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Theory and language in landscape analysis, planning, and evaluation

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Abstract

A soft paradigm for landscape analysis is presented. This paradigm focuses on the analysis of function first, and then on structure. The objective is to determine which factors are operationally significant, how these factors bring about change, and how they define the spatial characteristics of landscapes.

Landscape ecology has two central themes which give it meaning, purpose, and unity as a field of study. The first theme emphasizes the need to accommodate living things and their environments (Maguire 1978). Closely tied to this is the second, which is a desire to maintain or create a sense of place, orientation, and order with respect to the users of those environments (Eliade 1961; Dubos 1970; Seddon 1972, 1979; Tuan 1974; Lynch 1960, 1976). These two themes demand our understanding of how these environments came to be, how they currently exist, and how they will change in the future. This understanding seeks to clarify their meaning through the analysis of their function and form. This analysis is dependent on a spectrum of knowledge and creativity which supercedes disciplines and requires a method of expressing, in a consistent pattern, the meaning of that knowledge.

The field of landscape ecology is one which demands the contributions and interactions of a range of professional disciplines. If we are going to plan and manage the landscape in a thoughtful and creative manner, we must adopt an attitude wherein we identify the environmental issues and through the processes of problem solving, bring to bear the knowledge of those disciplines that can contribute to their resolution (Jantsch 1971). The holocoenotic environment is a theoretical viewpoint in ecology. That same viewpoint needs to be instilled in the intellectual environment of those disciplines contributing to the field of landscape ecology (Naveh and Lieberman 1984). If there is to be a lack of barriers between the various disciplines involved in landscape ecology, then there must be a language and a paradigm which transcends those disciplines. This would allow a common base of communication so that knowledge from numerous disciplines can be used to solve problems in landscape planning and management.

The dark side of paradigms

One of the most serious impediments to the interaction between disciplines is the ‘tacit infrastructure’ each discipline imposes on one of its own (Bohm and Peat 1987). This infrastructure, or paradigm, further restricts the view of the discipline with the consequent effect of narrowing its verbal, mathematical, and visual language, theory, and knowledge (Adams 1974). 'A paradigm is not simply a particular scientific theory but a whole way of working, thinking, communicating, and perceiving with the mind. It is based largely on the skills and ideas that are tacitly transmitted during what could be called a scientist's apprenticeship' (Bohm and Peat 1987, p. 52). The presumption is that if an answer exists, it exists within the paradigm; if the answer cannot be identified within that structure, then it does not exist in that discipline's theory, language, knowledge, and values. Such an attitude can cause serious setbacks in both theory and practice (Bohm and Peat 1987; Naveh and Lieberman 1984).

As specialization increases, the highly individualized paradigm of a discipline becomes more restricted and less interactive with ideas in other fields. Paradigms clearly involve the process of taking ideas and concepts for granted without realizing that this is in fact occurring. The paradigm tends to interfere with the exchange of ideas that is essential to both critical thinking and creativity. It is not that a paradigm is in and of itself inherently damaging to the development of ideas in the discipline. What is being suggested, however, is the impact that a paradigm has on many individuals practicing in that discipline.

Professionals involved with landscape ecology are in the process of creating a paradigm for its research, educational, and applied activities. It is essential that the formation of a paradigm in landscape ecology expands the boundaries of those tacit infrastructures of associated disciplines in order to maximize the opportunity for communication and critical thinking between them. Perhaps those individuals who are concerned with landscape ecology could agree upon a landscape ecology 'universe of discourse'. This would provide a neutral environment for critical thinking and creativity to take place. This view would help us to supercede the common assumption that it is only knowledge and facts in the discipline which gives us our legitimacy (and security). 'Knowledge is necessary but not sufficient for successful thinking' (Yinger 1980, p. 17). Knowledge should be associated more with growth than a data bank, for it is in a continual process of change. 'When serious contradictions in knowledge are encountered, it is necessary to return to creative perception and free play (exchange of ideas), which act to transform existing knowledge. Knowledge apart from this cycle of activity has no meaning' (Bohm and Peat 1987, p. 56). As knowledge changes, one must also change the skills and strategies for manipulating and processing that information (Yinger 1980).

The goal of landscape ecology is to understand the landscape in order to treat it in a thoughtful and creative manner by evaluating plans concerning its use, non-use, or reuse. Our perception of landscape issues is clearly tied to the cognitive structures of our various disciplines with respect to their theory, language, knowledge, and values. 'Not until the basic cognitive scaffolding is set up does information begin to make sense' (Yinger 1980, p. 18). Consequently, a paradigm is necessary in landscape ecology for the purposes of manipulating and processing information. Language is essential to the development of that paradigm.

A 'soft' paradigm for landscape analysis

Landscape analysis, as an activity, has benefited a great deal from the concepts and language developed in ecology (Toth 1968, 1972; Smith 1970; Odum 1971; Billings 1970; Naveh and Lieberman 1984; Forman and Godron 1986). Major portions of this language help to establish the fundamental 'what' and 'why' of landscape analysis, and it is a necessary first step. The second step is to organize the theoretical contributions of the 'what' and 'why' into a network in order to establish, even temporarily, 'how' to go about the task of analysis. The first criterion for that network is that it be replicable regardless of location, content, scale, time, or technology. The network should identify, and at least tentatively locate over time and space, key terms and concepts related to the objectives of the analysis (see Fig. 1). The third step should address three major subject areas with respect to the key terms. They are the ***site,*** the ***program*** or objectives, and the ***context*** of the site. The site is a given parcel of landscape having distinct physical or measured boundaries. Program is a list of things,

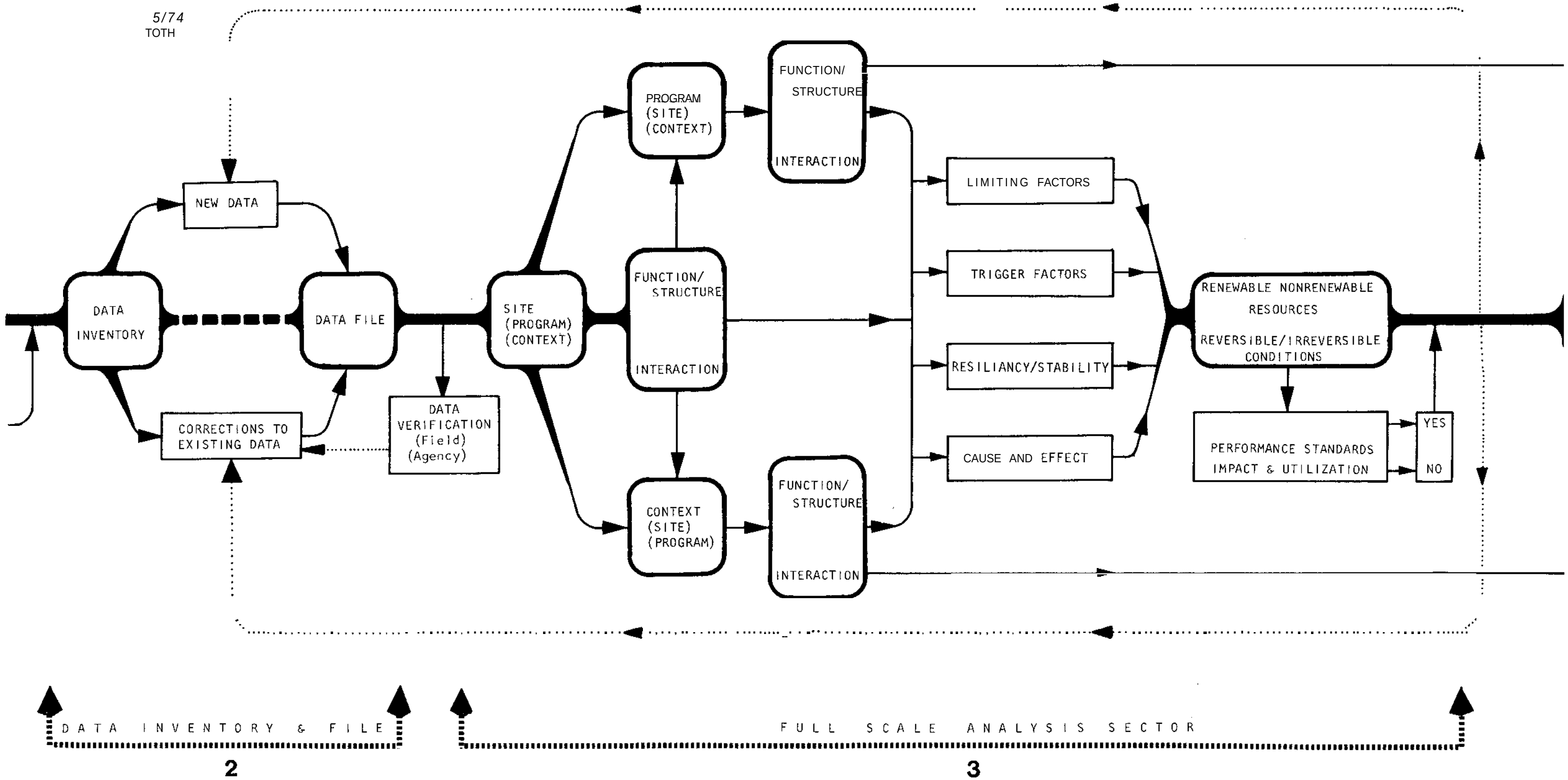

Fig. 1. A net work to analyze function and structure of a landscape.

activities, or objectives to be applied to a site. Context is the setting, before and after action in order to determine its meaning; the background, or environment relevant to some happening. It is the area surrounding the spatial units being analyzed (Toth 1974, 1979). Finally, the analysis should support the central theoretical purpose of landscape ecology: A search for a correlation between form and its meaning in the landscape, or to borrow from Bronowski (1975, p. 13). ‘A search for unity in hidden likenesses’. It is in this broadest sense that our intelligence is used in dynamic and creative acts of perception through the mind. It is the ability ‘to read between the lines’. Intelligence is the mind’s ability to perceive what lies hidden and to uncover, reassemble, and create new unity (Bronowski 1975; Podro 1972; Dubos 1974; Kennedy 1974; Judson 1980; Bohm and Peat 1987).

Analysis is the intellectual wedge used to pry open the landscape in order to understand and define its nature, proportion, function, and the relationship of its parts. Upton and Samson (1961) maintain that there are three broad analytical approaches with which we are all familiar: classification, structure analysis, and operation analysis. Classification deals with the kinds of things: classes, subclasses, specimens, qualities, and vertical/ horizontal sorting. Structure analysis deals with the parts of things but at the same time acknowledges the spatial relationships between the part and the whole. Operation analysis deals with the stages of change in things, wherein we examine a structure changing in time and space for a purpose. The various disciplines associated with landscape ecology vary in their approach and use of these three classifications. It is important to understand their differences, for they form part of that ‘tacit infrastructure’ of each discipline. These approaches condition the way we think about our individual disciplines with respect to their educational and research activities.

A majority of work in the structural analysis of a landscape is usually directed towards three separate analysis maps. The first is an analysis of the various networks formed by an array of linear elements. The second map identifies various shapes, areas, and patterns, which fall outside of or adjacent to the linear network. The third on a two-dimensional surface describes (symbolically) the three-dimensional qualities by the identification of planes and surfaces delineating the volumetric or spatial attributes of the landscape (Lynch 1960; Lewis 1969; March and Steadman 1971; Litton *et al.* 1974). But why limit the analysis to generally three visual descriptions? Most work in this area only delineates what is there as artifact as opposed to a visual spatial description of what is there as form as a result of process, or as an understanding of process. There are a few exceptions over and above classification and structure analysis (Wallace and McHarg 1963; Keene and Strong 1968; Ragan *et al.* 1968).

The analysis of function

The key terms to be applied in analysis have their roots in the broad discipline of ecology and natural sciences. To develop an understanding of any landscape or its individual components, we must address the questions of the *function* of those components. An understanding of the flows and interactions within and between landscape components is central to the mission of landscape analysis (Keene and Strong 1968; Toth 1968, 1972; Forman and Godron 1986). It is essential to know how a component works, and the *interaction* of its parts in the overall system of the landscape. It is from this analysis that we develop an understanding of *cause and effect* relationships within the landscape. How a component or a landscape changes over time *(process)* is the most significant product we can derive from landscape analysis (Toth 1979; Forman and Godron 1986). For it is only from a clear understanding of landscape processes that the synthesis of our work can hold the prospect of making a contribution to a landscape continuum. Process is the degree to which we grasp intellectually the manner in which things change. It is our ability to discern the patterns **of** shifting relationships among the identified elements of a given landscape. And, even though there are shifting relationships and changes occurring within all things, they are, at the moment that we are examining them in time, finite and actual-they exist. Therefore, 'if process be fundamental to actuality, then each ultimate, individual fact must be describable as process' (Whitehead **1968,** p. 88).

The 'operationally significant' elements derived from the analysis should include: **(1)** any factor which limits the growth or reproduction of an individual or community, *e.g.*, a *limiting factor*, as well as the identification of, (2) any changed or new factor that would set off a chain of events in an environment or ecosystem, *e.g.*, a *triggerfactor* (Billings **1970),** and **(3)** documentation with respect to a landscape component's *stability/resiliency* (Holling and Goldberg **1971;** Forman and Godron **1986).** In conjunction with these key terms, the landscape analysis should be directed by the 'emerging general principles' in landscape ecology in order to make as clear as possible the flows and interactions within ecosystems (Forman and Godron **1986).**

The key terms noted above may be applied to the functional analysis of any landscape issue regardless of location, content, scale, time, or technology. They represent a common ground giving direction and substance to our research. **A** common ground of key terms in the structural analysis of the landscape should also be a goal in our 'soft' paradigm. If we allow descriptive terms (districts, patches, corridors, etc.) to direct what we see then our vision, and paradigm, will become short-sighted and in some situations blind.

The analysis of structure

The second major area of analysis in landscape ecology is to address the issue of both the horizontal and vertical structure of the landscape. **As** mentioned earlier, the visual and spatial qualities of the landscape are important to the analysis and synthesis of both natural and built environments in that they contribute to a sense of place, orientation, and order for the users of those environments. Consequently, the development of landscape ecology with respect to landscape form must likewise trenscend the theory and language of the various disciplines in order to achieve its objectives.

When we analyze a landscape, we need to abstract and isolate various landscape components, 'indeed the study of any field begins with a natural act of abstraction in order to focus on certain features of interest. To be able to give attention to something it is first necessary to abstract or isolate its main features from all the infinite fluctuating complexity of its background. When such an act of perceptive abstraction is free from an excessive mechanical rigidity, then it does not lead to fragmentation, but rather it reflects the ever-changing relationship of the object to its background' (Bohm and Peat **1987,** p. **16)** (see also Billings **1970).**

Since landscape ecology focuses primarily on the horizontal attributes, and the relationship among spatial units (Forman and Godron **1986),** it should be clear that from the standpoint of visual phenomena, the field is dealing with a concept in visual perception known as figure/ground relationships (Gibson **1974;** Vernon **1963;** Arnheim **1974;** Kennedy **1974).** Briefly, this is the relationship of the object (figure) perceived to the area (ground) surrounding it. Further, this concept deals with the 'actual boundaries' (shape) of the spatial objects in relationship to the 'structural skeleton' (line) of those objects (Arnheim **1974).** This gives additional description to the form of the object with respect to its background.

It is the intent of landscape ecology to examine these figure/ground relationships with respect to both their ecological interactions and their spatial attributes. The complexity of this task should not be perceived to be burdensome since it is not the aim of landscape ecology to make long lists of possible factors but rather to focus on more significant objectives: **(1)** to discover, by way of analysis, which factors are 'operationally significant'; (2) to determine how these factors bring about changes in the landscape (Odum 1971), and **(3)** to describe how these factors define the spatial (form) characteristics of a landscape.

The basic elements of visual perception, both two-dimensionally and three-dimensionally, which allow us to differentiate between figure and ground, are well-documented by a wide range of individuals even though our perception of our visual world is further complicated by the differences between what we see and how our mind processes that visual information (Gibson **1974;** Vernon **1963;** Klee **1964;** Gombrich ***et al.*** **1973;** Kennedy **1974).** However, there appears to be a consensus on both the elements and the language which represent our visual experiences. Point, line, area, and plane are the ***basic visual elements*** which allow us to perceive, analyze, and describe our visual world. The continued processing of these elements by our mind into shapes, occluding edges and surfaces, superposition, and size form the more complex, three-dimensional features of our visual environment such as volume, mass, and space (Gibson **1974;** Arnheim **1974;** Kennedy **1974).** There are a number of secondary visual phenomena which enrich and make more clear the mind's interpretation of what is seen; texture, color, relief, and values (shading) all add information to these basic visual elements.

What is significant about the basic visual elements is that they are fundamentally value free: they have not been converted to descriptive nouns or adjectives, which can potentially modify both their perception and their interpretation. In delineating the forms and patterns of the landscape, it is more accurate to utilize the basic visual elements to describe what we see, as opposed to using a limited set of symbols which represent a preconceived idea of how the landscape should appear. 'The danger in this (a preconceived view) is that these convention bound mappings may cease to fit the facts; or at least they may fail to recognize emergent patterns. Our argument is that a new pattern will be recognized only by an observer who has available, or develops, an appropriate range of mental sets, abstract or otherwise, upon which to map the data, and who actively seeks not to corroborate the habitual (tacit infrastructure) but to conjecture potentiality' (March and Steadman **1971,** p. **30)** (see also Podro **1972).**

It should be clear that if the analysis of the landscape, both visually and spatially, is to achieve some degree of compatibility between the associated disciplines, the language must be clear and precise in order to facilitate communications. Additionally, professionals concerned with landscape ecology are advocating the need for a significant leap to incorporate operation analysis into the visual and spatial description of the landscape. Consequently, a more rigorous and lucid approach is needed to illuminate those hidden likenesses which demonstrate the relationships between existing and changing landscape form (Pile **1979;** Kepes **1965;** Judson **1980).**

If our activities related to delineating landscape form are tied first to a descriptive language denoting landscape elements as opposed to a structural language of landscape elements, we are limiting our potential to discover meaningful spatial and structural relationships within and/or between the various functional relationships identified. We are in a sense drawing a circle around our creative opportunities within the field of landscape planning and management.

A simple and direct approach to this problem would be to delineate two categories: first, the ***structural elements,*** and second, the ***descriptive elements.*** The structural elements may be presented in their order of contributing to visual pattern and form. The ***point*** represents those rare, unique, unusual, and spatially isolated elements in the landscape. ***Line*** (linear) elements display the network in a landscape which may contain, link, divide, block, or transport other landscape elements. ***Area*** constitutes any surface which is bounded by line and represents activity zones, districts, patches, etc. ***Nodes*** are points of concentration, intersection, or the contact points between areas. ***Edges*** are simply the borders of margins, where something begins or ends or where a transition takes place between two areas. These five structural elements represent the basic visual constructs of any figure description related to figure/ground relationships in landscape ecology. ***Matrix*** may be described as a sixth element within which the figure exists spatially and functionally; ***e.g.,*** the background (Lynch **1960;** Lewis **1964;** Toth **1968;** March and Steadman **1971;** Litton ***et al.*** **1974;** Forman and Godron **1986).**

The descriptive elements are virtually infinite with respect to language. There is, however, sufficient evidence from previous work that there is a basic descriptive language, which is being utilized in landscape ecology. The ***scale, size,*** and ***shape*** of structural elements are important to define and delineate. Their ***surface attributes*** of texture, value, relief, and color also require definition. The *con-*

Goals:

1. A paradigm which: is independent of location, content, scale, time, and technology
   exhibits a network of key terms and concepts
   takes into account the site, program, and context
   integrates classification, structure, and operation analysis
   promotes a "universe of discourse'

Objectives:

1. To maintain a wholistic view with respect to the accommodation of l i n g things and their environments.
2. To maintain or create a sense of place, orientation, and order for the users of those environments.
3. To discover through analysis how things change (process) by addressing: what was, what is, and what may be.

SUBJECT FRAME
(Environmental Components)
Natural 8 Cultural

'Operationally Significant'
Limiting Factors
Trigger Factors
Stability/Resiliency
Renewable/Non-Renewable

FUNCTION (Horizontal and Vertical)

- Flows 8 Systems Dynamics

INTERACTION (Cause and Effect Relationships)

- Component A on Components B, C, & D, etc.
- Component B, C, D. etc., on Component A
- Component(s) A on use
- Use on Component(s) A
- Reversible/Irreversible

EVALUATION (Implementation Criteria Stated)

- Beneficial
- Permutable
  - compatible
  - detrimental
- Terminal

STRUCTURE (Horizontal and Vertical)

Structural Elements

- Point (rare, landmark)
- Line (corridor, path)
- Area (patche, district)
- Plane
- Node
- Edge
- Matrix

Descriptive Elements

- Unique
- Scale (size)
- Shape
- Surface/Relief
- Configuration
  - Implied/Explicit (partial/whole)
  - Straight
  - Curvilinear (concave/convex)
  - Angular
  - Composite
- Pattern
  - Regular (repetitive)
  - Random
  - Clustered
  - Hierarchical (progression)
  - Interdigital (alternating)
  - Sequence
  - Direction
  - Rate/Density

Fig. 2. Summary of the development of the soft paradigm for landscape ecology.

figurations of structural elements with respect to whether or not they are implied or explicit, straight, curvilinear, concave, convex or angular, are necessary features to delineate. The *pattern* of the structural elements within the matrix is extremely important to acknowledge, whether they are regular, random, clustered, interdigital, repetitive, in progression, or alternating in their distribution. Finally, tied to configuration and pattern is the *spatial and temporal* conditions of the structural elements with respect to sequence, direction, rate, and density of their occurrence (Gibson 1974; Lynch 1960, 1976; Appleyard 1965; March and Steadman 1971; Gombrich 1973; Rapoport 1982; Forman and Godron 1986).

Over the last 30 years within the discipline of landscape architecture, there has been an intense interest to focus the objective of landscape analysis on illuminating the correlation between form and its meaning in the landscape. This search has and continues to take place within an interdisciplinary environment. It is a search for the relationships which take place within and between landscape components and how they, in turn, contribute to the overall form of a region. 'We are no longer preoccupied with the mere facts but with the relations which the facts have with one another – with the whole which they form and fill, not with the parts. In place of the arithmetic of nature, we now look for her geometry; the architecture of nature' (Bronowski 1965, p. 56). The theory and language of geometry as an art and a science is clear to each of us, even when we interact in its discussion between disciplines (Fig. 2). The theory and language of the architecture of the landscape demands equal clarity in its fundamentals, if we are to make a contribution to its thoughtful and creative management.

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