



PREFACE

A NATURE GUIDE IS A USEFUL COMPANION when you venture into the deep woods or the mountains. For better or worse, however, few of us spend much time in the wilderness; we live in an environment where most of what we see is man-made. Perhaps on your summer vacation you have a chance to hike the Appalachian Trail, but the rest of the year you drive through refinery row on the New Jersey Turnpike. Once in a lifetime, if you are incredibly lucky, you might look up a tree and spot an ivory-billed woodpecker, but on most days you are more likely to look up a utility pole and see the finned steel casing of an electrical transformer.

This book adopts the form of a nature guide, but its subject matter is everything that *isn't* nature. It is a guide to the common sights of the built environment—the power lines, water tanks, street lights, manholes, traffic signals, cellular-telephone towers—that we pass by every day and yet seldom really notice. In these pages I identify and classify some of the species that inhabit this familiar urban ecosystem. Farther afield, there are more exotic industrial habitats to explore: coal mines, oil refineries, railroad freight yards, power plants, garbage incinerators. These are places that most of us never see close up; many of us would go out of our way to *avoid* seeing them. But they are nonetheless a part of modern life—and worth a visit. There can be just as much of interest happening on a factory rooftop as there is in the forest canopy, just as much to marvel at in the operation of a strip-mining dragline as in the geological carving of a river canyon.

Some may find puzzling or distasteful the parallel I am drawing between the study of nature and the study of technology. After all, nature is good and good for you, whereas everyone knows that technology is ugly, evil, and dangerous. The mention of nature brings to mind majestic landscapes: Yosemite, Yellowstone, the Grand Canyon. The mention of industrial technology brings to mind a long list of disasters:

What is it and what does it do? We live in a world cluttered with industrial artifacts whose purpose and principles of operation are often unknown to those who see them. The curious rooftop structures on the opposite page are devices called cyclones, mounted atop a lumber yard and sawmill in Sacramento, California. Their function is to separate sawdust from a moving stream of air. The dust-laden air enters each funnel-like vessel tangentially, creating a whirlpool wind that spins the sawdust to the outside; the dust trickles down the walls of the funnel into a bin below, while the air exits through the question-mark vent at the top. The telltale shape of a cyclone is something you can expect to encounter not just at a sawmill but in many other industrial environments, from coal mines to flour mills.

Three Mile Island, Bhopal, Chernobyl, Love Canal. In the presence of nature we hold our breath in hushed reverence; in the presence of industry we hold our nose.

A few centuries ago—say, on the American western frontier—a quite different view prevailed. Nature was seen as savage, hostile, cruel. Mountains and forests were barriers, not refuges. The lights of civilization were a comforting sight. We took our charter from the book of Genesis, which grants mankind dominion over the beasts, and felt it was both our entitlement and our duty to tame the wilderness, fell the trees, plow the land, dam the rivers. In the most extreme version of this ideology, everything on the planet was put here explicitly for human use. At the opposite extreme, today, the earth-first sensibility urges us to treat the entire planet according to the campsite ethic: carry out what you carry in, and leave no trace of your passage.

It is not my mission to mediate between these strangely polarized positions. My chief aim is simply to describe and explain the technological fabric of society, not to judge whether it is good or bad, beautiful or ugly. And yet I would not argue that technology is neutral or value-free. Quite the contrary: I submit that the signs of human presence are the only elements of the landscape that have any moral or aesthetic significance at all. In nature undisturbed, a desert is not better or worse than a forest or a glacier; there is simply no scale on which to rank such things unless it is a human scale of utility or beauty. Only when people intervene in nature is there any question of right or wrong, better or worse. When we look on a pristine glade, we are mere bystanders, but when we walk down a city street, we are responsible for what we see (and what we hear and smell), and we are therefore called on to pass judgment.

The sandstone buttes of Red Rock State Park, near Gallup, New Mexico, serve as backdrop to the processing and storage facilities of El Paso Natural Gas Company and Conoco Propane. Do the tanks and towers spoil the view of the cliffs? Or does the overdramatic landscape distract from a proper appreciation of the industrial equipment?





In Cushing, Oklahoma (“pipeline crossroads of the world”), cylindrical tanks dot another bucolic landscape. Would the scene be more interesting or more attractive without them?

One winter afternoon a few years ago I stood by the side of a highway near Gallup, New Mexico, looking on a classic vista of the American West: red sandstone buttes rising from a valley floor. It was the kind of landscape made famous by films and paintings and postcards, not to mention all those Marlboro Man advertisements. But this particular vista had something more. In front of the cliffs, and towering over them, were several cylindrical spires that I recognized as petroleum fractionating columns; off to one side was a grove of gleaming white spherical tanks. The towers and tanks belonged to a plant for processing and storing propane, or liquefied petroleum gas. I suspect that most viewers of this scene would consider the industrial hardware to be an intrusion, a distraction, perhaps even a desecration of the landscape. I might offer the counterargument that the juxtaposition of natural landforms with the geometrically simpler cylinders and spheres adds visual interest to the composition, but I don’t expect to win many converts to that view.

When looking on that scene west of Gallup, the obvious question is: Why did they have to build it *here*? Couldn’t the gasworks have been put somewhere less conspicuous? There is an answer. The propane plant was put below the buttes because that’s where the pipeline runs, carrying petroleum products from Texas to California. And the pipeline takes that path because it follows the highway and the railroad. And before the highway and railroad were built, a stagecoach line followed the same route. And before that, there was a trail used by the native peoples who have maintained an urban culture in this region for at least a millennium. In other words, this is a landscape that has been put to human use for a very long time. Today, many of us might prefer to see it put to some *other* use, but that is still a matter of impressing

Sometimes the forms of industrial hardware are full of visual interest in their own right, quite apart from how they fit into the wider landscape. At right, an insulated pipeline and a row of air-intake stacks at an installation of gas-turbines next to the Ravenswood Generating Station in Queens, New York. Below, another rooftop cyclone, in Spartanburg, South Carolina.



human values on the land. We might choose industry or we might choose scenery, but in either case it is our choice and responsibility.

A field guide ought to offer more than just clues to identifying species. It should also lead to an understanding of how the various elements of a landscape or an ecosystem fit together in a coherent whole. In the rain forest, trees provide shelter for some animals; other animals eat the fruits and at the same time disperse the seeds; still others are parasites on the leaves or roots. Comparable webs of interactions can be found in some industrial ecosystems. A classic example is the damming of a river, which can supply hydroelectric power and drinking water for cities, irrigation water for agriculture, and protection from flooding downstream; but the dam also permanently submerges a valley, with a consequent loss of land area, and in some cases the dam may interfere with fisheries; the effects on river navigation could be either beneficial or detrimental.

Because the networks of the industrial economy are so tangled, there is no clear starting point or finish line; it's all cycles within cycles. But we have to start somewhere, and so in this book I have imposed an overall structure that traces the flow of materials, energy, and information through the system. The story begins with basic inputs, namely, raw materials such as metal ores, coal, and petroleum, as well as water and what might be called biological raw materials—food and other products of agriculture. Then we explore the various networks that interconnect us all: the electric power grid, communication channels, and transport by road, rail, air, and water. Finally we come to the nether end of the industrial economy—the disposal and recycling of wastes.



Not everything industrial or technological will be found within these pages. My emphasis is on landscape, meaning things you can see out of doors. I have had to ignore a multitude of familiar household technologies; thus, you will have to turn elsewhere to learn how a dishwasher or a microwave oven works. With regret, I have also had to leave out many manufacturing operations. I would have greatly enjoyed learning and describing what goes on inside a pharmaceutical plant or a fabrication line for silicon chips, but all the action in such places is hidden away; from the outside, you would have a hard time telling whether a factory makes aspirin or microprocessors. The manufacturing operations that do appear in these pages are those where the machinery is more or less visible from outside the chain-link fence, as with oil refineries and steel mills. (In fact, many of the photographs in this book were taken from outside the fence—or by poking the lens of the camera through it.)

Other excluded topics may seem more or less arbitrary. I decided not to attempt a survey of military technology, partly because poking a camera lens through *those* fences could get me in trouble. I also had no room for the construction industry. Finally, I should note that this is largely a guide to the North American industrial landscape, with some attention to Europe but almost nothing about the rest of the world.

The writing of this book has been an education and an adventure. I have crisscrossed North America as a technotourist taking in the highlights of the industrial landscape. Friends looked at me strangely when I announced that I was going to New Orleans not for Mardi Gras but to look at the drainage pumps, that I was driving to Vermont not for the skiing but to see a granite quarry, that my vacation in the south of Italy was spent photographing highways and harbors. At least I avoided the crowds.

My hope is that this book will cultivate greater awareness of all the miscellaneous hardware that goes into making a civilization, and perhaps even some enthusiasm for



Some industrial activities impress a pattern directly on the landscape itself, especially in mining and agriculture. At left, ponds are prepared in the surface of a towering artificial butte, made of low-grade copper ore. The ponds will be flooded in the mining process called heap leaching. The ore pile is at the Tyrone Mine in New Mexico.

the industrial landscape. It's all around you; you might as well get to know what it's called and what it does. If you would pull off the highway to admire a mountain vista or a waterfall, you might also consider pausing for a mine or a power plant.

Welcome to the world we have made for ourselves.

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This is a book that springs from at least three sources. One point of departure was the question that my daughter, Amy Hayes, used to ask from the back seat: "What's *that* thing?" I thank her both for asking the question and for letting me know when my answers grew too pedantic to endure.

Looking further back, my own interest in the artifacts of the industrial world was awakened in adolescence, when I was fortunate to have an older friend, Dave Fell, an engineer and an urban-industrial counterpart of the wise woodsman. One summer we explored the back roads near Cape May Point, New Jersey. The locale is significant. Witmer Stone's *Bird Studies at Old Cape May* was a founding work of American nature writing, and Lily Pond at Cape May Point still attracts an interesting population of birds and birders. When Roger Tory Peterson, the dean of field-guide authors, made his first ornithological expedition, his destination was Cape May Point. But the area is also a rich one for the technophile. Less than a mile from Lily Pond, Dave and I found a vast, humming plant that extracts magnesium from seawater; nearby we watched a dredge deepen the canal that crosses the cape; we clambered over a World War II blockhouse and gun emplacement, abandoned by the Coast Guard; and we puzzled over rusted remnants of bygone industries, such as a steam-driven mill for crushing oyster shells into powdered lime. Dave—sadly, now deceased—taught me the pleasure of puzzling out how things work.

The third influence was Dennis Flanagan, the editor of *Scientific American* through all its best years, who educated a generation of science writers, including me. In a conversation two decades ago, Dennis pointed out that although a great deal is written about technology, almost all of it focuses on a few fashionable topics such as computers and genetic engineering; the technologies that run most of the world's industries have become almost invisible. His remark inspired this book, and his continuing guidance helped to shape it. Dennis died in January, 2005.

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