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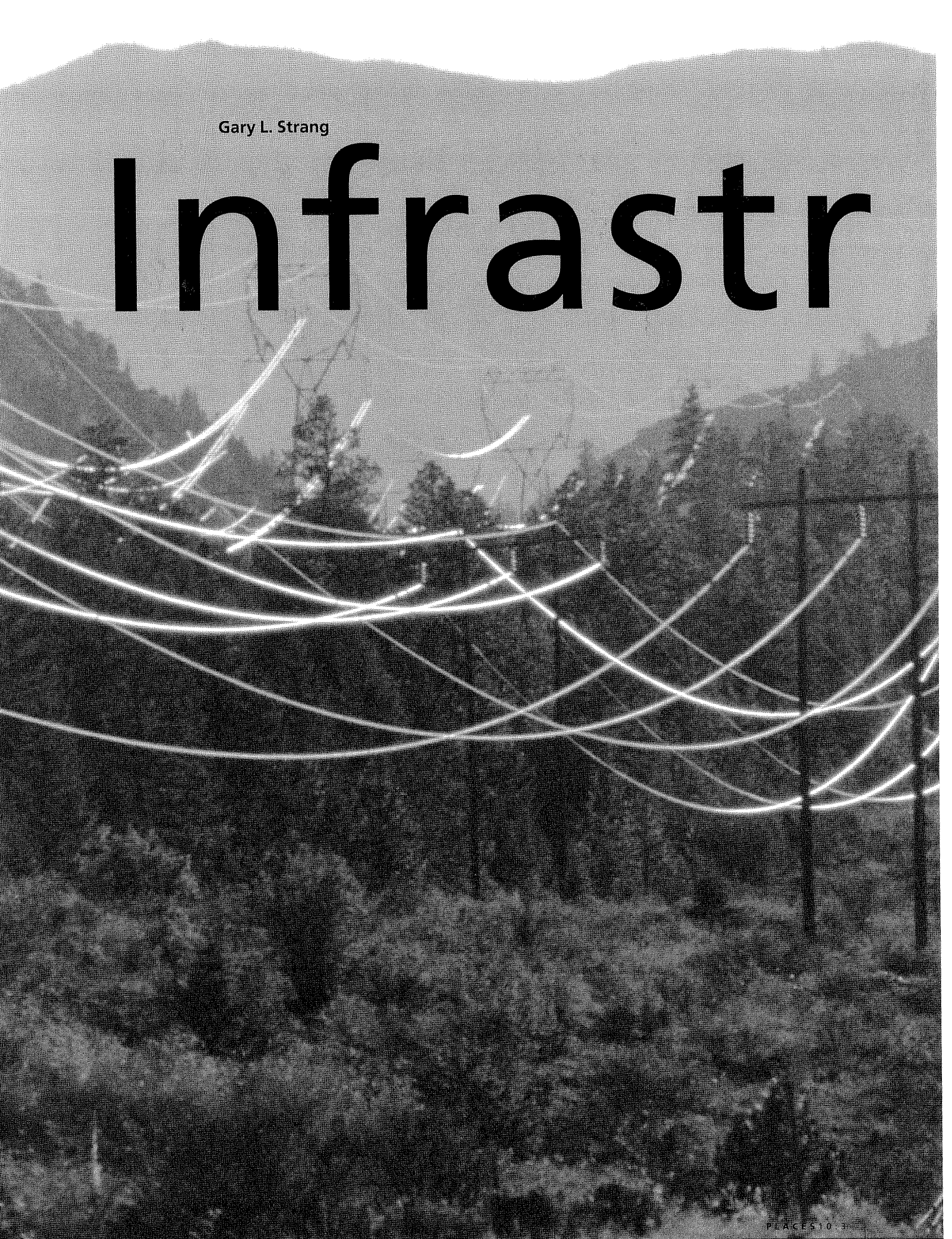
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Structure as Landscape

Traditionally, the tools and landscapes that insured human survival were viewed with great reverence. But in contemporary times, they have been replaced with centrally controlled systems that extract the resources necessary for life — food, water, power — and transport them hundreds or thousands of miles to urban centers. The architecture of the city has evolved into a complex mechanism extending deep into the earth and far into the hinterland, beyond any individual's understanding or direct influence.

Infrastructure systems, by virtue of their scale, ubiquity and inability to be hidden, are an essential visual component of urban settlements. Yet the responsibility for designing this machinery into the landscape is diffused, falling piecemeal to many disciplines — engineering, architecture, landscape architecture, agriculture, planning and biology.

Background: Eastern Washington landscape. Photographs courtesy Gary L. Strang unless noted otherwise.



Above: Missouri River Valley.
Right: Water from the California Aqueduct is piped across the Tehachapi Mountains before reaching Los Angeles.



Infrastructure and Landscape

In 1964, cultural historian Leo Marx wrote *The Machine in the Garden*, which explores an inherent contradiction in the American ideology of space. Free economic competition and technological progress are valued equally with the tradition of landscape pastoralism; thus, Marx observed, in our landscape the machine is accommodated in the garden. Today it is fair to say that the machine is not so much in the garden as it is indistinguishable from the garden; they are inexorably intertwined.

California was once a land of flash floods and drought, but most of the state has been transformed into a huge catchment basin, where water flow is monitored from Lake Shasta to the Mexican border. Most California rivers have been removed from their beds and flow directly into water treatment plants and irrigation canals that constitute the only visible, architectural components of a system that interfaces with every habitable space in the state.

In Los Angeles, the structure of the Los Angeles River is indistinguishable from the urban and residential structure of the city. If Angelenos know their city has a river, it may be because it has been featured in chase scenes in movies like *Grease* and *Terminator Two*. A member of the California assembly actually proposed using the river bed to carry a carpool lane in the dry season.

One needs to know that Los Angeles has 470 miles of concrete-lined channels in order to reclaim the meaning of the term “L.A. basin.” The river is a huge storm drain that carries rainwater from the Santa Monica and San Gabriel Mountains to the Pacific Ocean; much of the rainwater never even touches soil. As the Los Angeles basin has been covered with rooves, roads and parking lots, the land has lost its capacity to absorb water and the increased runoff has overloaded the system.

The potential these infrastructure systems have for performing the additional function of shaping architectural and urban form is largely unrealized. They have an inherent spatial and functional order that can serve as the raw material of architectural design or establish a local identity that has a tangible relationship to the region. They can be designed with a formal clarity that expresses their importance to society, at the same time creating new layers of urban landmarks, spaces and connections.

While the architecture of water systems provides the most easily understood opportunities for architects, there are corollaries for steam, natural gas, electricity, sewage, oil and telecommunications. Each of these constitutes a network as complex as a river system; each has the unrealized potential to perform multiple uses.

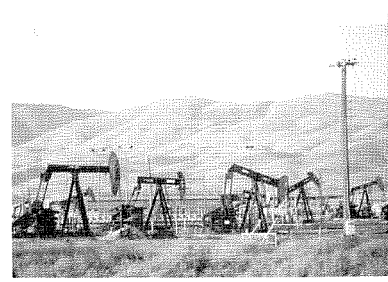
The tendency to engineer for a single purpose is also apparent in horticulture. Genetic engineering and cloning of plant materials has emphasized, primarily, visual characteristics while breeding out desirable qualities such as resistance to disease and drought and tolerance to local soils.

Plants have become unfamiliar to insects and wildlife. Parks and gardens may seem a minor consideration, but taken collectively, we are building large areas of a new habitat that is essentially sterile in terms of its ability to support the biological diversity necessary for human life. This new habitat is a mixed suburban forest that consists of a community of plants assembled from around the world and is guaranteed to confound any indigenous plant or animal that tries to colonize it (African daisies, Japanese maples, Aus-

tralian tea trees, Canary Island pines, Burmese honeysuckle and so on). Since the '50s, the whole thing has been supported by a horticultural heart and lung machine made up of irrigation pop-ups, electric timers, fossil-based fertilizers and the associated blowers and weed wackers. If we pulled the plug, much of this landscape would disappear in a few months.

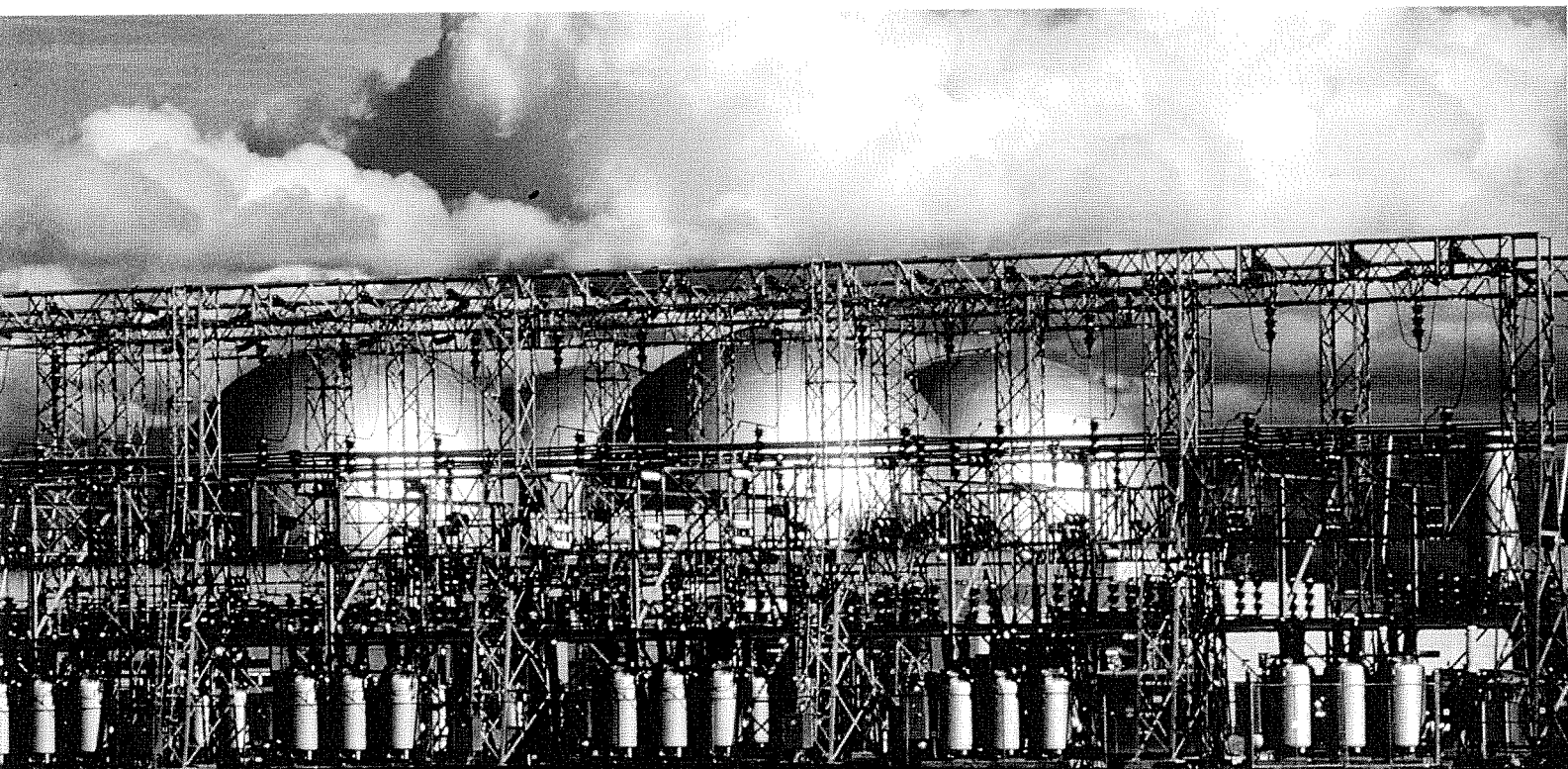
Despite this reliance on the constructed landscape, our culture's response to the disruptions of infrastructure has largely been one of denial, rather than reverence. Designers have most often been charged with hiding, screening and cosmetically mitigating infrastructure, in order to maintain the image of the untouched natural surroundings of an earlier era. They are rarely asked to consider infrastructure as an opportunity, as a fundamental component of urban and regional form.

As early as 1924, social critic Lewis Mumford castigated modern architects for romanticising new technologies while ignoring the potential for making civil architecture from the important, everyday elements of the city, such as water towers and subways. He attacked the City Beautiful



Above: Oil fields near McKittrick, California.

Below: Fuel tanks and electric power station at the NASA Ames Research Center in Mountain View, California.





Infrastructure often overwhelms the amenity it is meant to provide.

Left: Sidewalks often crowd street trees, sometimes with unexpected results.

Right: Temporary vents for underground steam conduits disrupt surface movement in New York.



movement for obscuring important structural and social developments saying that beautification was equivalent to “the icing on a birthday cake” that “detracts from the realism needed for the colossal task of the renovation of the city.”¹ Today we are still masking a system of infrastructure vastly and impractically expanded beyond the boundaries of the city, multiplying the task of maintenance and renovation beyond comprehension.

From Heroism to Biological Complexity

To regard infrastructure as a legitimate field for regional architecture, it helps to understand the periods of civil engineering have transpired in the last two centuries.

The first American school of engineering was started at the U.S. Military Academy in 1802. The Army Corps of Engineers, which is responsible for waterway design in the U.S., was founded at that time. The school was started with the aid of French engineers who had helped during the Revolutionary War. From them, we inherited the idea, dating to Louis XIV, that a nation needs an army to direct public works.

Beginning in the 1850s was the heroic period of bridge and dam building, which culminated in the great projects of the Works Progress Administration, which integrated engineering, architecture, agriculture and the arts and was memorialized in Diego Rivera’s murals.

To be an engineer between 1850 and 1950 was to participate in a great adventure, to lead the crusade for health and progress that corresponded to the high period of modern architecture in

Europe. Plumbers were the pioneers of cleanliness at the end of the pre-industrial age, when people could still remember that the earth was swept by plagues that traveled thousands of miles before their forces were spent. In 1898, Viennese architect Adolph Loos observed that the plumber brings civilization.

As the statue “Mercury, The Genius of Electricity” was being mounted on the top of the AT&T headquarters in New York in 1916, the street below told a dramatically different story. Romantic images that depicted the benefits of technology contrasted with the messy process of retrofitting cities to accommodate an overwhelming tangle of pipes and wires — which often laid claim to open space formerly reserved for people. The city was undergoing a fundamental, systemic change as energy formerly produced by human labor was being generated or collected in remote areas and carried into the city from the surrounding region.

In 1947, WPA writer Harry Granick identified the dawn of a new era of biological complexity in engineering. He authored *Underneath New York*, the first book to describe the anatomy of a modern city using the metaphor of the human body. The book conveys his sense of wonder at the hidden structure that converts natural resources into the energy that makes urban culture possible.²

Granick’s New York rested on a foundation of tangled plumbing as deep as the Chrysler Building is high. On the top lay a three-inch mat of asphalt, beneath that ten inches of concrete. Below that, a few inches of soil soaks up chemicals from the street. In the next three inches are the wires — telephone, electric, street light and fire alarm. Gas lines lay another foot below, water mains are four feet deep, steam pipes puff away six feet under. Sewer pipes are above the subway vaults, which vary from a few feet to eighteen stories deep. Water tunnels, running between 200 and 800 feet deep, occupy the farthest man-built depths.

There are two ironies about this infrastructure of biological complexity. First, the system is so complicated that it has begun to take on qualities of nature itself and, therefore, presents the same threat of random catastrophe that nature does. Infrastructure, like nature, is resilient and adaptable, but it is also unpredictable and uncontrollable.

“Man’s own cramped-together creations, anything from underground sewage systems and subways to a badly hem-med-in sky overhead, irritatingly criss-crossed by a maze of electric wires, should not prove as inescapable as fate. Lightning and the plague, once so formidable, have been countered by proper measures; must we then here find ourselves helpless? Must we remain victims, strangled and suffocated by our own design?”

— Richard Neutra, in *Survival Through Design*.



It is well known that a simple broken water main in Manhattan can trigger what is known in ecological circles as a “feedback loop.” The problem is directed back into the system, resulting in additional and magnified effects. In July, 1995, a 36-inch diameter water main carrying three million gallons per day erupted from beneath the asphalt on 34th Street, turning Seventh Avenue into a river that flowed to Greenwich Village. Water drained into subway ventilation grilles, shutting down two lines, forcing pedestrians to the streets and causing power outages. In extreme cases, technological malfunction can have catastrophic results. In April, 1992, the sewers of Guadalajara filled with propane and exploded, leveling 25 square city blocks and leaving 15,000 homeless.

The second irony is that the support system occupies so much space that it overwhelms the amenity it was intended to provide. The public realm and natural areas have become repositories for meters, transformers and zones of access to buried conduit networks. Anyone who has peered into an urban street during construction will need no explanation to comprehend the difficulty of finding an uninterrupted volume of soil large enough to support a tree for the seven to twenty years that now constitutes its average life span.

Infrastructure, Architecture and Landscape

Utilitarian intrusions — which often result in disturbed landscapes, defaced retrofitted buildings and the erasure of nature that we have come to accept as the everyday urban and regional landscape — are actually opportunities. Designers can generate meaningful new architectural, urban and regional forms by integrating the works of the estranged disciplines of architecture, civil and structural engineering, landscape architecture and biology.

An examination of pre-industrial cities shows that some of their most profoundly moving land-

scapes were nothing more than the irrigation, domestic water supply, sanitary sewer and flood control systems of the time. These landscapes allowed the workings of nature to be revealed in the urban setting.

The technology of a pre-industrial urban fountain maintained, by necessity, a legible connection to a watershed. At a tiny Inca village in Peru, a manmade fountain was the ordering system for the town. Agricultural terraces took their form from a bowl in the topography while an elaborate stair and fountain connected a temple at the top with a compact cluster of houses and storage buildings below. The fountain intercepted the flow of the drainage beyond with a series of stepping water basins, whose volume could be retained or released depending on the seasonal flow. The logic of the watershed was evident within the context of the city.

In contemporary American cities, the hydrology of the place has been largely ignored. Drainage systems have been put underground unnecessarily or channelized with concrete, erasing the visual and spatial logic of the region. Contemporary fountains, which are loops of recirculating chlorinated water that operate independent of rainfall and gravity, need to be replaced with fountains that have nature driven, seasonal variations.

A place’s hydrology should be part of the basic armature of the urban form. Water treatment

“For even as your brain, nerves, heart, lungs and stomach are hidden from view, so it is with the City. Its nervous system, the vital organs which provide it with heat, water, light and air, its intestines, which like yours, eliminate its wastes, its great arteries of rapid transit, which, carry its stream of life to all ends of its body, all these and more that make it possible for eight million people to live together, are out of sight under the pavements and waterways.”

— Harry Granick, in *Underneath New York*

Inset: A Moorish wall built with Roman technology at the Alhambra, Granada, Spain. Background: Kiwi vines near Woodland California.

plants should be designed to accommodate visitors and to demonstrate appropriate site design and water use. Sewage plants are magnificent sources of nutrients, which could be collected and expressed in landscapes that could rival the great gardens of the renaissance.

Significant sources, paths and transition points of our collectively owned resources should be made legible in the landscape. They can comprise an alternative system of urban and regional landmarks that replace those that glorify the transitory economic prowess of individuals and companies.

In Sunol, Calif., a water temple marks the place where water piped from San Francisco's Hetch Hetchy Reservoir, more than 100 miles away, surfaces before passing into Crystal Springs Reservoir, where it is stored for domestic use. This logic could be applied to all the great utilities. Oil, steam and natural gas lines should be marked at significant locations, such as their source and the point at which they enter the city, with structures that make their functions, and important positions in society, legible. A huge natural gas line could be marked with an eternal flame that announces the number of miles the gas has traveled. Invisible communications technologies should be expressed at transfer points.

The biggest immediate gains can be made in the renovation of single-purpose utilities. The reconstruction of urban drainage systems, for example, can provide networks of open space shared by people and working biological systems at little additional cost. To reduce the loads on drainage systems, many regions (such as Los Angeles, where proposals are already on the table) will eventually require that water be retained on site in basins, gardens and cisterns, from which it will soak directly back into the earth. Compare this approach to the recently adopted proposal by the Army Corps of Engineers to heighten the walls of the Los Angeles River by four to eight feet and to raise eleven street and railroad bridges.

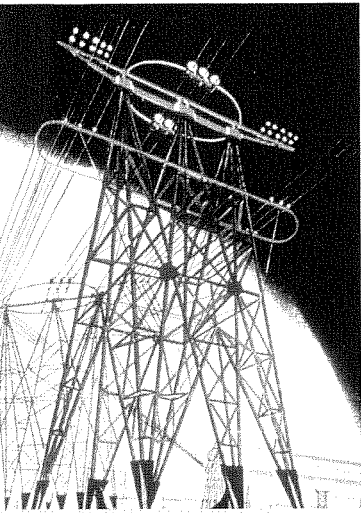
Architects should be more like farmers, who depend upon the architecture of natural systems for their livelihood. The strict lines of human geometry and production efficiency should be allowed to deform to incorporate, rather than neutralize, biological networks. Good agricultural

fields perform more than the single function of producing food; they can also be percolation fields, floodplains or flyways for migrating geese that fertilize the earth. Buildings, likewise, can be elements of infrastructure that contribute to stable natural ecosystem; they can they occupy more than one niche simultaneously.

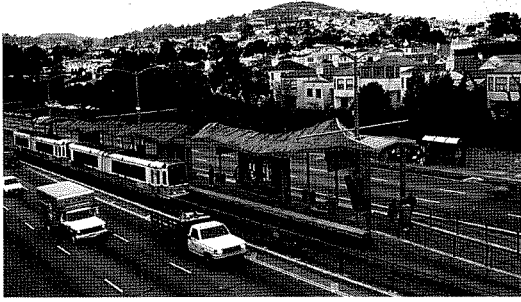
Horticultural practices also need to be revamped to incorporate the common-sense attitudes of small farmers who use materials at hand to solve complex technical and horticultural problems in an efficient and beautiful manner. Nature is being severely altered and we need new, legible models to illustrate how nature currently works and does not work — intertwined, such as it is, with architecture. We must find ways to allow the natural landscape and the landscape of infrastructure, which occupy the same space, to coexist and perform multiple functions.

In California, this means planting more Monterey Cypress in the fog belt, more oaks and grasses in the hot interior. It also means understanding that a western urban landscape is better informed by an Islamic courtyard in Spain than by the green English countryside. This was a principle not lost on Frederick Law Olmsted, who demonstrated his understanding of regional variation with his site plan for the Stanford campus, which included arcaded courtyards and a dry oak woodland landscape. The fragmentation of the building process into so many different disciplines has led to a gross simplification of the issues involved in building.

In the earlier part of the century architects were more optimistic about expressing utilities, buildings and highways as legitimate components of a larger system. Frank Lloyd Wright, raised on a farm and trained as an engineer, demonstrated an uncommon understanding of structure and nature. Taliesin West is sited adjacent to a seasonal desert wash that provided a full range of sands and gravel for his masonry and supplies water for domestic use (stored in a tower) and firefighting (stored in a central garden basin). Russian constructivist Iakov Tchernikov developed a language based on the new spatial possibilities of technological expansion. He produced exuberant architectural compositions from building types we have



Inset: Prototype design for a transmission tower, by Iakov Tchernikov.



New canopy for light rail station in San Francisco. Designers: Leonard Hunter and Sheila Ghidini. Photograph by Peter Hamblin, courtesy Federal Transportation Administration.

regretfully given up on — electrical towers, industries and factories.

More important are developments in architecture and structural engineering, which are being remarried after a 100-year divorce — a movement that predicts the corresponding and much needed reconciliation between landscape architecture and civil engineering. Renzo Piano and Ove Arup engineers have begun to overcome the barriers to developing integrated architectural systems by combining technological developments with the organic principles of nature. Says Piano, “at the beginning of the century technology was really an adversary to nature. But today you can see that technology and nature are not so far apart.”

In San Francisco, Bill Leddy has made a proposal for the renovation of Sutro Baths on the Pacific Coast, which would be enclosed by a water desalinization system driven by a dependable supply of offshore wind. In this instance, infrastructure, serving a multiple purpose, would renovate an existing ruin, reinvigorate a civic landmark, generate power, provide fresh water and relieve pressure on the Hetch Hetchy Reservoir.

In an open chapel and cemetery Dan Solomon and I designed in Houston, the 50 to 100 inches of rain that fall on the roof each year will be captured in a huge elevated gutter that doubles as a portico. The rainfall will be captured in a pool that retains floodwater as a seasonal site amenity. The pool overflows to walkways that double as drainage structures, and form the geometric lines which structure the site for the ritual of burial. The problem of drainage and flooding in Houston is seen as an opportunity to organize the site and to allow mourners to confront the cycles of nature.

Prospects for Regional Intervention

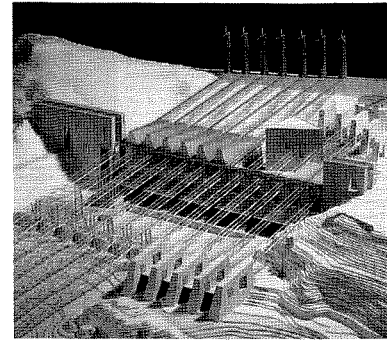
Acknowledging the potential for appropriating infrastructure as landscape offers pragmatic and immediate advantages. The amount of funding for

building and renovating public infrastructure is likely to far exceed the amount that will be available for buildings, parks and open space. These large budgets can be used to produce urban designs that simultaneously solve utilitarian problems and help repair cities and regional landscapes at a scale not dreamed of since the days of the great dams.

Given the magnitude of changes occurring within natural and technological systems worldwide, a position that links human survival to the preservation of pristine nature is increasingly difficult to visualize; nature is a dynamic process that is rarely independent of human interaction. Nevertheless, we must learn to intervene in a way that facilitates, rather than disrupts, natural processes.

The historian of religion Mircea Eliade contends that the Neolithic shift from nomadic to agricultural civilization provoked upheavals and spiritual breakdowns whose magnitude the modern mind finds it impossible to conceive. It is not only imaginable but probable that the current shift to a predominantly technological environment has provoked a similarly profound spiritual crisis — one that can be relieved by reconsidering the relationship between urban settings and natural processes.

Likewise, the total management of nature is a dream that fades farther from view with every Kobe earthquake and Mississippi flood. An architectural method that exploits the unignorable marriage between nature and technology provides an opportunity for new spatial and visual possibilities that result from using infrastructure as a fundamental component of architectural design. Nature and infrastructure, working together, must both be allowed to express themselves as a major determinant of urban and regional form. It is up to architects, landscape architects, engineers and biologists to show the way.



Proposal for the renovation of Sutro Baths, San Francisco. Designer: Bill Leddy.

Notes

1. Lewis Mumford, *Sticks and Stones* (Liveright: Boni and Liveright, 1924).
2. Harry Granick, *Underneath New York* (New York: Fordham University Press, 1991).