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DEDICATION

A. C. Dryden
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ABSTRACT

The purpose of this research was to explore concepts and perceptions in the area of visual resource management via geographic information systems. A scenic assessment of Interstate 17 was conducted, then a digital database was built for a subset of the study area. Theoretical frameworks were explored and expanded. Review of the current literature resulted in a methodologically alternate conceptual model which utilized spatial analysis. After checking for issues of validity and accuracy, data visualization products were developed which aided in understanding the procedures and results. The results showed that given the readily available data an automated scenic assessment was not currently feasible.
IV. INTRODUCTION

A. Problem Statement

The National Environmental Policy Act has mandated that agencies such as the BLM, the USFS and the NPS inventory, assess and manage visual resources. The Highway Beautification Act further stipulates the preservation of scenic quality along highway corridors. Laws ARS 41-512 through ARS 41-518, passed by the State of Arizona in 1982, responds to national concerns for the wise management of visual resources by providing for the establishment of Parkways, Historic, and Scenic Roads on Arizona City, County, Indian, State and Federal Routes. The Arizona Department of Transportation is responsible for the implementation of these laws and administers them through the Parkways, Historic and Scenic Roads Advisory Committee (PHSRAC) (Walker, 1993).

PHSRAC reviews and recommends action on application reports compiled according to procedures by either ADOT agents or outside contractors. Because of the ever greater complexities involved in visual resource management, many technologies are consequently evolving to assist in these endeavors (Gimblett, 1994). This research explores the feasibility of effecting a technology transfer of current GIS based scenic assessment to PHSRAC’s visual resource managers in terms of current software and data availability (Buyhoff et al., 1994).
B. Objective

The objective of this research project is to automate a scenic assessment procedure for PHSRAC that could facilitate the process of scenic quality assessment. The tasks involved were expected to be as follows:

Task A: Complete a non-automated scenic assessment of Interstate 17 from milepost 268, the cutoff to Dugas to milepost 320, the cutoff to Sedona, using the procedure as outlined in Application Procedures for Designation of Parkways, Historic and Scenic Roads in Arizona (Walker, 1993).

Task B: Complete an automated scenic assessment using GIS for a subset of the above stated portion of Interstate 17.

Task C: Compare the results of the two procedures, non-automated and automated.

C. Procedure

Theoretically, the non-automated procedure was to be conducted and then a straightforward automation of the PHSRAC model was to be applied. The two results would then be compared. It was expected that the results would be similar.
D. Background

The present methodology, which involves ratings for vividness, intactness and unity (Kocher, 1987), is probably not defensible on scientific grounds. Vividness measures how memorable a scene is. Intactness is an indication of how natural a landscape is, how unadulterated by the hand of man. Unity describes how well the parts fit together. In assessing unity one estimates how compatible the human construction melds with the natural landscape. In the case of a totally natural landscape, the parts are then judged for compatibility. In this manner naturalness is discounted when assessing unity since a second opportunity is provided to devalue it. This model, then, demonstrates internal antagonism since in the case of intactness it values naturalness and in the case of unity it devalues it. Since scenes which are on either end of the spectrum of beauty are most memorable, vividness can be interpreted as either ugly or beautiful and so demonstrates ambivalence in positive ratings. Since natural settings are indicative of peak aesthetic experiences (Gobster and Chenoweth, 1990), landscapes which are high in intactness will also rate high in unity and vividness. This exhibits a redundancy of measurement. This model also fails in meeting the mandate of citizen participation (Blahna and Yonts-Shepard, 1989; Blahna and Black, 1992; Blahna and Toch, 1993) by using a non-normative expert approach. The PHSRAC formula was decided against because of the following inadequacies:
1. Discounting of natural landscapes
2. Internal antagonism
3. Ambivalence
4. Redundancy of measurement
5. Reliance on a non-normative expert approach

A more valid procedure for the intended goal of automation was discovered through a literature review. This more defensible methodology was selected for the purpose of modeling a stretch of highway previously evaluated using the present procedure. The intention was to compare the results. Data resolution inadequacies revealed in the process of automation precluded this objective. However, the attempts of effecting a technology transfer to facilitate scenic assessment by PHSRAC’s visual resource managers shed light on several areas meriting consideration in future research and applications. Much was learned through the selection process of an alternate model and automation.

The maze of scenic assessment instruments encountered led to an inquiry on the possible theoretical underpinnings of these various methodologies. This study has significantly contributed to a more rational methodology of scenic assessment by:
1. Bringing to light more defensible methods for quantifying visual quality.

2. Exploring through Geographic Information Systems (GIS) models methods of assessing roadside scenery, and

3. Delving into the fundamental psychological framework of existing scenic assessment methodologies.

The procedure currently in use by PHSRAC was developed by Sarah Kocher (1987). The alternate method selected was developed at the Harvard Graduate School of Design by Carl Steinitz (1991). Although the selected procedure suffers from the nontransferability of site specifics, conducting a methodological study to develop a site specific instrument is beyond the scope of this thesis. This research accomplished the following:

1. It discovered a more defensible, rationale model and justified it on theoretical grounds.

2. It demonstrated procedures for automation, and

3. A relationship was discovered between Sell et al. (1984) and the work of C. G. Jung (McGuire, 1984; Sharp, 1991) that could have great potential to provide insight and understanding and also provide further justification for scenic assessment models.
When one enters into the research of scenic assessment, one has stepped into the area of beauty in the eye of the beholder and all that it entails. One is now in the land of the psyche's projections, its myriad aspects of expressions in individuals, groups, cultures and collectives, both conscious and unconscious. In the opinion of this writer there is no area of study so untenable, so unknowable, so undefinable, so pervasive and therefore so intriguing and so demanding as that of the human psyche. It is these qualities of the research that have at once mystified and clarified the goal of automating a scenic assessment procedure for A.D.O.T.

Problems arose in attempting to automate a scenic assessment model because the method currently in use by A.D.O.T., was heavily flawed and could not be supported as a valid instrument for G.I.S. conversion. A search was undertaken to find a method that could be considered methodologically defensible. This search revealed many procedures all claiming to be scientifically valid and accurate. The question was raised, how could scenic evaluation be attempted through such diverse avenues and vehicles and all be right, as their proponents claimed?

But the trail of the literature review led to some, hypothetically speaking, fertile grounds. This was the work of Sell et al. (1984) who organized the multifarious visual quality documents into four paradigms and Steinitz's (1991) incredibly clever spatial analysis involving five distinct scenic assessment instruments. The research of Sell et al. and Steinitz fit neatly into a model of the human psyche as developed by Jung. The pieces of the puzzle began to fall in place. There were significant correlation's between
the findings in the work of Sell et al. and in Carl Gustav Jung’s fourfold structure of the psyche.

When Sell et al. analyzed the various methods of evaluating visual quality as developed by many individuals, Schaeffer, Kaplan, etc. and also those of agencies, such as the Bureau of Land Management and the Forest Service, who are mandated to perform scenic assessments, they were discovered to fall into four general categories. These paradigms are cognitive, experiential, expert and psychophysical. The cognitive approach attempts to know and understand in a conceptual manner the components of visual quality and thereby quantify them. In the experiential approach, a place is valued by the feelings invoked in the viewer. The expert approach depends on the knowing expertise of the expert performing the assessment to intuitively arrive at an evaluation. The fourth and final approach, the psychophysical, seeks to quantify the aesthetics of a landscape by assigning numbers to physical components such as water and color, the sum being an indication of scenic value.

Jung, in his explorations of the psyche, discovered that it too was structured into four components. These are the thinking, feeling, intuitive and sensation functions.

*There are the four sides of our orientation in the field of consciousness.... The four functions are based upon the fact that our consciousness says there is something in the unconscious. Sensation is a sort of perception, it knows the thing is there; thinking tells us what it is; feeling says what it is worth to one, whether one accepts it or rejects it; and intuition tells us what it might become, its possibilities.* (McGuire, 1984)

The thinking and feeling functions are considered the rational functions since they involve a rationale in arriving at values. The thinking involves logical arguments while the feeling function uses affective values to judge. In contrast, intuition and
sensation involve ways of just knowing and so do not provide a rational argument. Intuition and sensation are know as the non-rational functions of the psyche. While all functions are present in all individuals, they vary in importance or personal emphasis, with some interesting traits observable in groups and cultures, depending on variations of value orientations. Individuals (or groups or cultures) can be discerned to lead with a specific function, much as one can be thought of as being right or left-handed. Thinking types seek to understand through logic. Feeling types value through affects. Intuitives depend on intuition to assess. And sensation types know through the body and physical environment. The anatomy of the psyche will be further addressed and expanded upon in the literature review.

   It would seem reasonable, then, that persons (or groups) would choose valuation instruments in which they had the greatest degree of comfort because of similarity to their dominant function. Thinking types would prefer a cognitive approach, feeling types, the experiential approach, intuitives would consider the expert paradigm as being the wisest, while sensation types would want a psychophysical approach. In the small world of the writer’s experience, this has been found to be true. These empirical results deserve further research beyond the scope of this work.

   Steinitz takes various scenic assessment instruments and, using GIS, dissects them and then synthesizes an actual model of roadside aesthetics. This is important because he takes from the four paradigms of Sell et al. and analyses the components to come up with a new model which represents in Jungian terms, the collective psyche in a certain place and time as it projects and perceives scenic beauty.
The five models which Steinitz utilized for his study, those of Kaplan (1979) and Kaplan and Kaplan (1982), Shaeffer (1969) and Brush and Schafer (1975), Steinitz (1979), the BLM (1980) and Appleton (1975), reflect Sell et al.'s (1984) four paradigms.

The above discussion of the fourfold structure of the psyche to provide a case for the selection of the Steinitz model as the most defensible product in the category of scenic assessment instruments for automation: it represents normative public values.

In summary, this project has investigated the fundamental theoretical framework of landscape perception provided by psychology's investigations of the psyche, has reviewed and assessed in this light an assortment of visual quality models and evaluation procedures, both automated and non-automated, and has explored the application through GIS of a selected methodology.

Beyond this introduction, the two parts of the literature review, chapter two, survey writings that apply to and support this area of research. The processes of digital database development and constructing the surface model are discussed in chapter three. Analysis and results of visibility are presented in chapter four, along with diagnostic visual simulations. Recommendations and conclusions are reached, finally, in chapter five.

The complete methodology included four modules as depicted in Figure 1. The original proposal was to automate the model used by PHSRAC, but because it was found to lack scientific validity, it was rejected and a search was conducted for an alternate model. The diversity of models encountered necessitated the construction of a theoretical framework in order to provide a logical rationale for an alternate model.
selection. This then allowed the automation to continue with the alternate model.
Finally, because the highway failed to qualify for designation and the natural resource protection provided by designation and the writer felt strongly that it deemed special designation on ecological grounds, a proposal for a Heritage Highway designation was produced.

The initial PHSRAC procedure involved a manual scenic assessment of Interstate-17 from milepost 268 to 320 (Figure 2). This was to provide a comparison for the automated version, which is a subset of the original study site.
Figure 2. Arizona State Map of study area and automated study subset area.

The methodology utilized was according to the procedures manual using the sum of vividness, intactness and unity scores. Here, vividness is a measure of the memorability of the diversity and contrast which is conveyed by the distinctiveness of the visual impressions received from the landscape unit. Intactness refers to the landscape's apparent degree of natural condition. Unity is the degree to which man-made elements harmonize with the natural features. In the case of a wholly natural setting, the overall unity is rated, or the degree to which all the visual elements of the view are compatible. Vividness rates how moved you were by an image, how long will you remember it?
Intactness pertains to how much or how little the pieces of the whole have been messed with. Unity has to do with how well all the pieces fit together in the whole.

These categories are rated on a scale of one to seven with seven being best. The three numbers are added up within the range of three to 21. A highway must score 70% or average 14.7 to be considered scenic. It can then be designated as a scenic highway.

The study section was first visually assessed using the vividness-intactness-unity evaluation procedure along one mile intervals using visual resource data gathered by Dr. Wilkin and the researcher in the form of slides, photographs and video. The slides and photos were then assessed as is outlined. The result going north was 14.68. Traveling south scored slightly lower, 14.66. Both totals were lower then the necessary minimum result of 14.70 for recommendation as a scenic highway (Figure 3).

**Scenic Assessment of Interstate 17**

![Scenic Assessment Graph](https://example.com/figure3.png)

*Figure 3. Scenic Assessment Graph.*
When assessment units were later used as prescribed in Application Procedures for Designation of Parkways, Historic and Scenic Roads (Walker, 1993), Interstate 17 received an even lower evaluation, 14.03. The forms for Assessment Unit Inventory and Visual Quality Ratings (Figure 4) and Visual Quality Summary Sheet (Figure 5) outline these procedures.

**VISUAL QUALITY SUMMARY SHEET**

<table>
<thead>
<tr>
<th>Name of proposed route:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route number:</td>
</tr>
<tr>
<td>Date:</td>
</tr>
<tr>
<td>Assessor:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overall ratings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viewpoint No.</td>
</tr>
<tr>
<td>Viewpoint Total</td>
</tr>
<tr>
<td>Unit Length</td>
</tr>
<tr>
<td>Unit Total</td>
</tr>
</tbody>
</table>

**Road Total:**

**Average Visual Quality:**

1. Unit Total = Viewpoint Total X Length of Unit
2. Road Total = Sum of Unit Totals
3. Average Visual Quality = Road Total X Total Length of Road

**Overall Visual Quality Ratings:**

3 = Very low visual quality
12 = Medium visual quality
21 = Very high visual quality

*Figure 4. PHSRAC Assessment Unit Viewpoint Inventory and Visual Quality Ratings Form After Walker, 1993*
### ASSESSMENT UNIT VIEWPOINT INVENTORY AND VISUAL QUALITY RATINGS

**Unit ID number and name:**

**Milepost and name of road segment:**

**Viewpoint milepost and selection factors:**

**Roadway direction:**

<table>
<thead>
<tr>
<th>Topic:</th>
<th>Foreground</th>
<th>Middleground</th>
<th>Background</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetative Cover:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landform:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landuse:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Features:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Visual Quality Ratings (1-7)**

<table>
<thead>
<tr>
<th>Visual Quality Ratings (1-7)</th>
<th>Visual Quality Rating Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vividness:</td>
<td></td>
</tr>
<tr>
<td>Intactness:</td>
<td></td>
</tr>
<tr>
<td>Unity:</td>
<td></td>
</tr>
</tbody>
</table>

**Viewpoint Total:** Overall Visual Quality Evaluation of View (3-21)

*Figure 5. PHSRAC Visual Quality Summary Sheet After Walker, 1993*

Information on natural and cultural resources and land tenure was also compiled but was not used in the assessment, as can be seen in the PHSRAC Scenic Assessment diagram (Figure 6).
Because, as discussed above, the highway failed but was deemed by the writer to merit protection on the grounds of an ecological aesthetic, a Heritage Highway proposal was produced which examined natural resources in light of climate change indicators, global climate models and paleoclimatology. A case for a climate drift corridor was made as outlined in the Heritage Highway Proposal Diagram (Figure 7).
The Theoretical Framework diagram (Figure 8) outlines the process of constructing a theoretical framework for alternate model selection. Again, because the PHSRAC model was found scientifically lacking, another model was required for automation. This disallowed a direct approach from manual to automated procedures. The exploration and expansion of a theoretical foundation was necessary to judge the selection of an alternate model for automation.
The literature review discusses in greater detail the voyage via the writings in the areas of landscape perception through individual, group and collective models and their evolution through time. Various existing scenic assessment models are examined, and then the models of these models. Finally, Jungian typology is reviewed to make sense of all of this and provide a basis for model selection and allow subsequent automation.
V. LITERATURE REVIEW

A. PERCEPTION? REALITY?

1. INTRODUCTION

Visual resource management and related government policy are based on perceptions of scenic values. A variety of instruments for scenic assessment abound in the public, private and academic sectors. Examination of these assorted methodologies reveal personal and group biases. These inherent perspectives bring into question their validity. A clue to these differing approaches may be the divergent images though which we see our world and the resultant behavior (Boulding, 1956) of concretizing our perceptions in various conceptual models.

Dr. Andrew Weil (1990) has stated, we perceive the world through conceptual models, rather than directly...if you don't know you are using a model, you laugh at it. You have to become aware of the model you are using... and if it doesn't work then throw it away.

2. A.D.O.T. MODEL

The Arizona Department of Transportation uses its' own conceptual model for evaluation of scenic quality along road and highway corridors (Kocher, 1987). It is based on a trinity of interrelated facets: vividness, unity and intactness. According to the procedures manual,

vividness is a measure of the memorability of the diversity and contrast which is conveyed by the distinctiveness of the visual impressions received from the landscape unit. Intactness refers to the landscape's apparent degree of natural condition. Unity is the degree to which man-made elements harmonize with the natural features. In the case
of a wholly natural setting, the overall unity is rated, or the degree to which all the visual elements of the view are compatible (A.D.O.T., 1985).

These are not three separate and distinct criteria. Vividness is a function of intactness and unity. Vividness can be interpreted to occur at both ends of the scale; high vividness can be positive or negative, resulting from a view that is either beautiful (Figure 9) or ugly (Figure 10). If a landscape is natural, devoid of human impact and wholly balanced, it will score high in vividness. If it is heavily impacted and visually unstable, it will also be very memorable. The more intact the landscape, usually the less there are cultural modifications and the more harmonious is the landscape. Consequently it gets a higher unity rating. So intactness and unity also correspond to each other. Finally, unity is discounted if there are no cultural modifications, because then one gets a second chance to negatively judge the elements of the natural landscape.

Figure 9. Northerly view of Milepost 284
3. B.L.M. vs. FOREST SERVICE MODELS

A comparison of models of two federal agencies, the Bureau of Land Management (BLM) with the Forest Service (FS) illustrate how perceptions affect methodologies. The components of the BLM's scenic quality evaluation are landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications, while the FS lists landform, rockform, vegetation, water forms, lakes and water forms, and streams (Smardon et al., 1986).

Cultural modifications, or human impact, is a criterion in the BLM model. The BLM operates under the multiple use concept. Mining, cattle grazing and recreation are permitted. This criterion, cultural modifications, is missing in the FS model, where they are primarily oriented towards forestry. Color, a category in the BLM model, is also
missing in the FS model. The dense vegetation of forests usually does not allow for the marked color contrasts of soils and rock formations in the more open lands managed by the BLM. Water in the BLM model is considered only one category. The FS model divides water into two categories according to form: lakes and streams. The more abundant precipitation and lower evapotranspiration rates that make forests possible also carry with them the need for a greater consideration of the distinct features of water in the landscape. Through the eyes of different federal agencies, we see and evaluate very different worlds.

4. PERCEPTION = REALITY

Sell et al. (1984) says we should ask why or how this is so. Perception is a function of the object and the receptor or viewer. Not only is vision physically limited (Higuchi, 1983), it is cognitively limited as well. Images are received, then judged negatively or positively. A person's perception is biased by their expectations, associations and desires.

*Decisions to modify or change the environment are based not so much on the environment as it is but rather on the environment as it is perceived or conceived by the decision-maker.* (Saarinen, 1976). *Perception may literally be reality* (Mattingly, 1993).

Or as Jung would state:

*Thought is matter, and matter is thought; there is no difference any longer. That is the Einstein theory. The latest truth about matter is that it is like thought, that it even behaves like a psychical something, that it is a psychical phenomenon.* (McGuire, 1984, p. 615)
5. LAYERS OF ASSOCIATION

The world is filtered through layers of associations (Fleming and Tschomer, 1987). Some layers can be identified through a review of the literature. These include personal, group, cultural and universal or archetypal layers.

a. PERSONAL LAYER

The first layer is the personal layer. It varies with the individual's past experiences and present "set" or attitude acting through values, needs, memories, moods, social circumstances, and expectations. (Saarinen, 1976)

For instance, whereas a satiated passenger may be distressed by McDonald's signs sticking up far above buildings into a mountainous horizon, a hungry traveler might find those familiar golden arches very appealing. Sell (pers. com.) has considered doing a scenic assessment by comparing the capture of automobiles by a beautiful view versus a McDonald's and a miniature golf establishment. Magill's (1989) research suggests that the proximity of such establishments would make the view rank higher. Gimblett (pers. com.) questions just what is being scenically rated and so instead evaluates preferences correlated with personal activities.

b. GROUP LAYER

The next screen is that of the group. The A.D.O.T., BLM and FS models are indicative of this layer. Kaplan and Kaplan (1989) explain how these are learned within a specific discipline. In order to reflect normative public values the whole range of these experts must be taken together.
c. CULTURAL LAYER

The subsequent filter is that of the cultural unconscious (Henderson, 1990). As landscape architect Carl Steinitz (1991) puts it, *individuals have shifting visual preferences and ... the judgments which people make are colored by their cultural background, active purpose and geography.* An example of this is the preference of Northern New Mexican Hispanics for pastoral landscapes (Halmbacher, pers., comm).

Variations in Value Orientations (Kluckhohn and Strodtbeck, 1961) is a treatise which deals in great detail with the differing perceptions of several American groups. Edward Hall’s books *The Silent Language* (1959) and *The Hidden Dimension* (1966) also deal with the different sensory worlds of diverse cultures (Saarinen, 1976). The Bathroom by Alexander Kira (1966) is yet another work which stresses cultural aspects (Saarinen, 1976).

d. ARCHETYPAL LAYER

Finally we get to the core or archetypal layer. *It is Itelsons belief that apart from aesthetic judgments of a cognitive nature, there is also a prejudgemental affective system* , which...is central to environmental experience (Sell et al., 1984). This layer is primal, preexisting the upper layers and providing them with a fountainhead. Archetypes are the expressions of a primordial psychic process that may even precede the advent of the human race (Weiner, 1973). They are a controversial way of looking at the old and still unsolved problem of how it comes about that societies remote from one another in time and place may nevertheless invent pretty much the same stories (Ruthven, 1976).
Jung postulated the theory of an individual unconscious plus a universal or collective unconscious linking man to his primitive past, and in which are deposited certain basic and timeless nodes of psychic energy, which he termed archetypes. It precedes all conscious experiences and therefore cannot be fully explained through conscious thought processes. Perhaps one of the simplest analogies is that offered by Jacobi of a kind of "psychic mesh" with nodal points within the unconscious, a structure which somehow has shaped and organized psyche into potential images, emotions, ideas, and patterns of behavior (Cooper, 1974). It manifests in our thoughts, feelings and actions and is entirely dependent on the arbitrary emergence of those primordial image-symbols. We are in their grip, whether we like it or not, and yet we never really know what we are in the grip of" (Gould, 1981). In short, we are attempting to interpret what is not interpretable, and the archetype as a primordial image "simply dominates consciousness and gives birth to an art which lives in its shadows" (Gould, 1981).

Tadahiko Higuchi (1983) proposes the existence of spatial archetypes. These spatial archetypes could occur anywhere and everywhere, their images common to all human beings through the collective unconscious. The Eight-Petal Lotus Blossom type and the Sacred Mountain type are two of the seven types of landscapes Higuchi discusses.

Byoung-E Yang’s research supports Higuchi’s theory (Kaplan and Kaplan, 1989). A cross-cultural study was conducted by Yang both with respect to the landscapes and the participants. Korean, Japanese and western landscape styles comprised the samples. Both western and Korean participants preferred the Japanese archetypal landscapes.

W. C. Yeomans (1983) characterizes Landscape Composition types. There is a similarity between his Focal Landscape and Higuchi’s Sacred Mountain type.

Landscapes are frequently conceived as “type” with their own internal coherence and scale of evaluation. When we make judgments of landscape beauty, we
judge within these archetypes rather than among them. We can simultaneously judge landscapes in the coastal zone, in the desert, in the mountains, and in a great city as being "most beautiful", even though these landscapes exhibit great diversity. No single descriptive or predictive model can account for these equivalent judgments (Steinitz, 1991, p. 218).

6. CONCLUSION

The graphic illustrates the layering of filters and the ways different people perceive and relate to their environment. The first consists of personal models. An example may be that as a child your father took you into the woods and beat you. Your negative associations might lead you to dislike wooded landscapes and label them as ugly. Or maybe he took you camping in "naked" landscapes. Pleasurable memories may cause you to conceive and perceive them as especially aesthetic.

**Figure 11. Intrapsychic Levels of Conceptual Models**
Below that you have group models. These are shared and can be acquired through indoctrination and initiation. Kaplan and Kaplan (1989) review how different federal and state agencies instruct their members on the use of landscape assessment instruments. Various professions see their environments in terms of their expertise; geologists view the world in terms of geology, while botanists think and see in terms of botany.

Still lower are cultural models. These account for cultural variations in value orientations and affect how a society will impact its environment. Several cultures around the world deify nature. First Americans have mountain spirits. These are called Devas by the East Indians. The Druids held religious ceremonies in Sacred Oak Groves. The Greek culture, which fathered our modern day tradition of logic and reason, has minimal nature divinities, with these being human/animal only (pan, centaur, satyr), somewhat demonic, and not of any landscape type. This may be a significant indication of the development of an anthropocentric world view as opposed to the more biocentric or pantheistic world views of other cultures.

At the bottom lie universal models or landscape archetypes. The parameters for landscape archetypes consist of geomorphic clarity (Leveson, 1988) and spatial form in either a feminine positive space mode or masculine negative space mode (Higuchi, 1983). They resonate with external landscapes, and so elicit a response in the viewer, perhaps even moving one to return to a site year after year. Landscape archetypes speak to us, through us:
The silence of the landscape said 'No!' (we) had already been placed at a distance. (Or is it that we had placed ourselves at a distance?) The silence of the bush seemed already to have spoken: the earth had been waking itself and through us (were we chosen?) had been coming to its own realization. Rilke, the poet, had known this secret of the earth. "Earth! Isn't this what you want: an invisible re-arising within us?" (Romanyshyn, 1989, p. 3).

B. LANDSCAPE PERCEPTION: TOWARDS THEORY THROUGH APPLICATION

1. INTRODUCTION

A review of recent literature in the area of landscape assessment reveals a multitude of approaches. These appear to be fostered by several very different perceptions of the landscape. In specific cases they find their validation through the variety encountered in the viewer (subject) and the landscape (object).

It has been said that:

Every man is in certain respects

a. like all other men
b. like some other men
c. like no other man (Kluchohn and Murray, 1974)

So, too, can it be said that:

Every landscape is in certain respects

a. like all other landscapes
b. like some other landscapes
c. like no other landscape
With this amazing diversity and complexity, is there any hope of bringing understanding and meaning to the theory and practice of landscape assessment?

2. THEORETICAL FRAMEWORKS

Efforts have been made to organize the various landscape perceptions or paradigms into holistic frameworks (Daniel and Vining, 1983, Pitt and Zube, 1987, Sell et al., 1984, Taylor et al., 1987, Zube et al., 1982). For the purposes of the this paper, the more popular four paradigm framework which collapses Daniel and Vining’s (1983) ecological and formal aesthetic into one expert paradigm will be discussed. This theoretical framework relates to the work of Ittleson (Sell et al., 1984) and the transactional relationship of humans and landscapes as graphically illustrated in Figure 12:

![Figure 12. Ittleson’s Transactional Model](image)
After Sell et al., 1984

These four parts may be considered representative of the four paradigms, expert, psychophysical, cognitive and experiential which comprise the framework. The expert paradigm stresses the need for “expertise,” either aesthetic or ecological, of the human
evaluator and is an approach commonly used by government agencies. In contrast, the psychophysical paradigm sees relative importance inherent in the components of the landscape and commonly uses questionnaires to arrive at normative public values. This approach is rapidly gaining favor (Zube et al., 1982). The cognitive paradigm seeks to understand the processes of the interaction. Finally, the experiential paradigm focuses on the outcome of the experience.

These four paradigms appear to echo the psyche's four functions as described by Jung:

*In conscious psychology, we know that we can speak of the four functions, ways in which we adapt to a given situation, and we know by experience that people as a rule possess one function that is really differentiated, and that they have some disposition towards an auxiliary function. For instance, take a thinking-sensation type. Such a man knows what he hears and sees. (Not everybody knows that!) Then besides these functions, there is also some consciousness of a third which might serve the superior function; in this case it would be intuition. But what doesn’t appear among the conscious functions or only occasionally as phenomena that one can’t control, is in this case feeling. It is the last, the unreliable thing, the sore spot, where such a man is inferior, where he receives his shocks and wounds. For thinking and feeling exclude each other because of their contrary nature. When thinking it is better not to feel, and vice-versa, in order that the two shall not upset each other. (McGuire, 1984, p. 314)*

In short, thinking tells you what things mean, feeling tells you what they are worth, sensation tells you what they really are, and intuition tells you the possibilities of a situation. (McGuire, 1984, p. 315)

A comparison of the four paradigms and the four functions reveal interesting similarities. The expert paradigm assumes that the perceptions of professionals are valid surrogates for the perceptions of the public... (Pitt & Zube, 1987) The ADOT model relies on an expert approach; as has been discussed above, it is neither logical (thinking), rational (feeling), nor reliant on landscape objects (sensation). Instead, it relies on the viewer's gut response to vividness, intactness and unity (intuition).
Psychophysical models of perception attempt "to determine mathematical relationships between physical characteristics of landscape and perceptual judgments of human observers" (Daniel & Vining, 1983, p. 56, Pitt & Zube, 1987). This is like the sensation function, it knows the thing is there (McGuire, 1984). Zube's cognitive paradigm ... attempts to explore and interpret the meaning of the environment in the perceptually based aesthetic experience (Pitt & Zube, 1987). Thinking tells you what things mean (McGuire, 1984). The experiential paradigm ... strives to understand human-environment interactions on unstructured phenomenological exploration (Pitt & Zube, 1987); feeling says what it is worth to one, whether one accepts it or rejects it (McGuire, 1984).

It appears that the four paradigms of aesthetic valuation may correlate to the four functions of the psyche and it could be that the choice of methods may relate to the dominant function of the evaluator. Figures 13 and 14 serve to illustrate this when compared to Figure 12.

The four paradigms have also been analyzed in the context of scientific methodology. In terms of reliability, or how likely the results would be replicated if repeated, sensitivity, the ability to acutely measure differences, validity, measuring what is said to be measured, and utility or usefulness of application, the four paradigms are rated below.
Table 1. Evaluation of Paradigms

EVALUATION OF PARADIGMS

<table>
<thead>
<tr>
<th>Paradigms</th>
<th>Expert</th>
<th>Psychophysical</th>
<th>Cognitive</th>
<th>Experiential</th>
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<tbody>
<tr>
<td>Reliability</td>
<td>Low</td>
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<td>Sensitivity</td>
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</tr>
<tr>
<td>Utility</td>
<td>Mod**</td>
<td>Mod</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

* After Daniel and Vining (1983) **Mod = moderate

After Sell et al, 1984

Note the low validity of the expert approach and the low utility of the experiential approach.

The above-mentioned disadvantages do not seem to appear in the literature when authors score their own procedures. Kocher (1987) compared the reliability and validity of the assessment methodologies of several government agencies. These included the Bureau of Land Management, the Arizona Department of Transportation and the Federal Highway Administration. The BLM considers such physical aspects as landform, vegetation and water while the FHWA and ADOT measure vividness, intactness and unity. All agencies, in spite of very dissimilar methods, scored in the high 60’s to the high 90’s on Kocher’s scale. While the BLM model tends toward the psychophysical paradigm and ADOT and the FHWA follow the expert approach, all exhibited high validity and reliability when tested by Kocher. This tendency was seen even when one
crossed into the other more grossly dissimilar paradigms. It is as if an experimenter projects their theoretical perceptions on to the landscape. In the area of landscape perception and scenic assessment research, it appears that the experiment becomes the paradigm for how we arrange the space in which nature appears (Romanyshyn, 1989, p. 56).

The images a person holds colors their perception and impacts their behavior (Boulding, 1956). In science, the fact that one can not study something without impacting the results is called the Heisenberg principle. Fixed ideas act as blinders (Lewis, 1979). One is reminded of the Sufi tale of the blind men of Hindu Stan that each grabbed hold of a different part of an elephant and proclaimed the whole to be identical to the part.

An article that dramatically illustrates the discrepancy between perception and objective reality is The Romantic Face of Wales (Zaring, 1977). Photographs depict the rivers and mountains of Wales dramatically different in contrast to those described and sketched by eighteenth century artists and writers visiting the region with a romantic eye. In another article, Norberg-Schultz (1979) speaks of internally held schemata which may impact one's view of the world. Perhaps no clearer discussion of this phenomenon can be found than that by psychologist M. L. von Franz (1980). In a chapter on how projection of unconscious archetypal material affects scientific hypothesis, she writes:

"Strictly speaking, projection is never made; it happens, it is simply there. In the darkness of anything external to me I find, without recognizing it as such, an interior or
psychic life that is my own."). During the course of his experiments the researcher may have had certain psychic experiences that he interpreted as the particular behavior of the chemical process. "Since it was a question of projection, he was naturally unconscious of the fact that the experience had nothing to do with matter itself (that is, with matter as we know it today). He experienced his projection as a property of matter; but what he was in reality experiencing was his own unconscious" (von Franz, 1980, p.73).

von Franz (1980) further discusses the evolution of bringing the unconscious to light, that is, integration into consciousness as models. As new material is drawn up, the old models may no longer be seen as valid. In the case of science they may simply be dropped, but if religious in nature they are more apt to be reinterpreted. Figure 15 shows how social values in terms of environmental perception may evolve over time. In a scheduled discussion session, a university class showed greater concern for environmental conservation than for the apparent national norm of personal economic enrichment through land and resource development. As the relatively younger students are assimilated into the mainstream, differing perceptions and values may cause conflict. This could seed controversy which may aid progression of consciousness to a new model incorporating these values.
Von Franz thinks that the discarded material still retains significance in understanding ourselves.

A second element that, up to the present, seems to be missing in the history of natural science is the insight that outmoded models originated in the human unconscious; scarcely a thought is given to what they may mean, psychologically, once they are no longer fit to serve as a model in describing the outer world. It is only today, when we know that the assumptions of the observer decisively precondition the total results, that this question is becoming acute. (von Franz, 1980, p.72)
By acknowledging even discarded parts one can come to understand and realize a greater whole. A dissection of the psyche may serve to illustrate its impact on environmental perception. Cappon (1994, p.40) describes this mental landscape:

*The bulk of latent intuition finds its store in imagery, and with the collective memory vault as its repository... Because it was generated and stored in prelogical areas of memory, intuitive information had to be stored economically, iconically unfolding in response to stimulation, like the “life passing before your eyes” that allegedly precedes drowning, or the messages encapsulated in archetypal sleep dreams... On the other hand, conscious reasoning has been increasingly processed verbally, through learning, with its information stored audiovisually in the more recent, though deep, layers found at the interface between the collective and personal memory vaults.*

Worldview allometry, the evolution of the layers and relative changing emphasis through time of Cappons’ (1994) mental landscape is depicted in the following graphic. The earlier prelogical intuitive function is often represented as feminine and embodying Eros while logical thinking is seen as a masculine form. A short history of feminine versus masculine perspectives illustrates this point (Figure 16). The evolution of an Eros (synthesis, relatedness) view is contrasted with that of logos (analysis). The bottom photo shows a terra-cotta figurine of the goddess Inanna-Ishtar dating back to the Sumerian period. She represents a time when god was a woman and the chthonic feminine, the Plutonic earth-goddess, was revered. Instinct, intuition, and feeling were heavily relied on and intrapsychic elements were attributed to the landscape (von Franz, 1980). Humanity extended synthetically (Eros, feminine) into the environment.
Figure 16. Worldview Allometry - A Historic Perspective
Above this is a representation of a part of the perspective plan of the Villa de Arnada de Duero. This was painted before the concept of a one-point perspective and so shows the buildings from different angles and viewpoints and at different scales. This is a holistic view (feminine) without the aid of a well developed logical (masculine) perspective.

Next, we see a copy of the drawing by Albrecht Durer, Artist Drawing a Nude through a Gridded Screen. It embodies (or rather disembodies) a disciplined perspective and an analysis (logos, masculine) of the naked woman as she is taken apart and placed in the separate boxes of the grid.

The transition between this perceptual mode and the next is important because it portends our conceptual/perceptual development, in as much as artists form the vanguard of collective consciousness. Artists mine the collective unconscious for material for their work, and because they are at the forefront, their work is usually not accepted, hence the term starving artist. Van Gogh is a great contemporary example of this, with his art currently selling for millions. It only took us over a century to catch up with him.

Alberti, who first conceived of one-point perspective in the early fourteenth-hundreds, is another example of this normative lag-time and how it heralded our modern techno-perception. Romanyszyn (1989) writes about how this way of knowing and seeing is so taken for granted that we forget it is but a historical-cultural construct. These different perceptions attest to different worlds and world views:
Between a da Vinci and a Cézanne the human world and the human eye have changed. Painting indicates not only that styles of human perception change but also that the world itself changes. The invention of linear perspective in fifteenth-century Italy is one such moment of change, and the tale to be told... concerns how the invention and development of this artistic technique became the cultural vision which has shaped our contemporary technological world. Linear perspective vision, in the words of art historian Samuel Y. Edgerton, is 'the "innate" geometry in our eyes,' and although this way of perceiving space is no more natural to humanity than, say a Picasso canvas in which multiple perspectives appear simultaneously, the latter remains for us abstract and unreal while the former defines for us what is real and what is natural. Before we know that we know it, we have learned to see the world as a three-dimensional plane where depth is a matter of spatial distance from the viewer and where all objects decrease in size as they recede from the viewer toward a vanishing point. In short, before we know that we know it, we have learned to see the world as if we were focusing through the lens of a camera, or as if we were standing on a railroad track looking at the parallel rails converging in the distance. (Romanyshyn, 1989)

And so the multiperspectival painting by Picasso which follows above Dürer’s nude in the graphic gives hope, for, in contrast to the distancing effect of linear perspective, it implies an immediacy. The viewer is involved with the woman, at once all around her, viewing her from top, bottom, front and back. Here the naked body of a woman is drawn from all angles reminiscent of the perspective plan of the Villa de Aranda de Duero, but with a difference. You can see the back of her head, the side of her face and the front of her face. Picasso paints the front of her body, the back of her body and the bottom soles of her feet. This is a synthesis born of analysis. The artist knows all the parts and puts them back in a consciously visible form, demanding their integrity. The masculine (analysis) enables a new feminine (synthesis). If art presages collective consciousness, a holistic, ecologic perception may be in the making. Science is bringing back Gaia and the earth-goddess may again be revered, this time with the
developed conscious support of the masculine (logos). A biocentric view is debated as being more sustainable than anthropocentrism.

With this understanding, the upper left graphic declares the necessity of the integration of all views to arrive at a more accurate whole (Kaplan and Kaplan, 1989). To the right is a symbolic depiction of human ecosystems (Lyle, 1985). Humanity is seen as a part of the whole. From an ecological perspective, people and environment are synthesized.

While not wanting to confuse the reader with thinking that masculine means men and feminine means women (both aspects are found in each), it is interesting to note their different ways of relating to nature. Monk (1988) learned that men preferred to either dominate or leave the desert alone. Women, on the other hand, searched for ways to live within the limits of the scarce resources of an arid environment. Saarinen (1976) has pointed out that despite the Chinese adaptive attitude towards the environment, their landscapes have not escaped degradation. Perhaps what is needed is a creative dialog between masculine and feminine voices. Science and the knowledge of ecosystems and environmental impact must support the intuitive understanding of the Tao. A rational perception can be illuminated and enlivened by transcendent experiences of nature (Relph, 1979).

The writer Robert Waller tells how he got the story for his current bestseller when out taking pictures of covered bridges in Madison County. It is as if the universe gave it to me (Kuralt, 1993). In his letters to his brother Theo, Vincent van Gogh
explains his art with *I feel as if nature has spoken to me* (In Search of Vincent van Gogh, 1993). In this manner, then, do humans resonate psychically with their environment. And here may lie the answer to the question of the social value of environmental quality, (Sell et al., 1984) for one cannot

... *split the human psyche away from relationship to the land on which humans live, away from the knowledge of the cultural etiologies of malaise and unrest, and also to sever psyche from politics and policies which shape the inner and outer lives of humans— as though that outer world were not just as surreal, not just as symbol-laden, not as impacting and imposing upon one’s soul-life as the inner din.* (Estès, 1992, p.67)

This, then, is the rationale for treating the areas of landscape perception and landscape assessment with the concern due their importance. The question is how does one go about integrating the different views, the multitude of paradigms, the complexity of human - landscape interactions and outcomes in a methodology that is valid, reliable, sensitive and has reasonable utility?

3. STEINITZ COMBINATION MODEL

Steinitz (1991) may have just come up with a way. While only a very few studies have managed to do research across two paradigms (Sell et al., 1984), Steinitz (1991) has pulled apart the components of value of models in the expert, psychophysical and cognitive paradigms and tested them against each other. And it is possible that the fourth paradigm could be accommodated by building a huge experiential database covering a spectrum of situations and integrating results. Table 2 illustrates the components of the five models utilized in the Steinitz (1991) study.
After Steinitz, 1991

On a study of a road in Acadia National Park, Steinitz used a normative public value approach by conducting surveys of visitor preferences to assess scenic values. Then a normative expert approach (he and a group of his graduate students) was used to assign values in a cartographic format using GIS. He took the BLM (1980) procedure, which relies on expertise, the Shafer (1969) and Brush and Schafer (1975) method which belongs in the psychophysical paradigm and two cognitive paradigm formulas, that of Appleton (1975) and the Kaplan (1979) and Kaplan and Kaplan (1982) model, and Steinitz (1979) and mapped them. The individual components of each of these conceptual models was attributed to the landscape and then analyzed. This resulted in
the synthesis of a completely new model with components from the different paradigms.

In order of importance, it was found that:

(1) people do not like to see a developed or urbanized landscape or evidence of crowded use (with the exception of no. 3);
(2) they like a sense of mystery; they wish to be further drawn into the scene;
(3) they like coastal development which is considered generic to the Maine Landscape, and they like development with a distinctly “historic” character;
(4) they like to see water;
(5) they do not like to see tourist-oriented commercial development;
(6) they like long distance views;
(7) they like to see a “folded” landscape, typically mountains and islands;
(8) they like to see a diverse and well-maintained vegetation distribution in the foreground and middle ground of the view. (Steinitz, 1991, p. 224)

This model has the following formulation based on all variables being normalized to a 0-4 range: average score = -0.249 + 0.128 landform • 0.0730 vegetation + 0.149 water + 0.204 mystery - 0.251 tourist development + 0.741 absence of development + 0.184 distant view (Steinitz, 1991, p. 223-224)

This model is not a universal model. It honors the specifics of human-landscape interaction. It is spatio-temporally specific. It is also limited in what was included. With computers everything must be made rational and explicitly conscious and entered into the computer or it will not be in the results and accounted for in the model. This procedure does, however, offer a cognitive framework in which a multitude of conceptions and perceptions can be explored at once.

4. GIS APPLICATIONS

The literature is rich (Steinitz, per. comm.) with examples of GIS applications in scenic quality assessment and visual resource management (Gimblett et al., 1987). Gimblett, no date, Lynch and Gimblett, 1992, Itami and Daniel, no date, Smardon et al.,
1986, Steinitz, 1991, Dryden, 1990). There is also the present move to incorporate other methodologies in the field of artificial intelligence in these procedures (Gimblett et al., 1994, Buhyoff et al., 1994). There is also the concern that they be made representative of normative public values (Itami, 1985, Blahna and Yonts-Shepard, 1989, Blahna and Black, 1992, Blahna and Toch, 1993, Steinitz 1991). Just as critical is the appropriate paradigm for roadside scenic assessment. The Steinitz (1991) study arrived at different sums according to the direction of evaluation. This research, too, had a higher rating going north as opposed to going south. This argues a case for the experiential nature of assessment, as is supported in the literature (Gimblett, 1990, Gobster and Chenoweth, 1990, Schroeder, 1990). Questionable, then, is the practice of surveying 8 psychology students in a visualization laboratory to evaluate scenic beauty. But Itami (1985) stresses the importance of such practices in order to make projects doable. Steinitz (1991) emphasizes that the procedure but not the model has potential for wider application. A public survey was beyond the scope of this study, and so the Steinitz model was chosen with the knowledge that it was site and time specific.

The components of scenic assessment are complex, time consuming and sometimes tedious. It is necessary that the infrastructure for interaction be built for the best possible results in visual resource management (Skirvin and Dryden, 1995)

5. CONCLUSION

GIS can act like a lever to allow an extension of the mind to grab hold of all parts of the “elephant” simultaneously. Greater complexities and more intricacies can be
explored. Although we probably never will understand all that is, GIS can help us reach farther. The visual format of GIS also aids in recognizing patterns. This form of application can then support and drive theory which can in turn modify further application.

Digital mapping will allow people to grasp the connections between cultural, physical and geographic patterns. "We're reaching the ragged edge of sensitivity on this planet,....Things are getting more complex, and there's not enough time to focus on them. GIS promises to interrelate things. Even if we can't solve our problems, we'll understand them." (Pope, 1991, p.82.)

One may hypothesize that collective models can be statistically extrapolated out of a sufficient number of properly constructed databases. It is only with larger numbers of opinions that one can be assured that personal bias is canceled out and collective projections are represented. Studied through time, we might even arrive at trends in the upswellings of unconscious material. And we may begin to understand how:

Every landscape is in certain respects

a. like all other landscapes
b. like some other landscapes
c. like no other landscape
VI. METHODOLOGY

A. Site Description

U.S. Highway 1-17 crosses Arizona’s three geologic provinces as it goes up through varying elevations. It is the only interstate in Arizona that does this. Starting at Phoenix where it is linked to interstate 10 and ending in Flagstaff where it joins interstate 40, it crosses the basin and range province, the central highlands and enters the Colorado plateau (Figure 17).

The highway intersects six of Brown and Lowe’s (1994) vegetative communities. These six are: montane conifer forest, juniper-pinyon woodland, chaparral, mountain meadow and both Arizona upland subdivision sonoran desertscrub and lower Colorado subdivision sonoran desertscrub. Riparian communities can also be found along rivers and streams. In contrast, Mt. Lemon, famous for its numerous lifezones, intersects only

Figure 17. Arizona’s Geologic Provinces
After Hendricks, 1985
five. The interstate also crosses all five climate zones and the state’s diverse precipitation zones from ten inches per year to 25”. All five animal zones in Arizona touch I-17. These life zones are biogeographic systems (Hendricks, 1985). The indicator species are cactus mouse, beaver, Abert’s squirrel, red squirrel and little pocket mouse (Figure 18). The geology, vegetation and wildlife make this interstate ecologically unique.

![Figure 18. Arizona's Animal Zones](image)

The area studied for manual assessment extends from milepost 268 to 320 and lies mostly in National Forests (Figure 19). If a two-mile-wide corridor is delineated along I-17, one mile wide on each side, 11% of the adjacent land is privately owned. National Monuments account for one percent, two percent are state lands and the remaining 86% are federal lands within the Coconino and Prescott National Forests (BLM, 1979). Cultural resources along this route include historic Fort Verde and the ancient dwellings of Montezuma's Castle and Montezuma's Well located in the heart of Arizona, I-17 transects regions that may well be vital to the state's and even the nation's natural heritage.
The area was subset for the automated procedure. Two USGS 7.5 minute quads were selected on the basis of having the most components of the Steinitz model, notably mystery provided by the bend in the road which promised further information. The two adjacent quads were Mund's Mountain and, directly to the east, Stoneman Lake. These quads are comprised mostly of Coconino National Forest lands and lie on the boundaries of Yavapai and Coconino Counties. This subset contains I-17 between milepost 305 and 318.
The automated study site has rolling terrain along the highway corridor and hills on the eastern edge. The western third is comprised of a dual series of cliffs and deep erosional ravines. Intermittent streams generally dissect the two quads from an eastern to western direction, except in the northwest corner, where the cliffs/ravines run in parallel from north to south.

Vegetation types are described as in the GAP Analysis Project. Milepost 305 through to 308 are in Pinyon-Juniper(Mixed)/Mixed Chaparral-Scrub, with 308 being on the edge. Between mileposts 308 and 309 lies an area covered with Pinyon-Juniper-Mixed Grass-Scrub. Mileposts 309 to 314 travel through Pinyon-Juniper (Mixed). A tongue of Ponderosa Pine licks the east side of milepost 311. Just past milepost 314 and northward along the highway, barely engulfing milepost 318, is Ponderosa Pine-Gambel Oak-Juniper/Pinyon-Juniper Complex. Other vegetation types found on the two quads include Arizona Cypress, Interior Riparian/Cottonwood-Willow Forest, Ponderosa Pine/Pinyon-Juniper, Great Basin Mixed Grass-Mixed Scrub, Interior Chaparral-Mixed Evergreen Sclerophyll, and Interior Chaparral-Shrub Live Oak-Pointleaf Manzanita. Other landcover types include a small urban area in the southwest corner and Stoneman Lake.

The Model Automation Software/Hardware Implementation diagram illustrates the variety considered and utilized (Figure 20). The Map Analysis Package, although indicated in the Wilkin proposal (1990), was rejected on the grounds of computational limitations. IDRSI was also rejected for analysis because PC-Arc/Info showed more
promise. An attempt was made to integrate scanned Landsat vegetation data using MIPS but memory problems encountered disallowed this procedure.

Figure 20. Model Automation Software/Hardware Implementation Diagram

Several layers were digitized on a freestanding tablet, the first being the 7.5 minute quads in Autocad which is considered best for contour line attribution. After plotter hardcopy was produced to allow editing, it was ported over to PC-Arc/Info. The hydrology was captured on Host Arc/Info from HUCS, which use an 8-digit number assigned through the USGS/EPA (Arizona Rivers Assessment, 1990) river reach system to identify hydrologic units. This hydrologic data was provided by ALRIS then ported to PC-Arc/Info for editing. The ridgeline and highpoints themes were screen digitized from the topographic layer on Host Arc/Info. The highway and viewpoint maps were tablet digitized on Host Arc/Info.

The construction of the vegetation theme suffered from various problems. Brown and Lowe (1994) was rejected for possible data capture on the basis of being way too
coarse. Attempts at using Landsat data were discontinued for reasons described above. Finally it was decided to wait for the GAP vegetation to be made available and this was then captured and attributed with additional information. The database development is outlined in the two database development diagrams (Figure 21, 22). Hardcopy visuals were produced from the ART Lab's printer and also from a remote printer via ftp and a remote PC with Hijack to convert .ai files to .drw, Designer for vector graphic manipulation and Picture Publisher for raster graphic manipulation all employed in the process.

Figure 21. Database Development Diagram - Topography and Hydrology
Figure 22. Database Development Diagram - Vegetation, Highway and Viewpoints

The Surface Model diagram (Figure 23) shows the different algorithms tested. The first was TIN using the Douglas-Peuker algorithm and incorporating topographic, hydrologic, ridgelines and highpoints themes. This produced a surface model that suffered from the Potter Indentata effect, named after the person who named it. Terracing appeared where slopes should have been. Next a combination of TIN and Inverse Distance Weighting was explored. While better results were observed, some terracing was still occurring. Finally, Arc/Info (ESRI, 1995) came up with a new module incorporating algorithms based on the work of Hutchinson (1988, 1989, 1993)

This procedure stressed hydrologic aspects and also performed analysis on less data, employing only one critical point per cell. For this reason the ridgelines layer was left out of the final surface model construction.
The following maps (Figure 24, 25, and 27) show the digitized map then the same map incorporating hydrology and highpoints to produce the surface model which is graphically depicted in relief with early morning summer shadows. The last map in this chapter (Figure 26) illustrates the vegetation overlaid with highway and viewpoint themes that were required in the analysis as discussed in the next chapter.
Figure 24. Digitized Contour Map

Figure 25. Contour Map showing digital hydrology and highpoints themes overlaid.
Figure 26. Vegetation Map obtained from GAP Analysis coverage with Digitized portion of Interstate -17 and fourteen viewpoints overlaid. The most southern (bottom) viewpoint is milepost 305. The most northern viewpoint (top) is milepost 318.
VII. ANALYSIS AND RESULTS

Once the surface model was constructed, visibility analysis from all viewpoints was conducted. The vegetation layer was attributed with the height of the vegetation. *Landscaping with Native Arizona Plants* was consulted for vegetation height. Since it provided ranges and exact numbers were needed for analysis, experts were also surveyed. This resulted in a vegetation height layer. Next, this vegetation height layer was computationally added to the surface model to provide a canopy theme. Figure 27 illustrates this effect.

![Figure 27. Canopy Map showing the effect of adding vegetation height to topography.](image)

The viewpoints provided exact xyz coordinates on the surface. To these, an offset was added to the z units to accommodate the height of a vehicular viewer. A normative expert approach was utilized to arrive at an average of 4.5 feet converted to
1.38 meters. Subsequent measurement of actual vehicles demonstrated that this was an accurate estimation. These new xyz coordinates were then utilized to analyze visibility over the vegetation canopy. This produced a coverage containing the polygonal areas visible in terms of the 14 viewpoints. From this individual viewpoint viewsheds could be isolated. Figure 28 diagrams this procedure.

Figure 28. Visibility Analysis Diagram

Visibility was found to correlate with highpoints, areas and ridgelines and followed vegetation edges in some places. These last correlated with high places along washes. These can be seen in the aggregate visibility map (Figure 29).
A. Milepost 313

Examination of individual viewpoint viewshed coverages which were extrapolated out of the original visibility analysis showed that terrain was a good indicator of visibility as can be seen in the following photo of the westward view of milepost 313 and the visibility map for this milepost. The photo shows a near ridge, then one in the midrange and still another beyond. These three areas are indicated on the corresponding visibility map of milepost 313.
Figure 30. Westerly view from milepost 313

Figure 31. Milepost 313 Viewshed Map
Diagnostic visual simulations were subsequently constructed to further aid in analysis and decipher results. The process, diagrammed in Figure 32, involved taking the surface model to drape as a mesh to simulate the surface in 3-D. A single viewpoint was isolated from the viewpoints theme in terms of xyz coordinates and, again, vehicular viewer height was added to the automated computations. Other specifications included the azimuth and distance of the target relative to the viewer and, furthermore, the viewfield was modeled to mimic that of a 35 mm wide-angle lens as was used in the photographs.

![Figure 32. Diagnostic Visual Simulation Diagram](image)

Although the visibility analysis was generally good, it lacked the necessary resolution requisite of accurate scenic assessment. Details were missing because data was missing. The next photo demonstrates the effect of missing data. The view east from milepost 313 is that of a hill. The simulation which follows does not demonstrate the same amount of relief. This could be because the roadcut, missing from the 7.5 quad, lowers the viewer in the actual landscape and the virtual landscape is minus this detail.
Figure 33. View east from Milepost 313

Figure 34. Diagnostic Visual Simulation of easterly view from milepost 313
B. Milepost 316

Visuals that fell through the cracks, so to speak, are depicted in the following two photographs of views from milepost 316 (Figure 25). The view north shows the long corridor effect of the clearcut through the forest of the highway. The viewshed map (Figure 26) for milepost 316 on the next page does not reflect this. This appears to be because the highway clearcutting is missing from the GAP vegetation data.

Figure 35. View northward from milepost 316. Note the long corridor view accommodated by the highway.
C. Milepost 317

The view eastward in the next photograph reveals other missing data (Figure 37). Small ponds, isolated cabins, the mystery that is conjured by backlit partial screening which promises more information, all fall out of the combined 7.5 quad - GAP data (Figure 38, 39). Mystery, views of water and architecture in keeping with the setting were all found to be important components in the Steinitz model derived through linear regression performed on the components of the five models, as discussed above.
Figure 37. View east from Milepost 317.

Figure 38. Milepost 317 7.5 quad data

Figure 39. Milepost 317 GAP data
D. Milepost 307

Further diagnostic visual simulation was conducted, using the above described procedure, on the view south from milepost 307. The photograph below (Figure 40) shows a bluff projecting above the vegetation. Please note its distinct form. While the viewshed map (Figure 41) on the next page depicts the area seen, the following simulation, constructed minus the vegetation, lacks the singular articulation (Figure 42). Another simulation was run with the same target and viewfield dimensions, but with the vantage position elevated to ten meters. Even a vertically exaggerated viewer position could not resolve the issue of coarseness of data (Figure 43).

![Figure 40. View south from Milepost 307](image-url)
Figure 41. Milepost 307 Viewshed Map

Figure 42. Diagnostic Visual Simulation of southerly view from milepost 307.
Figure 43. Diagnostic Visual Simulation of southerly view from milepost 307 with vertically exaggerated viewer position.
VIII. CONCLUSION AND RECOMMENDATIONS

In order to reach the objective of facilitating through automation the process of scenic quality assessment for PHSRAC agents, this research consisted of three tasks, the success of each subsequent task dependent on the completion of the previous one. The first task was a non-automated scenic assessment of Interstate 17 from milepost 268, the cutoff to Dugas to milepost 320, the cutoff to Sedona, Arizona. This was successfully completed. The second task was an automated scenic assessment of a subset area. The construction of three models, each providing the foundation for the next, was required for this. A database was developed and the first layer, a surface model, was built. This was utilized to derive the visibility model which would then have been utilized in the scenic quality model. Problems were detected in the visibility model that indicated that both the foundational surface model and, additionally, the vegetation theme used in the visibility model was of insufficient resolution. This precluded the final scenic quality model. Since there was no automated scenic quality assessment, the second task, the final task of comparison of non-automated and automated results was not possible.

Analysis and results indicate that the resolution of readily available data, either in digital or non-digital forms, is not sufficient to model scenic quality and raised questions and highlighted areas of study for further research. Much has been gained by this work of GIS based scenic assessment. The interactive efforts of application drove the impetus towards finding a defensible model and forced the why of various models, the why of an ordering of these various models into a quaternity. The apparent relationship to Jung’s typological quaternity may hold the answer to these questions and
could begin to impact our scenic assessment model-making. Another hopefully fruitful outcome, although a by-product of the procedure, is the proposal for a designation of Heritage Highway, which may initiate a consideration by PHSRAC’s of protection of highway corridors on the basis of natural resources in the face of the uncertainties of climate change and the possibilities of climate drift. The model automation explored various operations and their relative merits and suggested guidelines for future studies.

Questions that could possibly greatly benefit GIS based scenic assessment, include:

1. What is the requisite resolutions of the various database components?
2. What data resolutions are needed at what distances from the observer?
3. What are the numeric parameters of vegetation screening/opacity?
4. How could the various scenic quality components be modeled?
5. Does the choice of scenic assessment instruments correlate with individual and/or group typology?
6. Does the temporal appearance of various types of computer programs, (expert systems, neural nets, etc.) correlate with the evolution through time of group dominant functions?

While data presently readily available is not of sufficient resolution, modeling attempts still benefit theory which further impact modeling as can be seen in this work. The process is interactive.

There appeared to be too many variables in this study and it may be better to isolate variables, preferably focusing future research on only one, or, if heavily impacted by other variables, limit to no more than two or three physical aspects of modeling.
(terrain, vegetation, visibility, etc.) or conceptual components of the model (naturalness, mystery, etc.). It could also prove to be more useful to use a winner, not loser, to model scenic quality. Probably mostly aesthetic viewpoints with some uglies for reference would be ideal. Also, it might be better to use a highway that had been previously assessed by an independent party so as to remove biases. Better measurements of vegetation heights are needed, and a sampling technique could be developed. GPSing the highway and viewpoints would increase accuracy of placement. And by putting the camera on a tripod, height and vertical azimuth of photographs and slides could be controlled.

A point that deserves further consideration is that of making computer graphics to simulate photographs. One must be aware of using a machine, a computer, to mimic another machine, a camera, instead of selecting photographic techniques that mimic how humans actually view the landscape. This is like the instance where design students are encouraged to letter in a mechanical style with stressed uniformity. The advent of more font types exhibited several that were styled after this fashion of human lettering: a machine mimicking a human mimicking a machine. Since perceptions are learned, how do mechanical views affect our views? The writer was acutely aware of the moment when she realized that hand-drawn landscape graphics were no longer acceptable for professional presentations and documents and that even the most the most primitive computer graphics were preferable. This was the event that heralded a new perspective, a new way of seeing, a new world view through technological eyes.
An application of this automated procedure that is worth considering is that scenic quality enhancement through visibility modeling and viewshed management. It could be utilized to delineate where to do selective cutting which would enhance viewsheds and affect scenic quality. Hypothetically, there could be an area on the study site where, if you cut down 12 trees, you could get a view into the red rocks of Sedona and it could be one of the best in the country from an interstate, whereas now you might as well be in the flatland forests of East Texas. By thinning for aspects of feelings of closure and long views, the scenic quality rating could be raised and boost the highway into a passing category. The tradeoff of a few trees for protection of scenic resources and consequently natural resources may be worth considering.

Although surface modeling has come a long way, with the most recent generation designed specifically for hydrological modeling a vast improvement over TIN and IDW models, the details that make for high visual quality, what makes landscapes interesting and beautiful, are still missing. Some of the coarseness of data resolution could be resolved by digitizing and patching in the highway corridor engineering data, but this would only affect the topographic theme. The vegetation and land cover would also need to be further refined. While doable, this may not be practical and better terrain data is still necessary for mid- and long-views. It seems to be advisable to wait for readily available digital data of finer resolution to restudy the automation of scenic quality assessment.

Along with waiting for better resolution data is the consideration of geospatial clearinghouses. While previously it was said that at least 85 percent of research time
was spent building the database, now at least 85 percent is spent searching for data. Waiting until the smoke clears on geospatial metadata and clearinghouse could prove wise. In the interim, new technologies are evolving. The newer technologies of airborne video mapping hold promise resolving issues of horizontal resolution. What is needed are new techniques to automate video technology. The dynamic nature of nature also needs to be addressed. Plants grow and die and are sometimes swept by fires. How do you factor and manipulate this? When considering the aesthetic effect of color, although large areas of, for example, exposed Sedona red rock can be modeled on a cellular level using neighborhood functions with the adjacency of the different hues and shades of vegetation types taken into account, how do you model a single tree silhouetted against a contrasting background? The solution may be a combination of typical horizontal mapping with vertical video mapping using the viewer's plane of projection. This dual sideward mapping and downward mapping may contain necessary information for automated scenic assessment. Another area of evolving technology is the software realm of artificial intelligence. Neural nets, genetic algorithms and intelligent agents show much promise and could be incorporated into GIS. As GIS technology becomes more accessible and appears on the desktop, it is reasonable to believe that the rate of innovation will increase. Lower cost systems will invite a larger and broader user base to develop a variety of GIS solutions.

While researchers may decide to wait until better data is available, made possible by the demands of multiple users and applications, there is one area of information that is used almost exclusively by the sectors involved in the assessment and
management of visual resources. The utility of landscape perceptual data lies mainly in the province of such agencies as the BLM, the Forest Service, the National Park Service, and ADOT. However, the federal agencies mentioned, as discussed above, focus on specific types of landscapes and have consequently developed type-specific assessment models. State highways cross these distinct landscapes. ADOT, through PHRSAC, then, needs to be able to assess all types. The state agency also has the added benefit of greater flexibility in administering programs and policies. This may put it in a viable position of interagency leadership in visual resource information management. There is a need to compile knowledge on various visual resource data, projects and procedures. There is a need to get geospatial databases built to suitable specifications. There is a need to develop the geospatial theme of landscape perceptions, in all its permutations and through time. There is a need to design and administer a clearinghouse for these data. It may be that ADOT is in the best position to lead these efforts.

Whether we are aware of this or not, we see the world through models, both conscious and unconscious, working in an interactive fashion, each dreaming each other on, each, like a two-faced Janus, blind to the other’s perspective (Figure 44). We need to encourage communication between these diverse views. We need to become conscious of how we evoke and provoke our realities.

Figure 44. Two-faced Janus
After Gayley, 1939
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