system in the forest or any developed recreation area, or any areas planned for development in the next 10 years. Here's a draft of the paperwork for competitive bid on the salvage sale."

<u>Landscape Architect</u>: "Please change the minimum bid considered from 4 to 6 million dollars. Then please route this draft form electronically to the timber sale officer's CRT.

Were there any other major activities last night?"

<u>Computer</u>: "Local police radio reported a traffic accident on Highway 79 next to the campground area that resulted in damage to several small trees and moderate damage to one large tree. You may want to do a ground inspection of this area later in the day; it may be on the same route with inspection of the blowdown."

"After 1 a.m. there was no apparent action to the landscape within the forest boundaries so I automatically set my program to scan the incoming electronic mail. From this search it appears that we will receive a formal request for extending the highway. Later this morning they will propose crossing the northeast corner of the forest. I checked your Supervisor's schedule and he will not be available for a meeting until 10 a.m. I made a tentative appointment. I did some additional analyses for you to use in your position paper. I carried out a preliminary visual analysis of this proposal and found it will visually impact 23,000 acres of our highest scenic quality land with high frequencies of viewing, 15,000 acres of medium scenic quality land, and 17,000 acres of low scenic quality land.

Because I'm not equipped to interface with the proponent's data files, I had to calculate the construction costs myself. I estimate costs will be 42 million dollars."

Landscape Architect: "Fine, but please check your files and show me all proposed routes through this area, for any purpose, over the last 10 years."

Computer: "Here are several past proposals. The closest to this alignment is the proposed expansion to the trail system. The expansion was not built because the results of our questionnaires showed that there was not sufficient potential traffic or public interest to warrant building the trail."

Landscape Architect: "Please provide a preliminary analysis of putting the highway on the trail system route."

Computer: "The cost of the highway going through the valleys, would be about 30 million dollars. This is a savings of 12 million dollars over the one that will be formally proposed later today. It would visually impact more medium scenic quality land with high frequencies of viewing. But, it would visually impact 16,000 acres less of our dispersed recreation area. It would also have an extremely good vantage point for a scenic overlook as it goes over the ridge into the next valley.

I can calculate additional quantitative results if, you desire. In addition to these two alternatives, I'm sure that you will be able to design modifications that will be more attractive."

Landscape Architect: "I will work on the modified design later today. In the meantime, please summarize the visual and economic results for these two routes in graphic and tabular form. Have this ready for viewing on the Supervisor's CRT by 10 a.m. today. Please start a draft EIS and put these summary results in the appropriate sections. Also, calculate and show me the minimum time route for visiting the blowdown, the campground, and the two alternative routes for the proposed highway. I'll need to return here in time for the meeting . .'

Key Scenario Points

The question is, what are the technological and institutional concerns embodied in this scenario?

- It assumes effective voice activation for input to computers.
- It assumes the operational development of dedicated minicomputers.
- It assumes that the costs of computers will continue to be less.
- In the matter of the blowdown, it assumes a monitoring system of the forest, either satellite based or ground based that is linked into a real-time computer system.
- It assumes in the matter of the police report, a verbal communication facility to the computer.
- It assumes the ability to analyze routes automatically in terms of scenic impact.
- It assumes the ability to recall previous statistics in the matter of projected recreational use for trail systems.
- It assumes limited capability of designing its own route for the highway system.
- It pinpoints those areas for which special design is absolutely necessary.
- It indicates that the costs of collecting new data will continue to be high, and that especially for socio-economic and preference data, it will be necessary to reuse previous data as much as is feasible.
- It predicts that objective data on the visual resource will become more and more important and that the public and managers will expect to see it in EIS documents.
- It predicts that administrative complexities will increase; for example, number of necessary forms and number of people concerned with visual resource decisions will increase; high level resource administrators will begin to use computerized robots to assist in coping with this problem.
- It predicts an increase in use pressures, of all types, for the land.
- It assumes that "man and machine" have developed a mature and satisfying relationship; this includes both management levels and analyst levels with computer robots.
- It assumes that "high-technology tools" will be used unevenly by both industry and government; that is, only where the value of the resource and the public demands warrant the expense.
- It assumes that many professionals will be trained equally well in landscape architecture and computer science; it further predicts that there will be an

increased demand for people with this balanced training.

- It assumes that the design profession will not be challenged by these computer robots; rather, the profession will be augmented with additional portrayal and analysis tools.

CONCLUSION: "Growing" with Computers

The "extended family" concept of the future will undoubtedly include computers. For, like children--we decide to have them or not--and we decide on education (upgrading), health insurance (maintenance contracts), and we must deal with death or divorce, or both (trade-ins).

Meanwhile, we are going through a learning experience with this new technology, that is often frustrating. Not only are there queues for the use of computers but also are there dollar costs that we must be willing to pay and, indeed, the learning experience itself may be trying.

Whether computers will play a role in landscape management and planning is not an open question. They already are! The extent to which the role increases, however will depend on the number of tasks that we can innovatively assign to the computer and our ability to teach the computer to carry them out.

REFERENCES

Arthur, L. M., and R. S. Boster.
1976. Measuring scenic beauty: a selected annotated bibliography. USDA Forest Serv., Gen. Tech. Rep. RM-25, 34 p. Rocky Mountain Forest and Range Exp. Stn., Fort Collins, Colo.

Elsner, Gary H.
1977. New techniques for coordinating timber harvesting and esthetic values. In Forests for people: a challenge in world affairs, p. 46-51. Proc., Soc. Amer. For., Washington, D.C.

Elsner, Gary H.
1976. Quantifying landscape dimensions for land-use planning. XVI IUFRO World Congr. Proc. (Div. 6) Oslo, 1976:28-38.

Elsner, Gary H., compiler.
1977. State-of-the-art methods for research, planning, and determining the benefits of outdoor recreation. USDA Forest Serv., Gen. Tech. Rep. PSW-20. 62 p., illus. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

Entzminger, R. A.
1976. MOSAIC/photomontage: a new concept to help reclamation planning. Coal Min. and Process. J. 13(6):76-78.

Litton, R. Burton, Jr.
1968. Forest landscape description and inventories--a basis for land planning and design. USDA Forest Serv. Res. Paper PSW-49, 64 p., illus. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

Litton, R. Burton, Jr.
1973. Landscape Control Points: a procedure for predicting and monitoring visual impacts. USDA Forest Serv. Res. Paper PSW-91, 22 p., illus. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

Travis, Michael R., Gary H. Elsner, Wayne D. Iverson, and Christine G. Johnson.
1975. VIEWIT: computation of seen areas, slope, and aspect for land-use planning. USDA Forest Serv. Gen. Tech. Rep. PSW-11, 70 p., illus. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

U.S. Environmental Protection Agency.
1973. Aesthetics in environmental planning. EPA-600/5-73-009. U.S. Environ. Protect. Agency, Washington, D.C.

World Future Society.
1979. Communications ... dramatic changes ahead. 13(2):80-158, World Future Society, Washington, D.C.

Zube, E. H., R. 0. Brush, and J. G. Fabos, eds.
1975. Landscape assessment--value, perceptions, and resources. 367 p. Dowden, Hutchinson and Ross, Inc., Stroudsburg, Pa.