



well for the investigation of very elementary and ancient objects in the world, but which was increasingly distorting when it came to biological and cultural entities. Science has, as we have seen, moved on from this initial prejudice; but the damage has been done. It is still intellectually respectable to deny any or all of the values of one's own culture, of civilization, of the human race itself.

In the absence of an objective way of determining value, we were left with four alternatives: to make value purely subjective, to determine it by money and votes, to make it identical with coercive political power (Foucauldian discourse analysis), or to deny its existence altogether (Deconstruction). All of these solutions consist in giving the local primacy over the global, or abolishing the global altogether. It is the various combinations and conflicts of these alternatives that have made up the texture of public life in the last half-century. But I believe this period is now coming to an end, and that we may have a chance to redeem the destruction of an old and productive, if flawed, value-system, by the introduction of a new one that has corrected the errors of its predecessor and learnt from the atrocities of the interregnum. If all the human cultures and ethnic groups are provided with a shared universal history, perhaps the old ideal of human brotherhood and sisterhood will take renewed hold in our imaginations.

At the core of the new value-system that is emerging is beauty. The capacity which our extraordinary self-evolution as a species sharpened, accelerated and deepened was the ability to recognize and join in the creation of beauty. Beauty is the creative principle of the universe, the feedback process that generates an ordered world with a

chaotic boundary in time. That boundary is the present moment, the culmination of the past and the source of the future; as it expands it generates broader and broader degrees of freedom, freedoms only possible and only articulable in terms of the greater intricacy of the new forms of order that are generated there. Its expansion is made possible through the existence of contradictions or paradoxes within it, and our human experience of these is of shame, tragedy, and death.

When we perceive this process at work in nature we are rewarded for the insight by the pleasure of beauty, and can harmonize ourselves with it and join it in creative activity, using our ancient artforms as the link between the constructive energies of nature and our own more reflexive and swifter forms of creative feedback. The complex, self-similar, fractal, paisleylike and organic forms, the complex melodies, that we find immediately attractive, are a sort of logo or epitome of the deeper and stranger, more multileveled and heterarchical systems which they

foreshadow and subtend.

The branchiness and inner articulation that such forms possess is a sign of the branchiness of the free processes that brought them about and the historical reflexivity that they embody. We see them everywhere in nature, in the whorls of galaxies, in the exquisite forms of crystals, in water-currents and sea-foam, in tree-branches and ferns and flowers, in the movements and ornamentation of animals, in Maori tattoos and Haida totem-poles and Hokusai clouds and the narrative structure of Don Quixote; in Claude Lorrain's arcadian landscapes and the musical organization of Mozart's Magic Flute and the fantastic hierarchy of the laws of science. Most beautiful of all, perhaps, is the brain-process of a human being that can experience these things.

If beauty is as it is described here, it must also be, as Keats said, the fundamental source and hallmark of truth. If truth is conformity to fact, and fact is the product of a feedback process which we intuitively perceive as beauty, then beauty is the way we



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perceive and intuit truth.

This formulation is nicely confirmed by the history of science: it is quite clear that of the infinite number of hypotheses that will coherently explain a given body of observational and experimental evidence, scientists instinctively choose the one which they find most beautiful or elegant. The power, economy, generality, richness, productiveness, and challenge that scientists admire in a theory are exactly the characteristics we have already demonstrated in the product and process of the universe's evolutionary feedback system: hierarchy, open-endedness, branchiness, self-similarity, reflexivity, mutual actualization and interdependence, fertile paradox, and so on.

The general structure of the hierarchy of the universe is now clear, and the great epoch of academic specialization and value-free experiment that revealed it might well be expected to be coming to an end. But something very peculiar happened to the academy. Even as the essential unity of the

world was being revealed, the academy increasingly divided itself into smaller and smaller microfields and microdisciplines. One reason for this is that the sociology of scientific investigation has demanded an essentially democratic and antiauthoritarian context, and thus the hierarchical form of the organization of the universe has had to be denied lest the cognitive dissonance with the spirit of inquiry paralyze the research effort. Our political philosophy has not been sophisticated enough to reconcile a hierarchical universe with a democratic society.

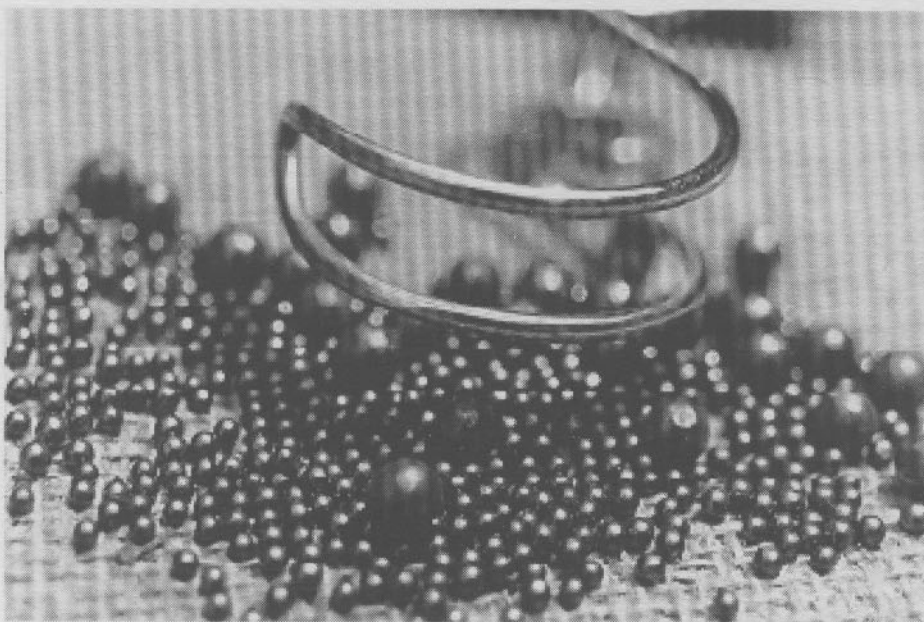
Another reason for academic specialization is human limitations; nobody is capable of absorbing the whole content of human thought. But the error of the academy has been to deny, by means of its metaphors of demarcation between fields, the intimate connections, the continuous and omnipresent relevance of other fields at every stage of investigation. After all, the metaphorical implication of the phrase *another field* —not my area, as academics say— is that the other field is over

there, not right under one's feet.

It would have been wiser—but there was no way of acquiring this wisdom except by going through the mistake—to describe the work of other scientists and scholars as being inside or containing one's own work, or as being above or below it. We would thus acknowledge the commonality of the world we study, and the uncomfortable fact that, for instance, the arts and humanities are a more advanced, but less basic, area of study than physics. To put this in an even more radical way: the arts and humanities are higher physics.

The present model of the academy, implicit in the metaphor of the academic field or area, is of a vast flat plain stretching in all directions and divided by departmental fences into disciplines, each with its own rules, language, and canons of proof. If, on the other hand, the universe itself is much more like a pyramid, then the academy is running the grave risk of falsifying the universe by its model. After all, the most insidious kind of misinformation is the kind that is not explicit but conveyed by the very form of the inquiry. So it is essential that we change our basic metaphor.

Such a change of metaphor is not conceptually impossible. One way of thinking about the structure of the new academy is in terms of one's own body. We do not need to know in detail how the minute chemical servo-mechanisms of the muscles operate in order to move our arms, or how the visual cortex performs its staggering miracle of constructing a coherent visual world out of the buzzing, booming confusion that hits the retina. But we do need to learn, as babies, how to operate the general controls that make it all work. Likewise, a detailed knowledge of the fields that underlie one's own discipline is not necessary,



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as long as we are able to understand their major principles and laws, their most powerful theoretical generalizations, and as long as we know where to look and what to use in order to retrieve more precise information as that becomes necessary.

So we need to teach our students in a *top-down* fashion how the grand principles work; and perhaps we should be prepared to abandon, sometimes, the minute processes of research by which we discovered those principles, at least until the student's general understanding is strong enough for him or her to ask intelligent questions. If the big principles really are as good as we believe, they will imply the minutiae of experimental and mathematical procedure, much as a motor command implies its implementation by the nervous system and muscles. If a student has a sound understanding of the principles of evolution, the beauty of the idea will encourage enough observation of nature to suggest how it was originally proved.

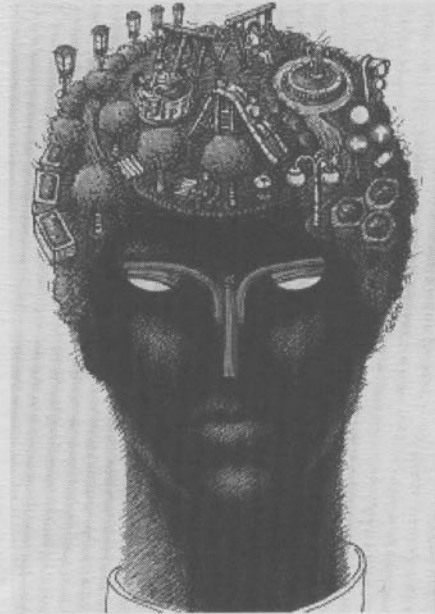
At this point an important distinction must be made. I am not advocating courses in research methods as such —*teaching students how to learn*, as it is often termed. The brain is hungry not for method but for content, especially content which contains generalizations that are powerful, precise, and explicit. Our memories are addressed and referenced not by an abstract methodological grid but by significant fragments of their own content. Thus our core courses should deal first with the why of the world, not the how of research, because the how of research is generated by the why of the world.

This may all sound harmless enough; but beware. What I am suggesting is that we reverse our ordinary procedure of teaching—

method first and conclusions afterward. Instead we must teach the conclusions first. When Bacon inaugurated the scientific project, it was indeed necessary to discard all of the classical conclusions about why the world worked the way it did, for they were not true in practice. Thus it was necessary to start off with method, and make that method as sure as possible in its exclusion of error. But we have been at this work for four hundred years, and the principles we have discovered work when we design an automobile, a telephone, a new strain of wheat. And those principles are more or less consistent with one another, and together can often act as a check on or confirmation of speculation based on one of them alone. Only when paradoxes arise do we need to go back to the old skeptical method.

And if a piece of the information hierarchy is missing —say, a body of data about turbulence and laminar flow— we will simply be prompted to go out and collect it. (I choose this example because I believe that, in this case, that is exactly what happened.) The point is that if the pyramid of information did not exist, but rather information was just spread out as far as it would go, as in the *academic field* model, there would be nothing to tell us when information was missing. The recent explosion of work in folklore and the oral tradition has a similar origin, I believe: because anthropology had been brought close enough to the humanities to be seen in some way to underpin them, we suddenly noticed how little information we had to make the connection, and set out to obtain it. And we found to our surprise that very rich sources lay right under our noses.

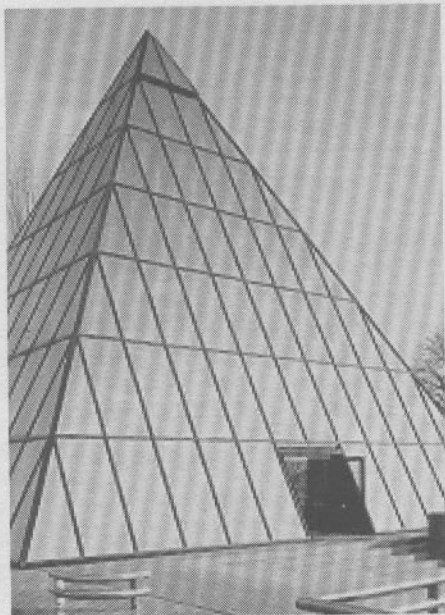
For those at home in the new great chain of being, nothing human is alien; indeed, nothing is alien.



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To say this is to predict the end of a whole cast of academic thought, that Brahmin prejudice which once wrote off other cultures as savage, and which now writes off our technological shopping-mall culture as barbarian or worse. The true pyramid dweller does not deplore pop culture. He or she sees it as the raw material of great art. Technology is one of the performing arts by which new realities come into being. And it needs scriptwriters, composers, choreographers.

The pyramid of knowledge is not a static or fixed one. It is continuously growing. And its growth is at all levels, the low as well as the high, the high as well as the low. This picture of things is not reductionist. Though by evolution the low can give rise to the high, the simple to the complex, the relatively determined to the relatively free, nevertheless the high, the complex, and the free, once they exist, can take control of those levels of existence that preceded them. This is a model in which we do not evaluate a descendant or an effect by reference



of ritual and dramatic performance—let us teach them all at once, not as composite lumps of evidence but as the natural modes of human action and perception. Our students should feel the fire packed into the atom, the inertia of the thrown stone, the stream eroding the valley, the field of flowers genetically drifting with a little assist from herbivores and climatic change, the sense of social attunement and insight brought about by ritual chant or dramatic performance. They should see the earth's spin toward sunlight, not the sun rising. Science teachers ought to be poets; it goes without saying that poets have to be scientists.

I am not suggesting that we can give up the painstaking process of careful experiment in scientific research. The obsessed and dedicated experimentalist will always be necessary. The point I am making is that there is now not only a process and method of science but also an achieved and powerful content—a content which must be grasped in principle by most citizens if we are to survive, and to survive as a democratic society.

What Prospero, in Shakespeare's *Tempest*, meant by Art—the unity of science, art, technology, moral choice, magic, craft, and delightful stage illusion—is increasingly feasible. A person educated in this way would be in a position to recover that sacramental sense of unity and meaning of the world which was lost when we took the great detour into academic specialization, and which utopians have since sought to impose, unsuccessfully and often bloodily, by political or economic force. Such a person would not be overwhelmed or paralyzed by the complexity of modern life, any more than we are overwhelmed by the complexity of our own nervous, motor, and sensory systems. We are plugged into our

nervous system in such a way that we sit at the top of a long chain of delegated responsibility. We are at the console of the ultimate user-friendly computer, insulated from the literalism of the machine language by a hierarchy of richer and more powerful special languages designed for easy use and referenced by the most simple mental “mouse”—the transfer of attention.

Notice that in this speculative meditation on the educational system of the future the distinction between knowing and doing—between the sensory and the motor capacities—has been blurred. For information, once it is organized in the new great chain of being advocated here, will become instrumental and dynamic, pointing not only to other information but to action suggested by the value system implicit in its hierarchical organization. Performance, including technological invention and artistic creation, will become central to education at all levels.

Our educational system has had a dangerous predilection for reductionism—an addiction to the primary, the elementary. If, in love with the exactness of those entities that can exist at a primitive level, we dismiss as unreal anything that requires a more sophisticated temporal environment—values, for instance, or individuality, or freedom—we are seeking to turn back the evolution of the universe. We democratize the universe, so to speak, and thus reduce it to easy comprehensibility, avoiding the whole exhausting business of making value judgments by denying their value altogether. The new model, on the other hand, automatically provides the universe with distinctions of value. The evolutionarily later always subsumes and includes the evolutionarily earlier; and therefore, given any measure of value, the more

to its parent or cause; rather, we evaluate the cause or parent by its fruits and progeny. By their fruits ye shall know them; and it is not that which goeth into a man that defileth him, but that which cometh out of him.

If my body is healthy, I can use it without thinking about individual muscles; only if I am building a new skill—a new control system—or rebuilding a damaged one should I think about the details of bodily motion. Indeed, an athlete must learn to forget the details of his or her training to achieve the instinctive sense of flow that characterizes a champion. Knowledge of scientific principles is like the possession of a motor skill. Because we have those beautiful, powerful, hard-won principles, or control algorithms—the inverse square law of gravitation; $E = mc^2$; the laws of chemical combination; the interplay of selection, mutation, and recombination in evolution; the relationship between brain chemistry and behavior; the three-second line in human poetry; the tripartite structure



advanced is going to possess more of it than the more primitive.

And it is precisely values that our educational system lacks. The work of the new academy will be to get those sweet and potent brain chemicals flowing, those endorphins which are apparently associated with our enjoyment of the higher intellectual, moral, and aesthetic values. Only in an academy that makes clear the relative importance of things can such a priming of the pump of self-reward be coherently undertaken. And it is not just the higher values that will benefit from such teaching. The lower values have their rightful and honored place in such a hierarchy. In the value-flat model, there are no values at all, because there are no distinctions of values.

This is a call for a change in the fundamental paradigms of study, and in the nature and function of the academy itself—a change as great, perhaps, as that which marked the end of medieval scholasticism and the beginning of the Renaissance

humanist university. We have in our own time a project that requires a full mutual engagement of all fields of study, physics as well as poetry, and the hint of a warrant for its success. And if not now, when?

III. Saving the Ecosystem

At first it looks like a big untidy field—tall grass infested with weeds. But then, looking a little longer and a little more carefully, the eye reorders it. There is an unfamiliar, breathtaking pale-yellowish jade freshness in the green, a preciseness and laciness in the texture that remind you of the wildflowers of rocky seacoasts or alpine meadows. Then you realize that all those plants are supposed to be there, and if you know the species you recognize the towering bluestem and indiangrass in the damper hollows, the twisted awns of the drier stipa, the feathery offset florets of the sideoats grama, the brilliant emerald clumps of hair-leaved dropseed.

Then there are the forbs, the broadleaved plants. Some are giants: the compassplant, with its leathery handlike leaves, turned edge-on to the sun at its height to conserve moisture; the blanched ultraviolet flowers of the downy phlox; the black-eyed susan, the hoary puccoon and the coneflower; and below, the cold green shields of the prairie dock, the exquisite turk's head lily, the leadplant thought by early miners to indicate the presence of ore, the wild indigo, the tiny lobelia, the purple and white prairie clovers; and look, a mottled white-violet-chocolate prairie orchid.

On the drier slopes that heave up sunlit into a sky darkening toward a squall, you can see wild roses, sage,



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horsetails, euphorbias; and there are seedlings from the nearby grove of savanna oaks that will, if a prairie fire does not kill them, transform these grassy hills after a few decades into a shadowy forest. A yellow butterfly staggers against the clouds; deer turn and move away into the trees.

This is a prairie, then; no doubt about it. You breathe that American sigh of relief that says you have made a clean getaway, found a place to settle, build a rancho, light a fire, raise some kids. Back to nature; at home on the range.

But again things are not always as they seem. This is Greene Prairie, planted forty years ago by the ecological restorationist Henry Greene on forty acres of degraded Wisconsin farmland, as part of the University of Wisconsin's arboretum at Madison. Almost every prairie plant here is descended from seeds or whole specimens found in old cemeteries, along railroad right of way, or other unfarmed scraps of land.



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How does one plant a prairie? First the existing vegetation —mostly European grasses or pantropic weeds— must be burnt off. Bulldozers dig ponds to allow alien material to settle out. The height of the water table is taken into account. Sweating gangs of young men and women in dungarees harvest the wild seeds or dig up clumps of virgin sod. A prairie contains over two hundred species of plants alone, not counting the bacteria, the mycorrhizal fungi in the rootweb, the insects, animals, and birds. The land is planted; then the real hard work, the weeding, begins. The volunteers must be drilled meticulously on the differences between native and alien species; the whole affair resembles a ritual, complete with ecologist-shamans, adepts, novices, ordeals, and mystical instruction. This procedure engenders an extraordinary familiarity with the land. I have seen Keith Wendt, an ecologist who had worked at the arboretum but had been away from it for several years, walk straight across the prairie to a single tiny flower that he wanted to point out to me. It was a

very rare species, and he knew exactly where it was.

After a few seasons of back-breaking work the prairie is established and, as if it were a single organism, it begins to police and nourish itself. Much has been written on the marvelous interdependence of species in the wild; the most recent thinking treats such ecological systems as if they were indeed single entities, with different organs for different functions. The Gaia Hypothesis, advanced by the visionary British ecologist James Lovelock, proposes that the planet itself is such an organism, a living unity in the wastes of space. In the prairie the fine network of mycorrhizal fungi which flourishes below the soil surface acts as a primitive nervous system, linking the plants and regulating the flow of nutrients. The actual soil of a healthy prairie is paradoxically very poor, because almost all the nutrients are in circulation in the living biomass. To make a prairie fertile, you must kill it.

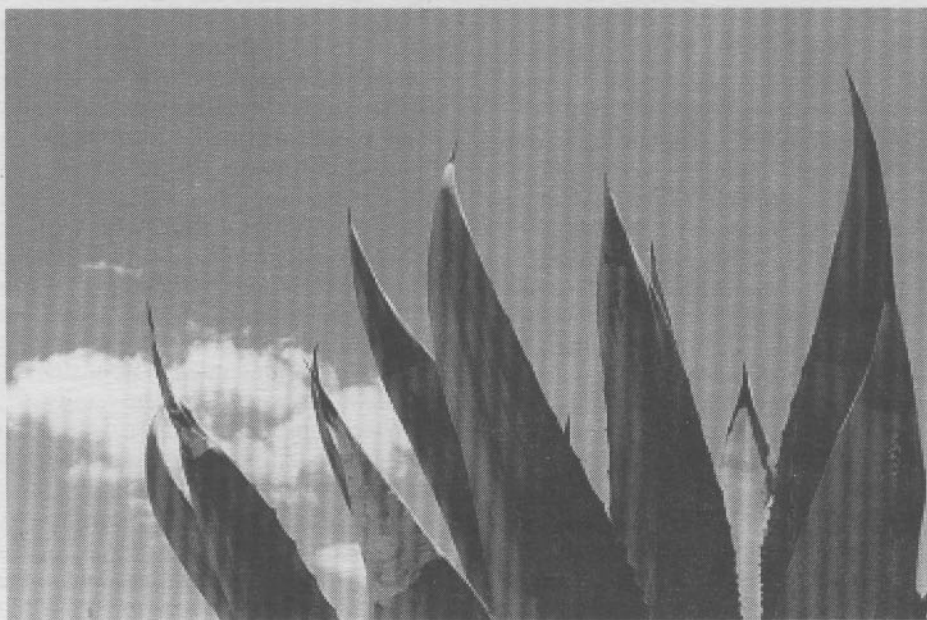
When one has planted one's prairie, what exactly has one got?

I have been seeking for an American garden, a new tradition that would bridge the deep and damaging gap in the American imagination between nature and humanity, the protected wilderness area and the exploited landscape. I believe that I have found it in the work of the ecological restorationists.

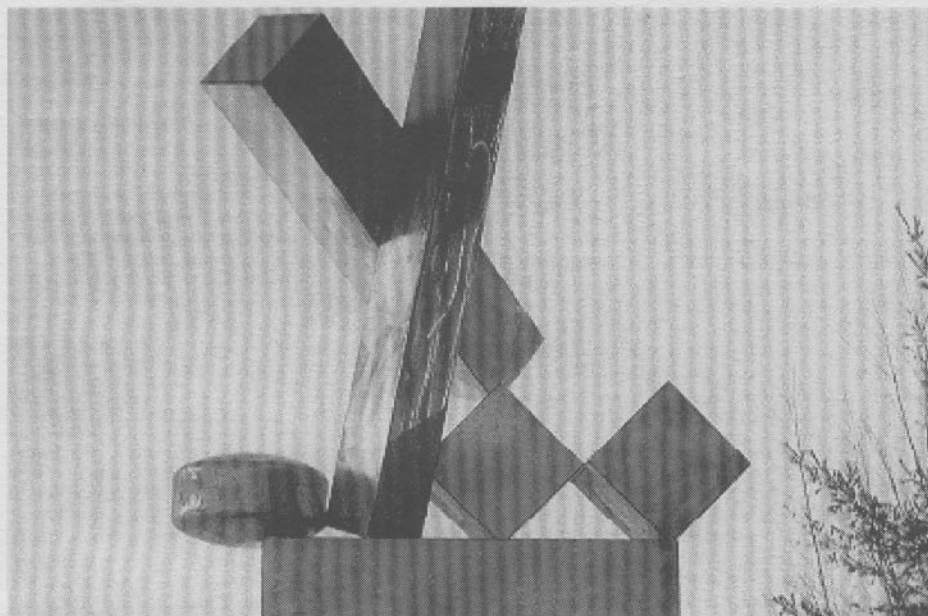
It seems to me we have here the philosophical elements of a new kind of environmental ethic, one that accepts human participation as essential to the wholeness of the world, and that actively seeks out ways in which that participation can be deepened and extended. It could be argued that the lovely complex tissue of the biosphere, threatened as it is, needs our best talents if it is to survive.

We may find our greatest hopes for the future, as did the Renaissance itself, in a re-creation of the past; the prairie may be the best long-term rotation crop for farm areas suffering from soil erosion and impoverishment. This vision is Arcadian in the best sense. If the restored prairie is one prototype of the American garden, that garden is the culmination of the Arcadian tradition.

What is Arcadia? One may find it in the paintings of Giorgione, Bellini, Titian, of Lorrain, Poussin, Chardin. In the western landscape gardening tradition it consists of a set of tastes handed down from the biblical gardens of Egypt and Babylon, to the Greek gardens celebrated by Homer in his mythical Phaiakia, to the Roman gardens of volcanic Sicily, Naples, and the Alban hills; and thence to the gardens of northern Europe—the gardens of Spain, Twickenham garden,



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Stourhead, Hidcote, and Sissinghurst in England, Monet's Clos Normand at Giverny in France; and then across the Atlantic to the painted landscapes of the Hudson School, the literary ones of Thoreau, and the real ones of Frederick Law Olmsted. There is a happy return to European models in the glorious American gardens of Longwood and Dumbarton Oaks. I do not know the great gardens of Mexico, but I have seen some of the lesser ones, and I am already seduced by their magic.

Arcadia, if we may characterize it generically, is a place where human beings cooperate with nature to produce a richness of ecological variety that would not otherwise exist. It undergoes continuous mild change, and is very adaptable to minor ecological alteration; but at the same time it is conservative and preserves things as they were in the Golden Age. Perhaps it is a country of the mind only, but we can see traces of it in the hills of Tuscany, the hedgerow and beech landscape of the Cotswolds in England, the savannas of Africa, the prairies of the

American midwest, the classic maize and amaranth country of the central valley of Mexico.

We human beings have a natural tropism towards such places, perhaps because they remind us in some genetic way of the savannas where we achieved our definitive evolution as the species we are. Our names for it —*Paradise*, which means a royal hunting-park; *The Happy Hunting Grounds* for the North American Plains Indians— imply a return after death to the place of our racial origins.

But perhaps we are misled by our very instinct for arcadia, and are therefore willing to accept an inauthentic substitute. In our admiration of this prairie, are we not like children gazing through the glass of a museum showcase? Is not the restored prairie little better than a dusty little diorama, with its perpetual brilliant sky lit dimly by the fluorescents, its claustrophobic trompe-l'oeil false perspective, its taxidermized specimens frozen forever in some *natural* act of forage or nestbuilding?

The preservationist philosophers of mainstream environmentalism, who believe that humanity and nature are two different things, and nature is good and humankind is bad, would say just this. For them the discipline of ecology is essentially elegiac, a eulogy to what we humans have destroyed; their science is a post-mortem, their myth is of a primal crime by which we are all tainted, the murder of nature. The best we can do to acknowledge our ecological sins —since we cannot expiate, let alone compensate for them— is to set aside whatever relatively untouched places remain and keep human beings out of them. For such perfectionists the study of nature is essentially passive and classificatory; action and experiment would be unwarranted. A real diorama might not disturb their fundamental sense of rightness so much as would this restored prairie. A diorama, after all, does depict nature as a corpse— a *nature morte*, as the French call a still life. From their point of view it would not falsify the truth so much as does the apparently blooming health of the living imitation.

One can encounter the dismal grandeur of this position, its *schadenfreude*, in many sectors of art and learning. There are performance theorists who regard the power relations of live performance as obscene; political purists who reject any reform as a palliative which will only delay the cleansing fires of the revolution; classicists who see only cultural decline since Homer; anthropologists for whom even their own presence in a traditional society is an irremediable taint to the purity of its unreflectiveness. Don't mess with Mother Nature. The opponents of genetic engineering are likewise haunted by the fates of Faust and Frankenstein. There are literary theorists who regard the process of verbal representation as a hegemonic



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power game designed to obscure the freeplay of reality, because language itself is an artificial ecology, and therefore essentially compromised. It is possible to sympathise with such a stance; those who hold it do indeed serve as a conscience to humankind.

But human beings are not at their best under the motivations of guilt and alarm. If not actually paralysed, they act mulishly, dutifully, without the joy and playfulness that liberate the imagination and start the flow of creative thought. The result is specialisation in knowledge and automatism in action.

Still, we cannot escape the awkward question: is the restored prairie a fake? One critic of restoration has argued that to have a restored coastline instead of a *natural* one is as if one's priceless Vermeer landscape painting were stolen and secretly replaced by a perfect replica. One would be as short-changed by the copy of nature as one would by the copy of the work of art. A large part of the value of a landscape, as with a Vermeer, is that it is the original; that is, its value depends on its origins.

This is a plausible and widely-held idea. Perhaps behind it we can glimpse the notion, fundamentally theological, that the world is a creation, and therefore inferior to its source, since the explanatory power of the creation would be quite void if there were properties in the creation which did not exist in the creator.

And under this notion there is, perhaps, that basic Indo-European habit of thought —perhaps a human habit of thought— that derives the nature of the child from the nature of the parent, and thus insists on the inferiority and subordination of child to parent. The very word *nature* is



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derived from an ancient Indo-European root meaning *birth*, a root perhaps sounding like *gand*, and giving rise also to such words as *natal*, *native*, *natural*, and *nativity* on one branch, *gender*, *genus*, *generate*, *general*, *genital*, *gentle*, *gene*, and *generation* on a second branch, and the Germanic *kin*, *kind*, *kindred* and *akin*, on yet a third. Even the practice of etymology as a pedantic explanation of the meaning of a word implicitly privileges origins as determinative of outcomes.

But is not the true role of the parent to educate the child to the point where it becomes independent of its origins, and capable of creation beyond its parents' dreams? The American revolutions were declarations of such independence from the motherland, the fatherland —Spain or England. And though there is one wisdom that says that we know a thing by its grounds or origins, there is another that says *by their fruits ye shall know them*, that derives the identity of something not from what produced it but from what it produ-

ces. The kingdom of heaven may be more like a mustardseed, like a leaven or ferment, than like an achieved perfection; more in potential than in exhaustion of possibility. The branching tree of evolution brings about wonderfully new forms of life, unpredictable from their origins until they have actually appeared.

Perhaps we should think of a living landscape not so much as like a Vermeer, but as like a sonnet, which, far from losing when it is copied, derives its very life as a literary object from its being printed and reprinted. Shakespeare has a sonnet (65) that says just this:

*Since brass, nor stone, nor earth,
nor boundless sea,
But sad mortality o'ersways their
power,
How with this rage shall beauty
hold a plea,
Whose action is no stronger than
a flower?,
O, how shall summer's honey
breath hold out
Against the wrackful siege of*



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*batt'ring days,
When rocks impregnable are not
so stout,
Nor gates of steel so strong, but
Time daccays?
O, fearful meditation! Where,
alack,
Shall Time's best jewel from
Time's chest lie hid?
Or what strong hand can hold his
swift foot back?
Or who his spoil of beauty can
forbid?
O none, unless this miracle have
might,
That in black ink my love shall
still shine bright.*

And it still does, unspotted by the centuries, precisely because it has been copied and recopied in *black ink*; precisely because it has taken on the ethic of the fruit and the seed, which is to give all to the future.

The analogy is a rather precise one. A landscape is not at all like a Vermeer if by that we mean that it is the same landscape year to year as a Vermeer is the same painting year to year. A prairie recopies, reprints itself

every spring, using seeds and cuttings which are the books wherein are inscribed the instructions of the DNA code.

In reproducing a prairie, then, the ecological restorationists only take a leaf out of nature's book. Nature copies; it is an uncopied prairie, if such could exist, that would be unnatural. When the retreat of icecaps, the silting up of lakebeds, or devastation by volcanic ash lays bare a new environment suitable for prairie, the prairie species are seeded by natural vectors—wind, birds, insects—and copy themselves into the empty page. Is not Homo sapiens in this case just another vector that the prairie biome employs to reproduce itself? A flower uses the esthetic preferences of the bee to attract its pollinator; likewise our esthetic attraction for the prairie causes us to carry its germs to a new environment. Only someone who denied the scientific fact that we are another animal species, generated by natural evolution as much as a prairie rabbit is, could deny us this function: to be the scholar who accurately reproduces the text of plant DNA to ensure its survival.

But perhaps even this conception is too conservative. It is the job of the scholar to ensure that the sonnet remains utterly uncorrupted by copying or printer's errors; but nature's copying is not exact. Though the copying process is entirely natural—and thus the preservationist's argument against the *fake* is without substance—nature itself goes beyond copying to innovation, and allows copying *errors* into its sonnets in an attempt to improve them.

A prairie grass can propagate itself in one of two ways: by cloning itself with runners or rhizomes; or by mating and sexual reproduction, using

flowers, fruits and seeds. When it sends out a new shoot, whether vertical, parallel to the ground, or under it, every biomolecular precaution is taken that the DNA in the new cells is identical to that in the originals. But when a plant reproduces itself sexually, the policy is utterly changed. The twin strands of the chromosomes are unwound from each other, the naked strands are paired with those of an alien individual, the genes are chopped up and reshuffled, the copies are conflated and thus corrupted. To an asexually reproducing organism such a procedure would appear madness: if the purpose of reproduction is survival, this deliberate self-infliction with cancer, this permission to an alien virus to corrupt the code, would be suicide.

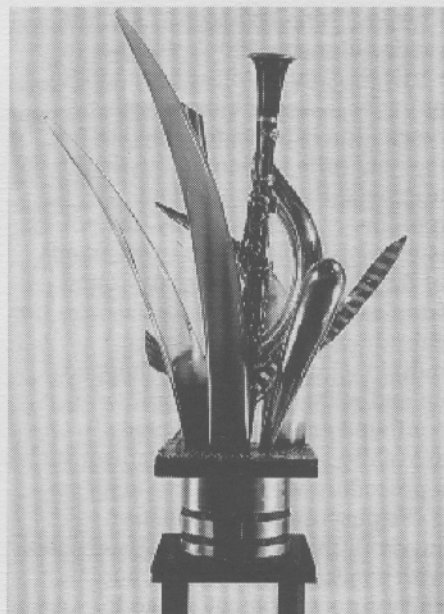
In one sense this is exactly the reaction of the strict preservationist philosophers to the work of ecological restoration. Sex, for the biological organism as perhaps for the philosopher, seems to threaten all consistency, all identity.



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The Reconstruction of...



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What, then, is sex for? Why should plants and animals go to the extraordinary expense of complex energy-using reproductive systems, brilliantly pigmented or fluorescent scales and plumage, flowers and fruit, courtship rituals and the rest, when they could simply use their built-in growth system and bud themselves a clone? It's all for one purpose: variation. To put this more precisely, it is to create true genetic individuals. And the function of individuals is to act as experimental tests of various possibilities in body conformation, chemistry, and behavior that fall within the range of variation for the species. If the individual survives to reproduce, then its particular traits are perpetuated in the gene pool of the species. If it reproduces itself more abundantly than its parents, then it has probably found a better fit to the vicissitudes of its environment. In biological terms, the offspring can better represent its species than the parent.

This is a long from the ideas of the purists, who see nature as an unchanging cycle of harmony; we

have instead a dynamic, innovative, self-transforming universe, one quite well matched to the human propensity for interference. Nature can in fact be defined as the interference of everything with everything else.

But our meditation upon flowers is not yet over; for variation by sexual recombination, which is the function of flowers, is not enough by itself to keep the breed adaptively abreast of its competition. Another element is required, and that is death. If death does not cull out of the species those individuals whose genes are not adapted to the environment, the defective genes themselves will remain to contaminate the more vigorous strains. It may seem paradoxical to describe death—which is after all the opposite of survival—as a tool in the process of evolution, whose mainspring is survival. But this is exactly the magnificently risky policy to which the sexually-reproducing organisms have committed themselves. Most sexual organisms even contain a programmed aging system on the cellular or genetic level to ensure that the individual does not outstay its time. Sex and death are the two sides of the same system.

Aging, though, is not enough in many cases to clean out the deadwood of genetic failure. Many prey species rely on their predators to cull the unfit. The old prairies were dependent on periodic fires to get rid of dead plant matter, fertilize the soil, and above all to kill the tree saplings that would otherwise quickly cover the ground. The richest mix of species only occurs on burnt prairies. Accordingly the Wisconsin Arboretum burns its prairies every two years. It is said to be an unforgettable sight, with flames leaping up thirty feet, and it is gradually taking on the status of a ritual for the professionals and

volunteers who supervise it. I myself can remember from my childhood in central Africa the spring burning practiced by the Ndembu tribe, and the air of festival it conveyed; it is associated for me with the smell of grass-smoke, harsh native honey beer, the hunters' rites and dances, and the delicious little ground-fruits that we village boys would find among the burnt grass roots. Perhaps one day the prairie burning will be one of the great ritual and performative occasions of the midwest, a sort of festival of Dionysus the god of inexhaustible life, an occasion for drama, music, storytelling, poetry. The burning showed that nature needed us, needed even those most Promethean and destructive elements of our nature which are symbolized by fire.

All wise arcadians know that Death is a welcome visitor there, and they resist any attempt to keep him out. And with death of course comes consciousness, reflection, that loss of innocence which makes Arcadia capable of birth and creative novelty. The dream of the productive and



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creative Arcadia—as opposed to the sterile and immortal place that always provokes us into rebellion and fall—may now make more sense than we have given it credit for. It is an ancient image of the garden that does not merely freeze a moment of nature's being or capture the appearance of nature, but does what nature does: reproduces itself, copies itself into the future, and slowly improves on the copies by the evolutionary play of mutation, sexual recombination, and selection. And now ecological restoration can give us the reality of that image.

The reason we need the great restoration projects with their thousands of hectares—the California redwood restorations, the restored wetlands, Dan Janzen's visionary tropical dry forest restoration project in Costa Rica, the *Bosques Colon* (Forests of Columbus) project in Hispaniola, the prairie restorations themselves—is to promote genetic diversity and adaptability. Their value is not merely to act as museums but as active gene banks, with multiple alleles and a strong repertoire of varieties and races ready to recolonize the world when agriculture has progressed to the point when it can share the land with them. It is not enough, perhaps,

entrusted with the wealth of nature, to go and hide one's talent in the ground.

We are the custodians of the only life we know of in the universe, and the only plausible vector by which life may propagate itself to other worlds and thus escape the risk that some minor cosmic accident—the impact of a stray asteroid, or a disturbance of the sun's activity—should snuff out the first shoots of life forever. It is becoming clear that we cannot survive, psychologically or physically, without the rich web of other lives around us. If we leave this planet we must take our biosphere with us.

The great phylum of the angiosperms, the flowering plants, which appeared in the mid-cretaceous period and came in a mere five million years to dominate the ecology of the planet, owed its very existence to its insect assistants and the new ecological niches they opened up. The simultaneous explosion of chordate species, of which we are one, may in turn be due to the richer carbohydrate and protein content of angiosperm seeds and fruits. The work of the bee and the bird in spreading angiosperm pollen and seed across the continents was not merely a conserving activity.

Rather, it actively promoted the creation of new habitats and ecologically richer regimes. The ecological restorationists are taking the first step toward being able to reconstitute on some alien soil the elements of an earthly forest or prairie. Their distant successors will be like the bees, which serve as the matchmaker and reproductive vector of other species, but on a cosmic scale: participant-gardeners of nature.

At present the restorationist bee is more necessary as a preserver than as a colonist. This is as it should be. But the time may come when we, and our sister species of this planet, may seed ourselves across the solar system and beyond, as once the oceanic species colonized the land, and the insects and the birds the air. The task will be enormous, and will be too much for the relatively slow and unreflective processes of genetic adaptation. Who will write the Georgics of this new arcadia? It will take wise bees, seed vectors of great exactness, able to provide the right environment for infant growth until the growth itself has altered those harsh environments into something hospitable to human beings. But one day the long discipline of restoration may bear a strange and unexpected fruit, and an alien sun may shine on miles of blowing prairie.

