"Seeing" the Future: Aesthetic Policy Implications of Visualization Technology

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Abstract: *Recent years have seen a plethora of articles, conference presentations, and the like on computer technology which allows the rapid manipulation of captured images. Often referred to as video-imaging, it is possible to create apparently realistic images which depict the appearance of proposed environmental modifications. Most information has concentrated on hardware and software requirements or on professional applications in areas such as architectural and landscape architectual design, graphics design and communication, advertising, etc. However, there may also be benefits in its use in resolving larger-scale planning issues. For example, resource managers, land use planners, developers and others are often required, either by law or under the force of public opinion, to be concerned about aesthetic values. This paper explores the potential of imaging technology in the context of landscape aesthetic policy development, implementation and evaluation: (1) to serve as a tool for enforcement of public rights to know the aesthetic consequences of environmental modifications, (2) to create simulations which might serve as negotiated legal documents in the context of existing policies, (3) to be a tool for establishing perceptually based performance standards in land use regulation, and (4) to assist in the assessment of monetary penalties for aesthetic damages.*

Technology in the form of land and geographic information systems, global positional systems, and image capture through satellite and aerial remote sensing is having a profound impact on those who are held responsible for planning and managing the public land, water, mineral and aesthetic resources. The long-term power of these technologies, however, is not the individual impact of any one technology; rather the intelligent and integrated use of a variety of these tools, including imaging, to solve complex problems, e.g., Gimblett's (1990) recent discussion of the Integrated Resource Assessment and Simulation System. With the addition of yet another tool, land planners and managers have increased ability both to analyze environmental issues and to communicate options in visual terms understandable by the lay public.

Similar to the land and geographic information systems mentioned above, video-imaging is well beyond the conceptual and developmental level; it is a functioning tool with a long history of development in military applications. The public is perhaps most acquainted with this technology through the motion picture industry, e.g., with the advent of "colorization" and more recently, hair styling salons offering "computerized" analysis of what one might look like in different hairstyles.

Judging from the number of articles, conference sessions, and the like, video-imaging is beginning to capture a lot of attention within the landscape and natural resource planning and management communities. With leadership from Orland (1986, 1988), Sheppard (1986, 1989) and others, this technology is being adopted by landscape planners, natural resource managers and others to augment more traditional means of producing visual simulations of proposed landscape change, or as an outright replacement of manual and photographic methods. In addition to professional applications, some have discussed the research potential of imaging technology (e.g., Zube

and Simcox, in press; and Zube *et al.* 1987). Finally, some investigators have begun to look at issues of realism and validity, i.e., how responses elicited by video simulations compare with responses either to the actual environment or to other kinds of simulations (Chapman, *et al.* 1985; Clay 1986; Vining and Orland 1988).

Concommitant with the trend to embrace new computer technologies is a renewed discussion of landscape stewardship responsibilities (Chenoweth 1986; Scarfo 1988), particularly with regard to visual resource quality. Therefore, it is important to begin to think about the marriage of new technology, such as video-imaging, with stewardship and policy issues that go beyond traditional, site-specific professional design applications or graphics communication. This paper is intended to articulate some generic possibilities for the use of video-imaging in the aesthetic policy arena and to stimulate discussion about how such technology might best be used within the context of other informational technologies. In addition to the ideas presented here, Pitt and Nassauer (1989) have provided a particularly valuable discussion on how imaging technology together with GIS might be used to identify and evaluate landscape values as matters of concern to policy-makers, and have provided instructive examples of their work at the University of Minnesota which integrates landscape values into the development and implementation of public policy for natural resource and land use management.

Aesthetic Policy and the Legal Landscape

Before turning to a discussion of potential roles for video-imaging in the policy arena, it is important to understand that there is an existing foundation and framework within which this technology may prove useful. At the federal level, for example, the National Environmental Policy Act of 1969 recognizes the assurance of "aesthetically and culturally pleasing" surroundings as a principal purpose of the Act and a responsibility of executive branch agencies both in the management of their own properties and in their regulatory functions. This language is repeated in many states in legislation often referred to as mini-NEPAs.

In Wisconsin, scenic beauty has assumed an importance in the law that currently serves as a major consideration in many of the state's regulatory functions. In 1952, the State Supreme Court ruled (Muench vs. Public Service Commission, 1952) that the "right of the citizens of the state to enjoy our navigable streams includes the enjoyment of scenic beauty. It is a legal right that is entitled to all the protection which is given financial rights." Thus, under the current interpretation of the Public Trust Doctrine, it is the obligation of the state, as trustee for the people, to be concerned with the visual quality of our navigable waters. Bridges, water diversion projects, shoreland modifications, and sand and gravel extraction are among regulated activities which are subject to aesthetic considerations.

In an important federal case involving an urban renewal initiative in Washington, D.C., Justice William O. Douglas determined that the concept of the public welfare should be broadly construed and that beauty is a legitimate purpose of legislation in the public interest (Berman vs. Parker, 1954). In Wisconsin, further flesh was added to this legal framework in Kamrowski vs. State (1966). This case dealt with a legislative program that included the condemnation of scenic easements along the Great River Road in order to provide natural, undeveloped views for motorists driving along sections of the Mississippi River. The targeted parcels would remain in agricultural production, but could not be used for more intensive purposes such as residential or commercial uses. The program was challenged on the basis that "public enjoyment of the scenic beauty of certain land is not a public use of such land." After all, it was argued, the public would not even be allowed on the property in question. The court held that "the occupancy (by the public) is visual" and that indeed the enjoyment of the beauty of the land constitutes a legitimate public use of land whether or not the public is allowed to set foot on it. There are at least 15 references to scenic or natural beauty in the Wisconsin Statutes and over 75 references imbedded in administrative rules governing the activities of the Wisconsin Department of Natural Resources. Bufford (1980) has reviewed some of the aesthetic legislation adopted by other states; at the

local level, most of us can identify some controversial issue which is essentially or largely aesthetic in nature, e.g., billboards, architectural controls, landfill siting, etc.

While there is clearly a legal basis for the consideration of aesthetic values, problems arise when attempts are made to implement laws/policies designed to protect those values. Some very common cultural cliches reveal the nature of the resistance to aesthetically oriented landscape policies: "Beauty is in the eye-of-the-beholder," and "beauty is subjective, purely a matter of personal taste." From a philosophical perspective, such cliches are insufficiently precise to be regarded either as true or false. Moreover, there are solid rebuttals to a variety of interpretations of the meaning of these cliches (Willard 1980). From a court's perspective, however, such cliches may be persuasive; any law or policy which imposes one person's set of tastes on another who legitimately holds a different viewpoint might be regarded a violation of the due process clause of the U.S. Constitution. In matters regarded as involving taste or aesthetic sensibilities, some argue that any governmental policy is bound to be substantively arbitrary and capricious. In addition, constitutional law requires that those who are regulated must know, without undue ambiguity, what is expected of them.

An example might be illustrative of the reluctance of governmental bodies to embrace policies which might protect aesthetic values. I referred earlier to the public rights in Wisconsin to enjoy beauty along navigable waters. In 1976, Mr. Wilfred J. Berry sought a permit from the Wisconsin Department of Natural Resources (WDNR) to build a boat slip on the South Fork of the Flambeau River in northern Wisconsin. The only issue was the possible impact on beauty (e.g., ecological impacts would be negligable). The WDNR decided to reject the permit application, citing the public right to enjoy beauty along navigable waters as the reason. Mr. Berry challenged the decision and the case was argued before a hearing examiner. Unequipped with the ability to argue aesthetic issues, much less having access to the kind of imaging technology available today, Examiner Joseph P. Schaeve said:

Beauty is in the eye of the beholder! So how does one get a handle on such a nebulous concept as scenic beauty? How do you test whether something is pleasing to the eye? If an analogous situation is determining whether something is pleasing to the nose, I note that the Department of Natural Resources has the following malodorous emission test: 'An odor shall be deemed objectionable . . . when 60 percent of a random sample of persons exposed to the odor in their place of residence or employment, other than employment at the odor source, claim it to be objectionable and the nature, intensity, frequency and duration of the odor are considered.

Should we randomly select 10 canoeists, who have canoed past Mr. Berry's lot, to study the application and let six of those 10 determine whether the boat slip would be scenically beautiful? How about using the determination of six out of 10 of riparian neighbors of Mr. Berry? I think either process would leave the determination wide open for the influence of individual quirks and biases. These processes are just too subjective to pass constitutional muster.

While there are many interesting aspects of this case, several are especially relevant to the discussion here. First, the determination of the outcome of the case occurred without any information on the aesthetic consequences of the proposed boat slip, whether that information be an aesthetic assessment technique of some sort (Arthur, Daniel and Boster 1977) or whether it be a purely visual description of the nature of the proposed environmental modification as might be provided by a simulation. Second, the examiner's decision assumed that different sets of actors would surely disagree in their evaluation of the aesthetic impact of the boat slip, although no information on what the boat slip might look like was provided by either of the interested parties. To the contrary, the preponderance of evidence from the aesthetic assessment literature as well as experience suggests that such an assumption is not warranted; while canoeists and riparians may well disagree on whether Mr. Berry should be allowed to build a boat slip, they would most likely agree on the aesthetic consequences of the boat slip. Third, while reluctant to impose the assumed tastes of canoeists on Mr. Berry, the hearing examiner was not reluctant, by virtue of ruling that a permit should be granted, to ef-

fectively impose his own aesthetic tastes on all of the public, canoeists and riparians alike.

Examples, such as that described above, of the difficulties of addressing aesthetic matters in a policy context are abundant. The question is: how might image-processing be used to provide information which might alleviate these and other kinds of difficulties?

Policy Roles for Image-Processing Technology

There are at least four kinds of roles that image processing might serve in the context of landscape aesthetic policy development, implementation, and evaluation: (1) to serve as a tool for enforcement of public rights to know the aesthetic consequences of environmental modifications, (2) to create simulations which might serve as negotiated legal documents in the context of existing policies, (3) help to establish perceptually based performance standards in land use regulation, and (4) assist in the assessment of monetary penalties for aesthetic damages.

The Public Right to Know

Legally-mandated environmental assessments are a product of the fundamental concept that the public has the right to know, within a degree of certitude limited only by the best available knowledge, the consequences of major modifications to their environment. There is no legal reason why the "right to know," so commonly accepted with respect to non-aesthetic environmental issues (e.g., introduction of toxins, etc.), should not extend to aesthetic aspects of environmental issues. It might be argued that imaging technology can provide the "best available knowledge" regarding the aesthetic consequences of proposed environmental modification. In the past it has been possible for the agents of change to argue that providing simulations depicting the appearance of the modified landscape would be too costly, too labor-intensive while yielding only a limited number of perspectives in an unrealistic, course-grained way. Such arguments should be regarded as unpersuasive in the face of the power and efficiency of new imaging technologies, particularly large projects where the overall cost and potential visual impact is substantial.

A simple anecdote might be illustrative: The Minnesota Department of Transportation (MDOT) has decided to put another bridge, in addition to the existing one, across the St. Croix River at Stillwater, Minnesota. This section of the river is currently included under the Federal Wild and Scenic Rivers Program. In a draft of the required EIS, MDOT addressed aesthetic issues with a pen and ink sketch of the type of bridge envisioned, assuring the public that the bridge would be a "nice" one. Pressed by the public for a more definitive idea of what might be meant by a "nice" bridge in the context of its location over a federally designated scenic river, the MDOT declined to provide simulations of the sort made possible with video-imaging, preferring to defer such information until after the important decisions were made, i.e., where to locate the bridge or indeed whether the bridge should be built in the first place. Situations such as this seem ripe for legal challenge based on the claim of an inadequate response to the public's right to know about aesthetic impacts using the best available knowledge.

Resource planners and managers are in a position to insist that the best available knowledge, as represented by imaging technology, be utilized in order to allow the public to anticipate the aesthetic consequences of landscape change. Thus, state-of-the-art video simulations could be regarded as an integral part of an implementation strategy to protect aesthetic values as they are expressed in new or existing laws and policies. Requiring by law that such simulations be provided as a part of environmental assessments is not outside the realm of the possible. Indeed, it seems to be a rather logical step in the evolution of technical means which might provide information useful in addressing aesthetic issues. Pragmatically, a policy initiative requiring that the public be provided a reasonably realistic look at proposed landscape modifications would likely have widespread popular support.

There are, of course, many methodological, substantive, and even ethical issues that will have to be resolved before

the use of video simulation to reinforce the public's right to know becomes commonplace: e.g., accuracy, vantage point, validity, incorporation of sounds and odors, and so on. These important issues are beyond the scope of this paper and require more careful definition and treatment than has been the case in the published literature.

Negotiated Legal Documents

With the exception of some maps depicting the distribution of environmental phenomena, legal documents are typically in a written format. Aesthetic policy issues are obviously visual in nature (not to discount auditory and olfactory). But there is no inherent reason that legal documents be confined to the written mode. With that in mind, I would like to create a scenario in which the products of video-imaging might serve as negotiated legal documents and suggest how such documents may be more palatable to the legal system than assessment procedures which require that aesthetic judgments be made, whether by the public or by experts operating as surrogates for the public.

Imagine now our Mr. Berry wishing to put in a boat slip on the Flambeau River. Undeniably, he has a right to the reasonable enjoyment of his property including, as a riparian, access to the river. The public undeniably has the right to the enjoyment of beauty along navigable waters in Wisconsin. In the contested case hearing described earlier, the WDNR was placed in the awkward position of determining whether or not the boat slip would diminish the enjoyment of beauty to the degree that it would be considered an infringement of the public's rights. To fully establish an evidentiary basis to make such a determination would likely require substantial resources, perhaps a public evaluation type of aesthetic assessment technique (Arthur, Daniel and Boster 1977) demonstrating consensus. The hearing examiner was placed in a similarly awkward position. Indeed, whether or not the examiner wished to be responsible for making an aesthetic (versus legal) judgement, he had little choice in this particular situation.

By contrast, WDNR field personnel armed with imaging capability might very well sit down with Mr. Berry and negotiate, through image manipulation, a visual solution which attempts to balance the rights of the riparian with the rights of the canoeing public. Such a solution may or may not include the construction of a boat slip. Or if it were to be a boat slip, there may be many alternative designs which would differentially impact on the public's rights. The negotiated agreement would consist, in part, of a visual simulation which would be regarded as a contract between the state and the riparian owner concerning a future state of affairs.

But suppose that the parties could not agree and consequently wind up in front of Examiner Schaeve. What then? Being provided with a set of visual alternatives, the examiner is in a position to make a legal judgment about which alternative constitutes an *appropriate balance* between the rights of the interested parties, rather than an aesthetic judgment, per se. While there would necessarily be aesthetic consequences of any alternative the court might select, those consequences would be a by-product of a decision more properly concerned with balancing rights.

To carry the scenario one step further, let us suppose that a visual simulation, either negotiated between the agency and the riparian landowner or mediated and imposed by the judicial system, becomes a part of the contract—e.g., a five-year projection about the visual appearance of the property as a set of conditions pursuant to the granting of a permit. How, five years from now, would one know whether or not such a visually based contract had been breached or not? The judgment now called for is a relatively simple one in a judicial context compared to a judgment about the aesthetic value of a landscape: namely, one must decide whether or not the existing situation, as it came to be after five years, is reasonably similar to the visual conditions depicted in the contract. Indeed, certain kinds of simple grid or raster overlay systems, now supported in many functioning, commercially available GIS systems, could be developed to quantify the degree of similarity.

The scenario portrayed above is only one among many possible. Another obvious possible use for negotiated "visual"

legal contracts is in the area of landscape restoration where aesthetics may be an objective either by choice or by legal mandate (e.g., mining reclamation). In this instance, contracts might well be comprised by some indicators of ecological integrity coupled with visual simulations depicting a mutually agreed upon aesthetic outcome of the restoration effort.

There are, of course, many issues to be resolved before the scenarios described above begin to find their way into the aesthetic policy arena. How does the state of our ecological knowledge affect our ability to predict future appearances, and within what limits of accuracy, precision and reliability? And how would such scientific uncertainties be regarded under the law? Nevertheless, if existing aesthetic policies, much less new initiatives, are effectively to be implemented, the implications and issues surrounding the scenarios described above will have to be explored. Such exploration will require the multidisciplinary efforts of environmental planners and managers working with the legal community as well as representatives of the natural and social sciences.

Perceptually Based Performance Standards

People, especially residents of rural areas, are notoriously reluctant to adopt local regulations which might protect the appearance of the landscape from potentially aesthetically unacceptable change. While the reasons for such reluctance go far beyond aesthetic issues alone, this phenomenon might be in part attributable to:

- The inability of people to picture the aesthetic consequences of future possible changes to local landscapes under existing regulations or a "no regulation" situation.
- An inability to link the provisions of proposed regulations, which are most often communicated in written form (e.g., "Thou shalt not . . ."), to visual images depicting future aesthetic consequences the provisions may afford or deny.
- An historical lack of efficient, cost-effective technical means, which would allow proposed regulatory language to be adjusted to preferred, concretely imaged, aesthetic outcomes of alternative future landscape change in the context of local decision-making.

The result of the situation described here is likely to be a series of disputes over the language and provisions of various existing or proposed regulations reflecting a pro-development versus status-quo dimension. A more productive approach would be to identify the limits of aesthetically unacceptable change based on responses to simulated images of the appearances of future landscapes. Such limits might then be used in the drafting of regulatory language which provides for growth and development, but within aesthetic constraints imposed not only by legislative mandates, but by shared, visually concrete expectations and preferences people express for how they want their local landscapes to look in the future.

Illustrative of this concept is recent legislation in Wisconsin creating the Lower Wisconsin State Riverway. Achieving a balance between local landowner rights and the clear intention behind the creation of the riverway to protect the scenic beauty of the area is likely to be an arduous process. The legislation establishes a LWR Riverway Commission comprised of local residents, and requires that development within the 92.5-mile-long corridor be "visually inconspicuous." To a large degree, the determination of the objective conditions which will be regarded as inconspicuous is left to the Riverway Commission.

In the School of Natural Resources at the University of Wisconsin-Madison, we are using imaging technology to create "probable" scenarios and "worst case" scenarios through simulations that depict how the river valley might look in the future: (1) with no additional regulations in effect, (2) with varying degrees of projected participation in voluntary programs such as farmland preservation, (3) subject to existing administrative rules, and most importantly, (4) under various specific provisions the Riverway Commission may adopt in order to operationalize the legislatively mandated performance requirement that development be visually inconspicuous.

Image processing is ideally suited for a technical assistance function in land-use policy deliberations such as that described for the Lower Wisconsin River. Imaging technology is already being used in this role to some extent: Pitt and Nas-

sauer (1989) in rural environments; Murray and Law (1986) in small-town main streets; and Orland (personal communication) in the urban environment whereby a community asked for assistance in understanding the aesthetic consequences of a policy which would require that utilities be placed underground.

In terms of research, video-imaging is ideally suited to establishing mathematical relations, which can be converted to regulatory language, between finely discriminable changes to selected manageable characteristics of the landscape and human reaction to such change. The work of Gregory Buhyoff at Virginia Polytechnic University and his associates is a good example. They consistently find a log function to describe such relations: e.g., when damage caused by southern pine beetles exceeds 3 percent, judgments of visual quality decline markedly (Buhyoff and Leuschner 1979). Findings such as these have profound landscape management policy implications, e.g., a policy concerned with forest aesthetics in which substantial intervention efforts were mandated when pine beetle damage exceeded 10 percent would be costly and wholly ineffective from an aesthetic perspective. The reader is left to consider other similar situations, such as fire control on federal lands, where aesthetic matters are to be a part of the overall policy analysis.

Aesthetic Damages

Despoliation of our landscape aesthetic resources is an everyday occurrence. Even if we became effective in protecting the beauty of many landscapes through planning, design and policy initiatives, there would still be numerous instances of violations. Unfortunately, economic analyses have not traditionally accounted for unmarketed resources such as aesthetics. Kelso (1972) notes that by excluding "nonpecuniaries" (such as aesthetics) from economic trade-off decisions, they have entered the system as though they were free, as if they were ". . . limitlessly abundant and their depletion or deterioration or exhaustion or enhancement for that matter have no value to anybody now or in the future" (Kelso 1972, p. 11).

The bottom line is that, in the advancement of a stewardship role, it would be most useful to have policies calling for the assessment of monetary penalties for aesthetic damages. In that regard, image-processing might play a role.

As one example, about two years ago the city of Lake Geneva, Wisconsin, contacted me about a most interesting problem. The cablevision company was refusing to pay its franchise fees for reasons not pertinent to the discussion here. One of the city's legal strategies was to claim that by stringing cable wires along city-owned rights of way, the company was causing visual blight in the community. The city would be willing to let the blight continue if a portion of the franchise fee would be regarded as compensation to the city for the visual blight. In this case, simulations were created showing the effect of undergrounding in neighborhoods, where wires were above ground as well as erecting cable wires in new neighborhoods, where they had been undergrounded. These simulations were then used in the context of an economic-contingent evaluation study of home purchase values and their attendant assessed valuation. Differences of $7,000 in reported willingness to pay were common in neighborhoods with homes in the $85,000 range.

In a second example, a wealthy landowner in the Lake Tahoe Basin cut down over thirty trees on U.S. Forest Service property in order to improve his view. The Forest Service landscape architect reported (personal communication) that he was working with the land appraiser and legal staff to develop a case. It is likely that monetary damages associated with aesthetic values would be higher than that of the replacement cost of the trees alone (e.g., Niemann and Chenoweth 1985). Computerized simulations of the original views, both from the landowner's property as well as pre-cut simulated views associated with travel corridors and the tourism industry could be used to help establish a dollar value associated with the aesthetic damages.

Conclusion

The adoption of image-processing technology, together with other computer developments such as land and geographic information systems, will create a unique informa-

tional basis and impetus for the initiation, implementation and evaluation of aesthetic policies. The various kinds of roles described here probably only scratch the surface of possibilities. The important point is that if land planners and managers are to be effective in meeting their stewardship responsibilities as well as existing legal mandates, imaging technology must join the set of tools that will ensure that the public, in the final analysis, is the essential instrument of land use policy.

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