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Integration of landscape ecology and landscape architecture: an evolutionary and reciprocal process

Landscape architecture is a professional field that is significantly focused on landscape pattern – the spatial configuration of landscapes at many scales. Landscape architecture is informed by scientific knowledge and aspires to provide aesthetic expressions in landscapes across a range of spatial scales. Landscape ecology has been defined as the study of the effect of landscape pattern on process, in heterogeneous landscapes, across a range of spatial and temporal scales (Turner, 1989). The logical reasons for integrating these two fields are clear and compelling, with a great potential to support sustainable landscapes through ecologically based planning and design.

The integration of landscape ecology and landscape architecture holds great promise as a long-awaited marriage of basic science and its application; of rational and intuitive thinking; of the interaction of landscape pattern and ecological process over varied scales of space and time, with explicit inclusion of the "habitats," activities, and values of humans. To the optimistic, this integration promises to provide a robust and appropriate basis for planning and design of sustainable environments. The focus on application is integral to most definitions of landscape ecology but has been slow to gain complete acceptance, or to demonstrate widespread success in "real world" landscape architectural applications. Unfortunately, the promise of integration remains more of a goal than a reality at this time.

I believe it is instructive to see the integration of landscape ecology and landscape design as an evolutionary, three-stage process (Fig. 30.1). I define key concepts and characterize the three stages including a discussion of the potential benefits and challenges of realizing a full, informed, and reciprocal integration (stage three). In this essay, "landscape architecture" denotes all those activities relating to the planning and design of landscapes, across a range of scales and landscape contexts. I submit that the three stages I describe have evolved uniquely in different parts of the

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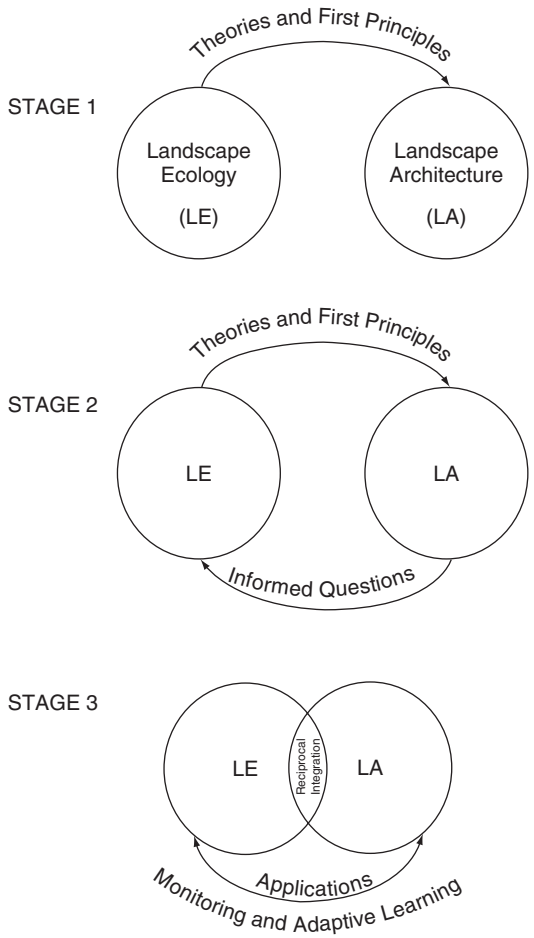

FIGURE 30.1
The three evolutionary stages of integration of landscape ecology and landscape architecture.

world. In Europe, for example, the integration of landscape ecology in landscape design is generally more advanced than in North America (Schreiber, 1990; Forman, 1990).

Stage 1: theory and principles

The first stage of the integration of landscape ecology and landscape design is the articulation of basic theory and first principles – robust statements of knowledge that transcend a particular cultural, temporal, or environmental circumstance. First principles synthesize the knowledge base, frame questions for future research, and build an intellectual basis for application. Defining contributions in this area have been made by Isaak S. Zonneveld, Karl F. Schreiber, Zev Naveh, Michel Godron, and Richard T.T. Forman, among

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others. Monica Turner's seminal paper "Landscape ecology: the effect of pattern on process" (1989) synthesized the discipline's knowledge into a clear and compelling statement which defined, from a scientific perspective, the potential of applications of landscape ecology. Richard Forman (1995) proposed 10 "first principles" that provide insight into landscape pattern or process. These ideas, principles, and theories, among others in the literature, have focused primarily on biological and physical resources and processes; for example, nutrient flow, landscape pattern change in response to disturbance, species response to landscape pattern change, and species movement and survival in heterogeneous landscapes (Hersperger, 1994). As a complement to the physical–biological focus, Nassauer (1995) proposed four "broad cultural principles" for landscape ecology to address culture–landscape interactions in the context of landscape ecology. The addition of these cultural principles to the previous physical and biological "first principles" represents a working theoretical base for an applied landscape ecology.

What distinguishes the landscape ecological principles from other established principles in ecology, cultural geography, and other physical and social sciences is the assertion that they are useful for application or, more specifically, to inform the planning, design and management of landscapes. These landscape ecological principles aim to integrate physical, biological, and cultural knowledge. They identify the potential for future experiments, and suggest a basis for informed application. I argue that these principles represent a sound foundation upon which an intellectual basis for informed application in landscape architecture can be built.

Stage 2: questions and dialogue

In the second stage of the evolution of the integration, planners and designers begin to ask intelligent questions of scientists that arise from their understanding of the landscape ecology theory and principles. The questions concern issues of scale, landscape process(es), disturbance, and human–landscape interactions. The questions include:

- What is the proper spatial scale for understanding ecological patterns and processes?
- How does a particular place constrain an ecological process?
- What timescales are appropriate for planning? For which processes?
- Which species or species groups should be planned for? Can a particular species represent the habitat needs of larger species groups?

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- How should disturbance be understood in landscapes? What are the intensity, duration, and spatial extent of disturbances?

The dialogue has evolved to more specific questions, for example:

- How large a forest patch is required to support a given species, or ecological process?
- What configuration of corridors is needed to sustain species interactions and buffer nutrient flows across a heterogeneous and fragmented landscape?
- How can the benefits and values of "ecological corridors" be tested to determine their value and appropriateness in conservation planning?
- How can landscapes be planned to accommodate specific disturbance regimes?
- What types of monitoring are appropriate to learn if landscape ecological applications achieve their intended results?

In this second stage, landscape architects also began to examine the implications for the new landscape-ecology paradigm on aesthetic expression at the scale of human experience and perception in the landscape. The quest for full integration of ecology and design transcends that of biological, physical, and cultural knowledge and principles. It requires a "consilience" of rational and intuitive thinking (Wilson, 1998). Landscape ecology, as a scientific discipline, is appropriately based on rational and empirical thought and research. Landscape architecture and environmental engineering are engaged in solving problems, mitigating impacts, and accommodating human activities. Landscape architecture, as distinguished from environmental engineering, strives to produce original combinations of science and art that which express cultural meaning and inspire intellectual reflection and aesthetic expression. As the late John Lyle argued, this cannot be achieved solely through rational thought:

> In reality, however, nature is silent, ambivalent, and contradictory. We know now that she will not tell us what to do. In any given situation, any numbers of different plans are possible. The recognition of diverse possibilities is the all-important element missing from the four-step (scientific) paradigm and from so many other efforts to define design process. Recognizing possibilities takes creative thought, and creativity tends to be stifled by a rigid framework of logic. When we stifle creativity, we shut out a great many possibilities, and in a world that so desperately needs better solutions, that is something that we cannot afford to do.
>
> *(Lyle,* 1985*:* 127*)*

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I submit that the second stage of landscape ecology–architecture integration is a self-limiting model. Because it is a one-way flow of knowledge and information, from science to application, it denies the possibility of a reciprocal integration in which new knowledge and modes of thinking can be learned through design and then examined or "applied" in the science of landscape ecology.

Stage 3: reciprocal integration

In the third stage of integration, landscape ecology and landscape design are engaged in a reciprocal integration in which theory, principles, knowledge, and applications flow in both directions: science informs design, and design informs science. Rational and intuitive thinking are integrated. The third stage of integration is more of a challenge than a reality at this point in time, with some notable exceptions (Hulse *et al.*, 2000). I believe it is the stage at which the application of landscape ecology can reach its full potential. I propose five issues and challenges that must be understood and engaged as a prerequisite to realizing a full and reciprocal integration.

The paradox of time

Change and uncertainty are fundamental in natural and cultural systems. In ecology, economics, and in other natural and social sciences, change is understood as a basic process rather than an aberration. Landscapes are not different. Change is also fundamental and uncertainty is a "given." Natural processes occurring in landscapes need time and certainty in some places, yet cultural and economic forces demand flexibility to change in others. This is the paradox of time in landscape planning (Sijmons, 1990). Landscape ecology can help to define or design a durable/sustainable landscape framework that supports the long-term ecological processes (e.g., the "slow turning wheels," groundwater and nutrient flows, species survival and evolution). By implication, the "interstices" within the landscape framework are available to accommodate change, specifically the intensive uses and landscape types (agriculture, urbanization, transportation) that contribute little to or that degrade ecological functions. The contemporary landscape architect is challenged with designing the framework and its interstices to simultaneously sustain long-term ecological processes and accommodate contemporary needs, while also being mindful of cultural needs, values, and aesthetics (Van Buuren and Kerkstra, 1993). The challenge presented by the paradox of time is familiar to designers: to artfully accommodate and balance complementary and competing land uses. The paradox presents challenges that are new to most ecologists: to

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think strategically, to make intelligent compromises, and to understand the place of dynamic land uses within a more stable framework.

The positive potential of landscape change

To resist landscape change unilaterally is like "putting on the brakes" against unstoppable ecological and global economic forces in defense of a historically and continually diminishing "nature." Resisting change is a defensive position that maintains a polarization between the "doers" and the "protectors" and denies opportunities for more creative and proactive solutions, in both landscape planning and design (Vroom, 1997). While many changes are undisputedly negative, an acceptance of the inevitability of change and recognition of its positive potential is essential to achieving a full integration of ecology and design.

The power of spatial concepts

A spatial concept expresses through words and images an understanding of a planning/design issue and the actions considered necessary to address it. Spatial concepts are related to the proactive or anticipatory nature of landscape design, in that they express solutions to bridge the gap between the present and some desired future situation. Spatial concepts are often carefully selected metaphors; for example, "Green Heart" or "Stepping Stones," which communicate the essence of the concept clearly to build consensus for an overarching planning policy and to form a clear basis for more specific design decisions.

Although scientific input from landscape ecology is essential to conceive spatial concepts, its potential is limited. Many scientists are reluctant to make the "leaps of faith" that are essential to conceive spatial concepts. There is an essential element of creativity in the design of spatial concepts. They represent an interface of empirical and intuitive knowledge. Through spatial concepts, rational knowledge is complemented with creative insights. A well-conceived spatial concept represents a powerful tool to guide, inspire, and support landscape design. Figure 30.2 presents an example of several spatial concepts often used in landscape architecture.

Physical expression of landscape processes

The idea of making natural processes visible through design is a common theme in the literature of ecological aesthetics (Olin, 1988). Indeed, the pattern–process dynamic, fundamental to landscape ecology, offers a

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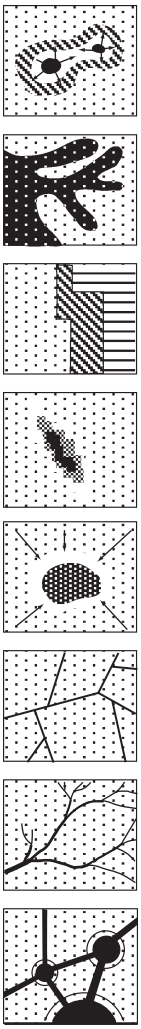

CONTAINMENT
To control the enlargement or expansion of a core resource area, or an area of land use change.
Example: urban greenbelt

INTERDIGITATION
A spatially integrated pattern based on an intrinsic resource distribution pattern.
Example: ridges and valleys

SEGREGATION
A strategic concept to benefit from concentration, or to minimize the impacts of selected land use(s).
Example: framework concept, zoning

CONTROLLED EXPANSION
To direct land use change or expansion in a prefered direction, as along a corridor.
Example: urban highway corridors

PROTECTED CORE
A defensive strategy to maintain a core resource area in a threatening or non-supportive environment.
Example: "the Green Heart," habitat patch

LINEAR NETWORK
A simple system of linkage in which discrete elements can form an integrated system, may be heirarchical.
Example: road network, hedgerows, canals

DENDRITIC HIERARCHICAL NETWORK
A system of linkage, caused by or emulating the most efficient means to accomodate flows or movements.
Example: drainage network

NODE AND CORRIDOR NETWORK
A system of core areas combining the benefits of large core areas with advantages of connectivity.
Example: ecological network

FIGURE 30.2
Spatial concepts for landscape architecture and planning.

compelling challenge to designers to give visible form to landscape function(s). Some notable success has been realized in this area when designers have engaged, for example, the ecology of storm-water hydrology, plant succession, and fire as an ecological disturbance. In this way, people can "see" where the rainwater goes, how a meadow can become a forest, and how a landscape responds to fire. When successful, such designs engage the public, raise awareness and understanding, and contribute to a new aesthetic sensibility. When these expressions remain in the domain of "high art," they have been criticized as being remote from the culture or elitist. I see this as a valid challenge, and one that offers tremendous opportunities for collaboration between scientists and designers.

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The dilemma of uncertainty

As professionals operating in the real world, landscape designers are often confronted with a mandate for action. Projects operate on short-term economic or politically driven goals and objectives. Inevitably, the knowledge on which to base these actions is incomplete and uncertain. The designer can't afford to plan through trial and error, and inaction is, in itself, a management decision with its own negative consequences. Scientists are justifiably uncomfortable making specific recommendations in the face of uncertainty. Adaptive management offers a strategy to address this dilemma. It explicitly acknowledges uncertainty and develops a range of possible actions, conceived as experiments. Hypotheses are formulated and design actions are proposed following accepted principles of experimental design. With an appropriate monitoring protocol, the experiments yield results, which contribute to new knowledge. The objectives, assumptions, decisions, and outcomes are documented so that new knowledge and understanding are gained through the process of application (Peck, 1998).

Conclusion

I have attempted to articulate three stages of integration of landscape ecology and landscape design, each characterized by specific activities and issues. The final stage, which may be elusive, promises a full reciprocal integration with a two-way flow of information and knowledge. It would be descriptive and prescriptive. Through empirical research, designs would be more informed of their ecological consequences, and through monitoring, implemented plans and designs would yield new empirical knowledge for ecology. The challenges to achieve such an integration have proven to be significant in terms of the modest successes to date in applied landscape ecology. The reward and motivation for a successful integration should be progress toward sustainability – hopefully a sufficiently noble goal to motivate ecologists and designers to seek deeper integration.

References

Forman, R. T. T. (1990). The beginnings of landscape ecology in America. In *Changing Landscapes: an Ecological Perspective*, ed. I. S. Zonneveld and R. T. T. Forman. New York, NY: Springer, pp. 35–41.

Forman, R. T. T. (1995). *Land Mosaics: the Ecology of Landscapes and Regions*. Cambridge: Cambridge University Press.

Hersperger, A. M. (1994). Landscape ecology and its potential application to planning. *Journal of Planning Literature*, 9, 14–29.

Hulse, D., Eilers, J., Freemark, K., Hummon, C., and White, D. (2000). Planning alternative future landscapes in Oregon: evaluating effects on water quality and biodiversity. *Landscape Journal*, 19, 1–19.

//INTEGRAS/TEMPLATES///INTEGRAS/CUP/3-PAGINATION/IPL/2-FIRST_PROOF/3B2/0521830532C30.3D – 311 – [311–319/9] 20.11.2004 9:15PM

Lyle, J. T. (1985). *Design for Human Ecosystems*. New York, NY: Van Nostrand Reinhold.

Nassauer, J. I. (1995). Culture and changing landscape structure. *Landscape Ecology*, 10, 229–237.

Olin, L. (1988). Form, meaning, and expression in landscape architecture. *Landscape Journal*, 7, 149–168.

Peck, S. (1998). *Planning for Biodiversity: Issues and Examples*. Washington, DC: Island Press.

Schreiber, K.-F. (1990). The history of landscape ecology in Europe. In *Changing Landscapes: an Ecological Perspective*, ed. I. S. Zonneveld and R. T. T. Forman. New York, NY: Springer, pp. 21–33.

Sijmons, D. (1990). Regional planning as a strategy. *Landscape and Urban Planning*, 18, 265–273.

Turner, M. G. (1989). Landscape ecology: the effect of pattern on process. *Annual Review of Ecology and Systematics*, 20, 171–97.

Van Buuren, M. and Kerkstra, K. (1993). The framework concept and the hydrological landscape structure: a new perspective in the design of multifunctional landscapes. In *Landscape Ecology of a Stressed Environment*, ed. C. C. Vos and P. Opdam. London: Chapman and Hall, pp. 219–243.

Vroom, M. J. (1997). Images of ideal landscape and the consequences for design and planning. In *Ecological Design and Planning*, ed. G. F. Thompson and F. R. Steiner. New York, NY: Wiley, pp. 293–320.

Wilson. E. O. (1998) *Consilience: the Unity of Knowledge*. New York, NY: Knopf.