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Solar Energy Education

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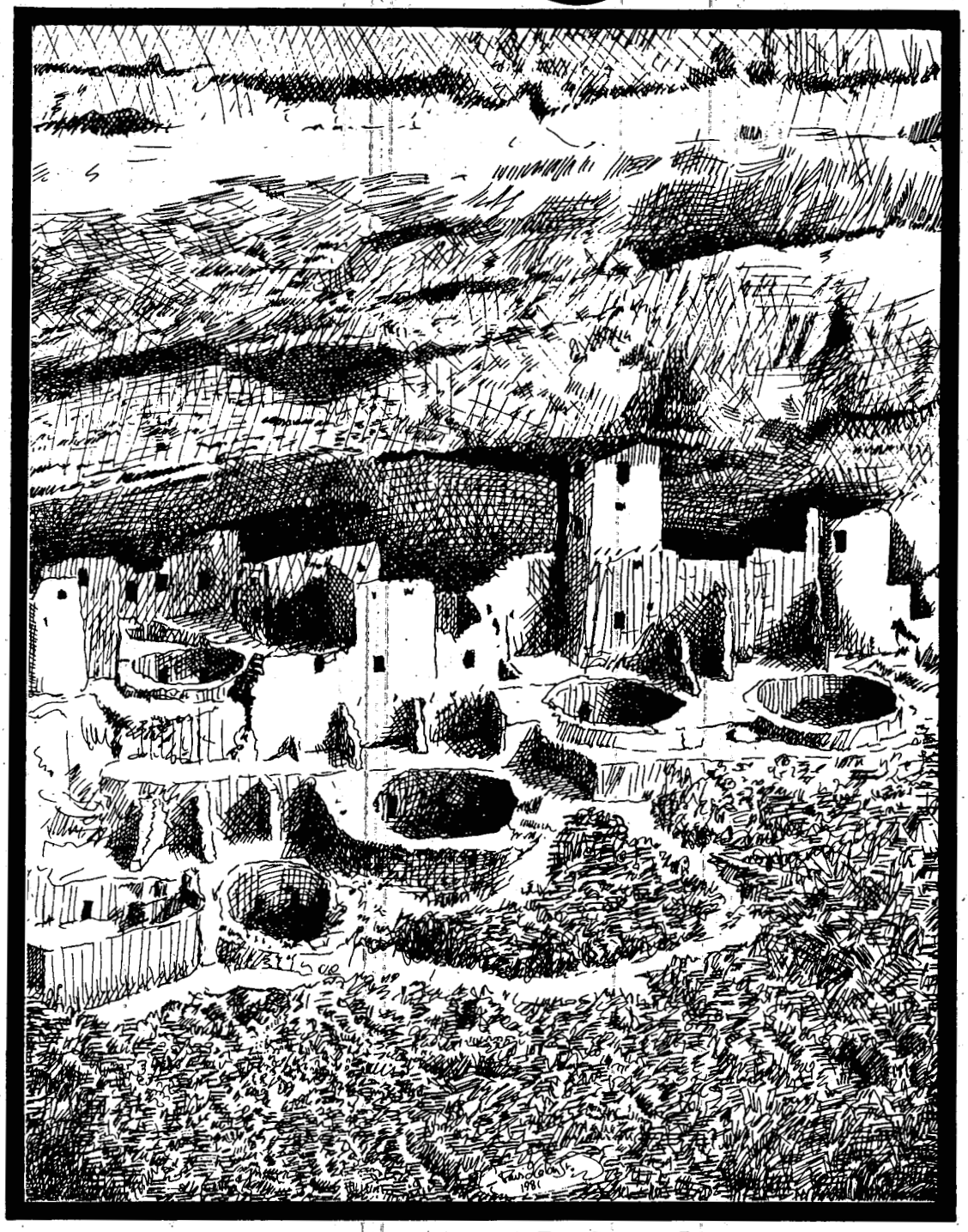

MASTER

Sun Story

READER Part II

Release for Announcement in Energy Research Abstracts

Notice

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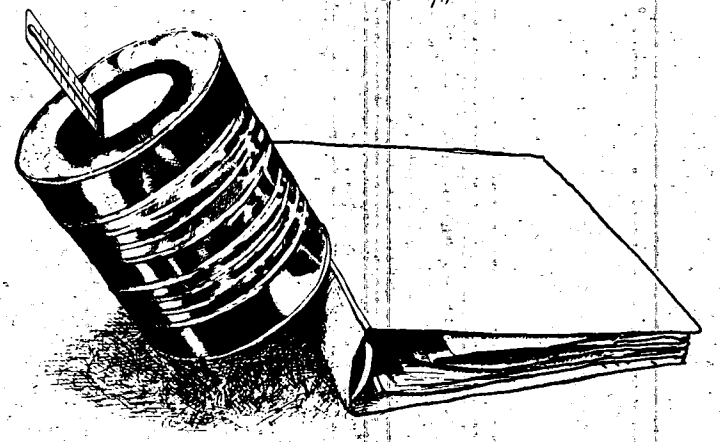

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Solar Energy Education

READER
Part II
Sun Story

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Table of Contents

Introduction

The energy picture is changing too fast to be captured in books. Before the ink is dry new experiments, technologies, and legislation make some of a new book's information obsolete. Magazines and newspapers are better able to keep pace with rapid change, and it is on these media that the well-informed energy consumer depends.

In your hands is a collection of magazine articles selected to help you focus on an important part of the changing energy picture: solar energy. This booklet is Part II of the Solar Energy Reader, a series of four booklets:

I. Energy, Society, and the Sun

(General readings on philosophical, political, and legal topics)

II. Sun Story

(Solar history, mythology, and poetry)

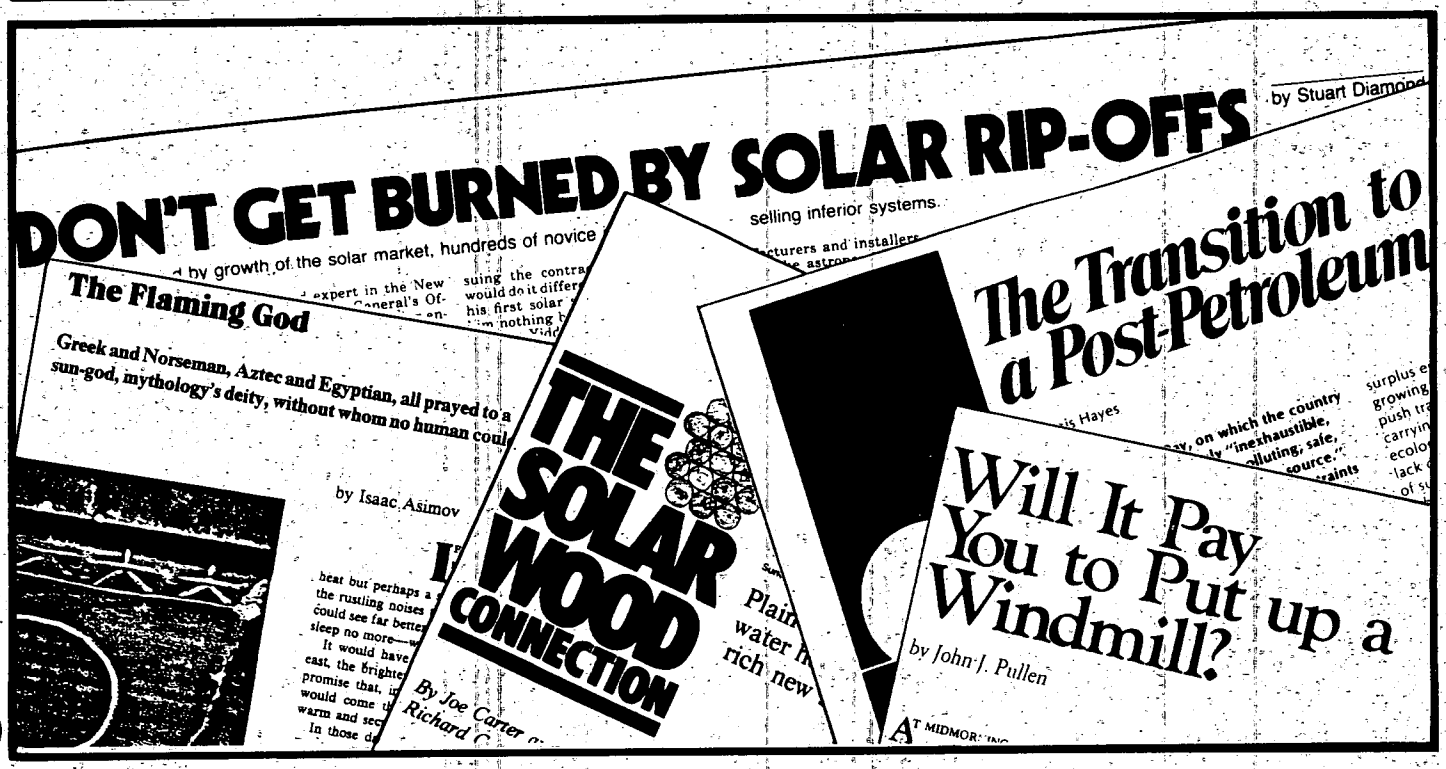
III. Solar Solutions

(Articles on the many applications of solar energy: heat, photovoltaics, wind, hydro, biomass, etc.)

IV. Sun Schooling

(Easy readings on energy and articles about teaching solar)

The bibliography at the end of this booklet will guide you to articles that time and space would not allow us to include here. But the magazines represented in the bibliography and the reader are continually publishing new reports on recent developments. The person who wants to be well-informed about the changing energy picture will follow these publications regularly.



The Readings

The Flaming God

Weaving together ancient myths and beliefs from many cultures, the author gives us a picture of the preeminent role the sun played in the lives of ancient peoples.

The Flaming God

Greek and Norseman, Aztec and Egyptian, all prayed to a sun-god, mythology's deity, without whom no human could live

by Isaac Asimov

Edwards: FPG

Tomb of Irinūfer, Thebes—"the god of that city became Amon-Re, god of Thebes and of the sun."

IF YOU were a primitive person waiting through a long night; if it were dark and chilly, with no source of light and heat but perhaps a smoldering campfire; if you could hear the rustling noises that might mean predatory animals that could see far better in the dark than you could; if you could sleep no more—what would be the greatest sight?

It would have to be the soft graying of the sky in the east, the brightening of the dawn, which brought the sure promise that, in a short while, poking above the horizon, would come the sun itself, to make the world light and warm and secure again.

In those days, when the workings of the universe were attributed to myriad gods, surely among the chief of them would have to be a sun-god, powerful and beneficent, for how could human beings live without the sun? God's first command in the Bible was "Let there be light" (to be collected into sun, moon, and stars on the fourth day), for without light nothing else was possible.

To the ancient Egyptians, the sun-god was Re, and he was the principle of creation, creator of everything, even of himself. Each Egyptian city had its own god, often equated with the sun-god. When the Egyptian empire was at its height, about 1500 B.C., with its capital the southern city of Thebes, the god of that city, Amon, became Amon-Re, god of Thebes and of the sun.

Then, about 1360 B.C., when for the first time in history, as far as we know, a monotheistic religion was established briefly under Pharaoh Ikhnaton, of Egypt, the one supreme god he worshiped was the god of the sun.

The equally old Babylonian civilizations had a sun-god called Shamash, the giver of life and light, and the father of law and justice. And why not? It's natural even today to equate law and justice with the light of the sun and to feel that the cloak of darkness hides evil and crime.

Every civilization had its sun-god among the great powers of the pantheon. India had the redheaded Surya, from whom the race of human beings was descended. Japan had Amaterasu (unusual in being a sun-*goddess),* and if she was not the ancestress of the human species, she was at least the progenitor of the Japanese ruling house, of which Hirohito is the current representative.

The Norse had the beautiful Balder, god of the sun, of youth, and of beauty, who was married to Nanna, goddess of the moon. And so it goes: the ancient Irish had Lugh; the ancient Britons, Lleu; the ancient Slavs, Dazhbog, who

---

A trained biochemist, Isaac Asimov is an unrestrained author who has written a galaxy of articles and more than 170 books. His latest: a collection of mystery short stories entitled More Tales of the Black Widowers.

was also the god of wealth and success—undoubtedly because of the sun's golden appearance; the Polynesians, Tane, who was also the god of all living things; the Maya, Itzamna, the sun-god who was the first, the oldest, and the creator of all else; the Aztecs, Quetzalcoatl, a sun-god who was also the god of wisdom and the inventor of the calendar.

In the West, however, the best-known sun-god is the Greek Helios, who was later identified with Apollo. Whereas the Egyptian sun-god, Re, crossed the sky in a boat, Helios crossed it in a magnificent golden chariot drawn by four fiery horses that only he could control.

The difficulty of keeping those raging steeds on their course was the thought that gave rise in Western literature to what is perhaps the best-known myth involving the sun-god. Helios had a son, Phaëthon, by the nymph Clymene. When doubts were cast on his paternity, Phaëthon went to Helios and insisted that the god vow to vindicate his son's honor. Helios vowed, and Phaëthon demanded to be put in charge of the solar chariot for a day.

Culver

Helios—"fiery horses only he could control."

Helios was forced to give in, and Phaëthon took the controls. Feeling an inept hand on the reins, the horses went out of control. Rearing and plunging, they came too close to earth, burned a desert across northern Africa, and baked the African peoples black. The earth would have been destroyed if the Greek master god, Zeus, had not struck Phaëthon out of the chariot with lightning and allowed the horses to return of their own accord to their accustomed path.

THE normal path of the sun is itself a matter of adventure. To help use the sun and moon as bases for timekeeping, the ancient Sumerians (the earliest civilization in the Tigris-Euphrates Valley) were the first to mark off the stars into those groups we now call constellations, and they gave them fanciful names based on resemblances of the distant star configurations to familiar objects. The sun, in the course of the year, passed through twelve constellations of the zodiac, called after the names of lions, crabs, and archers.

The tale of the sun's journey would recount his victory over each danger he encountered, and the suspense would be great, for only by his victory could his course be successfully completed and human survival assured. It may be that the twelve labors that Hercules must successfully complete before achieving rest in heaven is a version of the sun's passage through the twelve dangerous constellations—a version obscured by changes in the names of the constellations and by the accretions of incidents by ancient mythmakers.

Yet the sun's career is not one of unalloyed success. However triumphant he may be ordinarily, he can be obscured by clouds. In those parts of Europe where clouds and storms are common, it may be the lightning-wielding god of the sky or of storms who is supreme—the Zeus of the Greeks and the Thor of the Norse. Even the Bible seems to depict Yahweh as having been a storm-god in primitive times.

There is also the danger of eclipse, which temporarily seems to slay, in part or in whole, either the sun or the moon. In the Norse myths both the sun and the moon are eternally pursued by gigantic wolves as they make their way across the sky, and occasionally the wolves overtake the luminaries and hide them, temporarily, within their slavering jaws.

But the storm cloud appears only occasionally, and the eclipse is even more rare. One solar death, however, is periodic and inevitable. At the close of each day, the sun, no matter how glorious its reign, must sink beneath the western horizon, defeated and bloody, and night returns in victory.

This is represented most colorfully in the Norse tale of their sun-god, Balder. Balder, the joy of gods and humanity, is troubled suddenly by a presentiment of death. His mother, Frigg (the wife of the Norse master god, Odin), exacts an oath from all things to do no harm to Balder but neglects to include the mistletoe. The gods then engage in the game of hurling missiles at Balder in order to watch those missiles swerve away of their own accord.

The evil god of fire, Loki, learning of the exemption of the mistletoe, carves a mistletoe branch into a spear and gives it to Hoder, the god of night, who, being blind (after all, one cannot see by night), has not been participating in the game. Loki guides Hoder's aim and Balder falls. The sun had died under the attack of night.

A less obvious solar myth may be the Hebrew legend of Samson. The Hebrew version of the name, Shimshon, bears a striking resemblance to *shemesh*, the Hebrew word for "sun" (itself related to the Babylonian Shamash). Two miles south of Samson's traditional birthplace was the town of Beth-shemesh ("house of the sun"), believed to have been a center of sun worship.

Samson, like Hercules, survives various dangers because of his superhuman strength. What's more, Samson's strength derives from his hair, which may be viewed as representing the golden rays of the midday sun. When Samson's hair is shorn, he grows weak, as does the sun when it approaches the horizon, red and rayless, so that it can be looked on without harm. It is in the lap of Delilah that Samson sleeps when he is shorn, and Delilah's name is closely akin to the Hebrew *lilah*, meaning "night." The sun sinks into the lap of night and is defeated and blinded. But Samson's hair grows again and he recovers his strength for one last feat, since, after all, the sun does rise the next morning.

In fact, in the sunny lands particularly, the sun must survive all the onslaughts of night and must win in the end. In Persian mythology Ahura Mazdah, the god of light, fights Ahriman, the god of darkness, in a cosmic battle that fills the universe—and it is Ahura Mazdah who will win at the end of time. (The Jews of the Persian period adopted this view, and it is from 400 B.C. onward that Satan enters the

Judaic, and later the Christian, consciousness as the dark adversary of God, to be defeated at the end.)

The sun's setting and rising is one inspiration for the many mythic tales involving the death and resurrection of a god. An even more impressive death and resurrection is the death of vegetation with the coming of winter and its restoration in the spring.

The tale of Balder might just as well be the symbol of the god of summer's being slain by the god of winter. Similar significance can be given to the death and resurrection of Osiris among the Egyptians, of Thammuz among the Babylonians, and of Proserpine among the Greeks.

But the sun is clearly connected with the summer-winter cycle as well as with the day-night cycle. Throughout the European summer, the noonday sun reaches a slightly lower point in the southern sky each day than it did the day before. As the sun's path in the sky slowly sinks southward, the temperature grows colder and the vegetation turns brown and dies.

If the sun should continue to sink and should pass down behind the southern horizon altogether, death would be universal and permanent, but that does not happen. The rate of sinking slows, and each year on December 21, by our calendar, the sun comes to a halt—solstice (from the Latin *solstitium*, "sun halt")—and thereafter begins to rise again.

The winter may continue to sharpen after the solstice, but the fact that the noonday sun rises steadily higher in the sky is a guarantee that spring and summer will come once more. The day of the winter solstice, of the birth of a new summer sun, is therefore a time for a great festival, celebrating the rescue of all life.

The most familiar solstice celebration of ancient times was that of the Romans. The Romans believed that their agricultural god, Saturn, ruled Italy during an early golden age of rich crops and plentiful food. The winter solstice, then,

Incas worshiping the sun—"every civilization had its sun-god in the pantheon of powers."

Bettmann Archive

Culver

Balder, the Norse sun-god—married to the moon.

with its promise of a return of summer and of the golden time of Saturnian agriculture, was celebrated with a week-long Saturnalia from December 17 to 24. It was a time of unrelieved merriment and joy. Businesses closed so that nothing would interfere with the celebration, and gifts were given all round. It was a time of the brotherhood of humanity, for on that day servants and slaves were given their temporary freedom and were allowed to join in the celebration with their masters and even to be waited on.

The Saturnalia did not disappear. In fact, other evidences of sun worship came in the time of the later Roman Empire. Heliogabalus, a priest of the Syrian sun-god, sat on the Roman throne from A.D. 218 to 222, and about that time, the worship of Mithra, a sun-god of Persia, was becoming popular, especially among the soldiers.

The Mithraists celebrated the birth of Mithra at the winter solstice, a natural time, and fixed on the day December 25 so that the popular Roman Saturnalia could build up to the Mithraist "Day of the Sun" as a climax.

At that time, Christianity was locked in a great duel with the Mithraists for the hearts and minds of the people of the Roman Empire. Christianity had the great advantage of accepting women into the religion, whereas Mithraism rejected them (and, after all, it was the mother, not the father, who influenced the religious beliefs of the children). Mithraism, however, had the Saturnalian festival of the sun on its side.

Sometime after A.D. 300, Christianity managed the final coup of absorbing the Saturnalia, and with that it scored its final victory over Mithraism. December 25 was established as the day of the birth of Jesus, and the great festival was made Christian. There is absolutely no biblical authority for December 25 as having been the day of the Nativity.

All the appurtenances of the Saturnalia were adopted anyway—the joy and merriment, the closing of businesses, the brotherhood, the gift giving. All was given new meaning, but all was still there.

So that beneath the panoply of the celebration of the birth of the Son is the distant echo of that far older rite, the celebration of the birth of the sun. ◉

Energy, Technology, and the Story of Man

With this sweeping survey of energy use by human society, the author drives home one central theme: new forms of energy bring about new forms of society. As the energy picture changes, he says, humans are brought into confrontation with their values and their hopes for the future.

Energy, Technology, and the Story of Man

Melvin Kranzberg

THE physicists have defined energy as the ability to do work, and they have postulated thermodynamic laws relating different forms of energy to one another and to work performed. But energy is more than a physical phenomenon: It is a social phenomenon. The way in which energy is produced, controlled, and applied—used and misused—helps determine the nature of society. Or, as Fred Cottrell, the sociologist, stated, "The energy available to man limits what he *can* do and influences what he *will* do."[1] Certainly man's material civilization—and much of his cultural life—is dependent upon a technological base, which in turn rests upon man's use of energy. As man has learned to control and apply energy in different ways, society has undergone concomitant changes.

Our prehuman forebears might never have evolved into our present species had it not been for their ability to control energy in the form of fire. During the many climatic changes which occurred during the eons of geologic time, prehistoric men might not have survived without fire to keep warm. It is not surprising that fire was regarded as sacred—a gift from the gods, or, as Greek legend had it, a theft from the gods by Prometheus.

Fire also improved man's chances for survival by increasing his food supply. By enabling him to live in colder areas, fire enlarged the territorial range of man's food-gathering activities. It also made possible cooking, allowing unpalatable or indigestible foodstuffs to be converted into assimilable human energy.

Fire extended man's use of materials. Early man already used stone implements and tools, but the development of pyrometallurgy, enabling him to use the store of metals locked in the earth, greatly extended his power and skills. Copper, bronze, and, later, iron provided man with materials which he could utilize to control and subdue nature, as well as his neighbor.

Yet even with the application of fire, the greater part of energy available to man for performing work came mainly from his own strength. There were two ways by which man could augment his muscle power. One was by domesticating animals, so that they would perform work for him; the other was by devising tools and implements which would amplify and extend the power of his muscles. An increase in energy through the domestication of animals, about the seventh millennium BC, could not make itself felt until more efficient use could be made of animal muscle power by the invention of the wheel (about 2500 BC) and, much later, of a more efficient harness for horses. The increase in power through tools had come much earlier.

ONE of the first "machines" was the bow-and-arrow, which might be viewed as a machine for storing energy and releasing it in directed fashion. When the bowstring is slowly drawn back, human muscle power transmits energy to it; this energy is released suddenly when the archer shoots. The bow-and-arrow and other weapons expanded food supply by enabling man to kill small game at a distance. Other early tools and devices also multiplied human muscle power; this was especially true of the wheel, which made it easier to transport heavy loads over long distances. By classical antiquity, Archimedes could classify the "five simple machines" and analyze the mechanical advantage which they gave man in manipulating things.

[1] Cottrell, William F. *Energy and Society*. Greenwood Press, Inc., Westport, Conn. 1955. P. 2.

Dr. Kranzberg is head of the Graduate Program in the History of Science and Technology at Case Western Reserve University and editor-in-chief of Technology and Culture.

Even with only rudimentary tools, human muscle power can perform feats of great magnitude if organized effectively. The chief example is the pyramids. Although built before the Egyptians had the wheel, the pyramids demonstrate the prodigious accomplishments of human muscle power when effectively marshalled in the performance of a collective task.

It has been claimed that slavery militated against more effective use of human energy. When faced with a problem requiring the exertion of more force, the ancient engineer simply added more slaves to the work gang instead of devising some ingenious mechanical solution which would lessen the strain on human muscles. Proof of this is adduced from the fact that the water wheel was known in Roman times, but Romans scarcely made use of it. Instead, they continued to rely on human and animal muscle power.

THE Middle Ages witnessed a veritable "power revolution." Rome's decline coincided with the decline of slavery and stimulated the application of new power sources. Water wheels came into widespread use and were improved. The vertical water wheel, introduced in the fourth century after Christ, for instance, had a power capacity of 2 kilowatts, compared with only three-tenths of a kilowatt for the earlier horizontal type.[2] By the time of the Domesday Book (1086), there were some 5,000 mills in England, amounting to one mill to every 400 of the population. First used for grinding grain, water power was later applied to a great diversity of industrial uses, most importantly to drive the bellows of blast furnaces so that the economical process of casting metals could come into widespread use.

Another source of inorganic power contributed to the medieval power revolution: wind. Although wind had been used to drive sailing vessels since antiquity, its use as a power source in the West dates from about the twelfth century. Windmills provided power in flatlands where the fall of streams was too slight for a water mill and where a mill dam would flood too much land.[3]

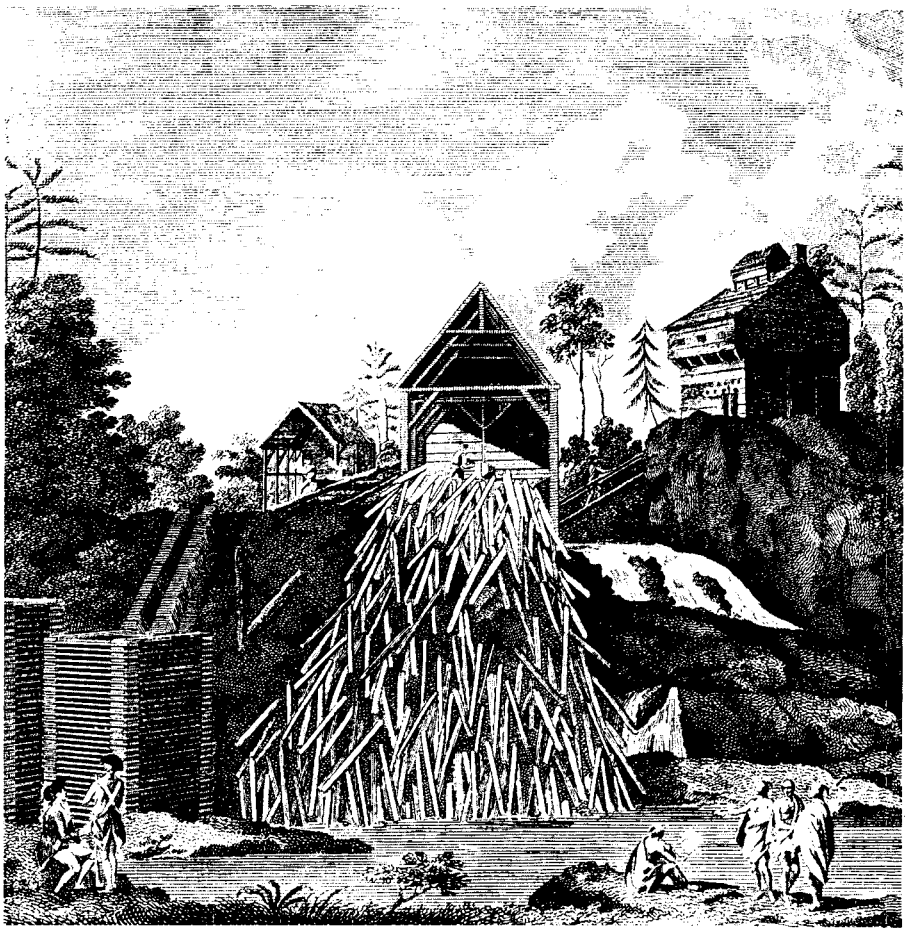
The medieval power revolution also enlarged animal power by improvement of the harness, which had remained unchanged since about 3000 BC. The old harness had been held in place by a strap around the neck; as soon as the horse exerted a heavy pull, it choked itself. Furthermore, the ancients did not know how to harness horses in file in order to multiply their tractive power; nor did they use horseshoes, and their horses often suffered foot injuries on rough terrain. The rigid horsecollar, probably introduced from Asia during the early Middle Ages, together with horseshoes (ca. the tenth century) and the tandem harness, multiplied the effective pulling power of horses by some three to four times over that in antiquity.[4] A horse driving a machine with the new and more efficient harness was the equivalent of 10 slaves, while a good water wheel or windmill provided the work of up to 100 slaves.

The medieval power revolution, coupled with technological innovations in agriculture and machines, laid foundations for the renewal of town life and the beginnings of industrial technology. The Renaissance saw continued growth in the exploitation of water and wind power as power devices increased in size. By the seventeenth century, the Marly works which pumped water for Versailles had a

[2] Starr, Chauncey. "Energy and Power." *Scientific American* 225: 37-49; September 1971.

[3] White, Lynn, Jr. "Medieval Roots of Modern Technology." In *Perspectives in Medieval History*. K. F. Drew and F. S. Lear, Editors. University of Chicago Press, Chicago, Illinois. 1963.

[4] White, Lynn, Jr. *Medieval Technology and Social Change*. Oxford University Press, New York. 1962. Pp. 57-69.



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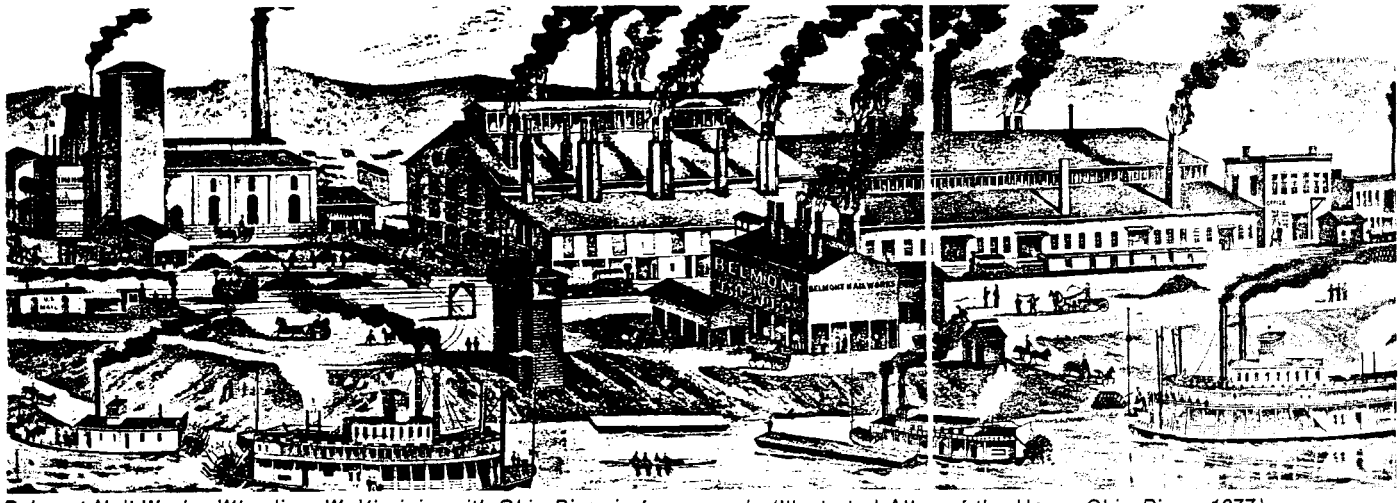
Water power was depicted in this engraving of a saw mill and block house on Fort Anne Creek done by Thomas Anburey. (Travels Through the Interior Parts of America, *1789)*



Belmont Nail Works, Wheeling, W. Virginia, with Ohio River in foreground. (Illustrated Atlas of the Upper Ohio River, *1877)*

power output of 56 kilowatts; similarly, the capacity of windmills grew from several kilowatts to as much as 12 kilowatts. In addition, the Renaissance developed complex gearing arrangements for the transmission of power from water wheels and windmills so that more efficient use could be made of the energy input.[5]

By the eighteenth century Europe was in desperate need of new power sources. Windmills were effective only in flatlands, such as the Netherlands, where the terrain did not interfere with a steady wind. Water power was intermittent in operation; the flow of water would decline during dry seasons or freeze in cold weather. In England, all the good industrial sites—that is, where there was a sufficient flow and fall of water—were already taken up by factories crowded close together. The need for a new source of power was especially prevalent in the mining areas, to pump water from mines. The steam engine answered that need and became the characteristic power source of the Industrial Revolution.

THE steam engine, and the Industrial Revolution of which it was a part, completely transformed the economic, social, and cultural life of Western Civilization—and ultimately of the entire world. For almost all of human history, the hearth and home had been the center of production, and agriculture had been the chief occupation of the vast bulk of mankind. Men lived in rural areas, their horizons limited, and with a standard of living scarcely above subsistence. Industrialization changed all that. The factory became the center of production; the city became the center of human life and production; family relationships changed, while traditional institutions, such as religion, lost their hold upon men's minds in the new urban surroundings.

A transformation also occurred in the centers of political power. The steam engine gave the industrial advantage to countries with abundant supplies of coal. This advantage was reinforced when steel became the basic industrial material. Because the making of steel required more coal than iron, the location of the energy resource determined the center of steel production. It is not surprising that Britain, with its iron and coal deposits, became the world's industrial leader and the dominant political power during the nineteenth century.

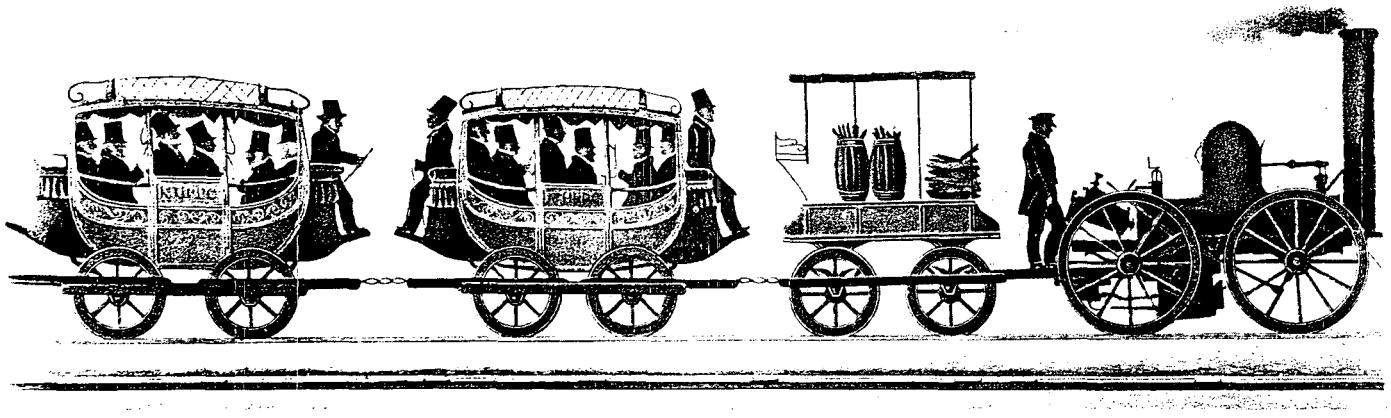
The steam engine was the first mechanical prime mover to provide mobility. Through the steamboat and locomotive, energy from steam revolutionized transportation and brought the world closer together.

Steam both epitomized and embodied the fundamental technological change of the modern era—an incredible jump in available energy. Before the age of steam, the sum total of energy which man could effectively convert to his purposes through wind and water, through animal and human power, was quite limited. Then, in the nineteenth century, man liberated the power of fossil coal through the steam engine on a scale never before possible. The new power, multiplied or divided almost at will, was applied to uncounted tasks.

Yet the steam engine had some disadvantages. It was heavy and cumbersome; almost a century and a half after its development, a reciprocating steam engine could operate at only 23 percent of thermal efficiency. Nevertheless, the power revolution ushered in by the steam engine expanded under the impetus of scientific discovery and technological innovation which created a new prime mover, the internal-combustion engine, and a new form of energy, electricity.

THE internal-combustion engine enlarged, accelerated, and altered the social changes already occurring as a result of steam power. Small, light, and powerful, the internal-combustion engine personalized the amount of power available for each individual, provided transportation for everyone, and made readily available a source of power with which to do a number of tasks, including fulfillment of man's ancient dream of flying. The automobile's effect on American society is so marked as to require no recounting here. The mobility of Amercian society is evident in every facet of our daily life—and this is the result of energy for transportation made available to everyone through the automobile. Furthermore,

[5] Keller, A. G. *A Theatre of Machines*. The Macmillan Company, New York 1964.



Drawing of the first American railway train as it appeared in July 1832 on the Mohawk and Hudson Railway.

the automobile represents a major factor, perhaps *the* major factor, in the American economy: One out of every eight workingmen in the United States is employed in a task directly connected with the automotive industry.

Equally portentous was the discovery, development, and utilization of electricity. A single comparison with the past illustrates one dramatic change wrought by electricity. One of the romantic episodes of the American West was the Pony Express, begun in 1860, but it was only the ultimate exploitation of a form of communication centuries old—a message carried by a man on a horse. The trip from St. Joseph, Missouri, to San Francisco took ten and a half days—ten fewer than the best stagecoach time. A year later, however, the transcontinental telegraph was completed, and the time for a message to reach the Pacific was again cut, this time to a fraction of a second. Within another 15 years the telephone was a crude though working reality, and the Atlantic Cable shortly after mid-century brought messages across the ocean in an instant. Today, through telecommunications satellites, events occurring halfway across the world are flashed immediately onto television screens in our living rooms.

Electricity has become so much a part of our daily lives that we sometimes fail to recognize how unique and important it is—until a storm or malfunction cuts off our power. We fail also to realize how really new it is in terms of the long time span of human history. Yet it was less than a century ago (1882) that the first electric power station for private consumers, the Pearl Street Station, was established by the Edison Company in New York City. It served a modest load of approximately 1,400 lamps, each taking about 83 watts and constituting an electric demand of 33 kilowatts.

Electrical energy found still another use in the twentieth century. In the census of 1890, the United States Bureau of the Census introduced machines to sort and tabulate data on punched cards, providing the prototype of new means for storing and manipulating information. Previous applications of energy through mechanical devices had lifted the burdens off men's backs. Now the use of energy for information purposes began lifting the burdens off men's minds, freeing them from dull and repetitive tasks.

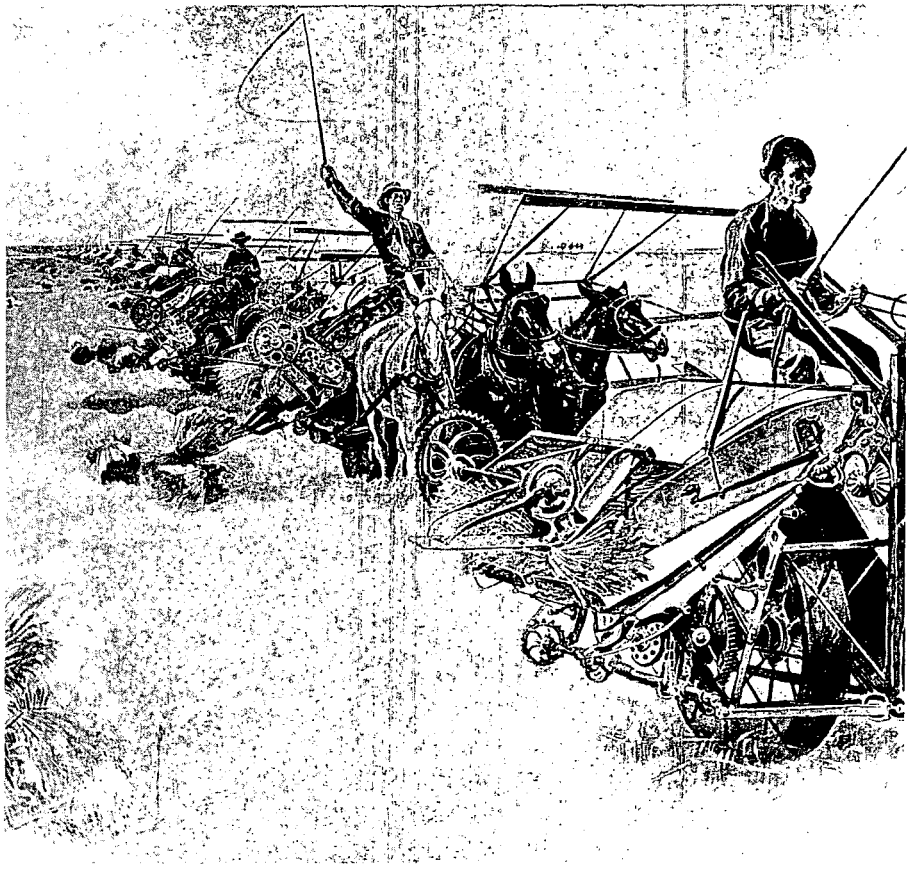
And, just as the development of earlier energy sources had allowed the exploitation of a wider field of materials, so did the new electronic devices allow for manipulation and exact control of the productive process. Automation reduced the need for human labor while increasing and standardizing output. For the first time in human history, a society of abundance and affluence was possible. The implications of this for work and leisure are still not completely understood.

Contemporaneous with the new applications of energy in the twentieth century—and, indeed, dependent upon them—was a revolution in agriculture. Farm mechanization demonstrates how the application of energy to food production has eased man's toil and, at the same time, increased productivity. As late as half a century ago, approximately one-quarter of the farm acreage in the United States grew crops for feeding the 25 million farm horses and mules; that acreage has been freed to provide food for human beings.

The growing utilization of energy on the American farm has meant that there is less need for human and animal muscle power. Rural workers have been displaced, for they are no longer needed to till the soil; the family farm is fast disappearing, and agro-business is taking its place. A vast migration from rural regions to cities has accompanied the growth of farm productivity, and this has given rise to urban and also racial problems as southern Blacks have migrated to northern industrial centers.

In brief, the manifold applications of energy in production, both industrial and agricultural, have given rise to a new type of society where production, which had occupied so much of man's time and energies over the course of the centuries, no longer presents a problem.[6] The census figures reveal the magnitude of the social changes. What was primarily still a rural and agrarian nation at the beginning of the twentieth century had by the middle of the cen-

[6] W. W. Rostow calls this "the age of high mass-consumption." In *The Stages of Economic Growth*, Cambridge University Press, Cambridge, England, 1960. Chapter 6.



Harvesting on a bonanza farm. (Harper's Weekly, *August 29, 1891)*

tury become predominantly urban. Late in the 1950s the number of people employed in the service sector of the economy surpassed those engaged in production of goods.

ALTHOUGH ushered in with an act of destruction which still echoes in the conscience of mankind, a new form of energy—nuclear power—marks one of the greatest triumphs of science and technology in our time. Radioactivity had been discovered near the close of the nineteenth century and had caused excitement in a small segment of the scientific community, but the idea of harnessing this energy for useful purposes was imagined only by science fiction writers. In *A World Set Free,* written in 1914, H. G. Wells predicted that nuclear energy would be invented about 1940 and, most presciently, that it would be used in war about 1950. Wells thought that about the middle of the 1950s, the world would come to its senses and realize the possibilities offered by nuclear energy in the form of unlimited, cheap, and ubiquitous energy which would, in a very real sense, set men free from the limitations of previous energy sources.[7]

But something happened on the way to Well's Utopia. Neither man nor energy is yet free. What is worse, the country is confronted with an energy "crisis." On June 4, 1971, the President of the United States sent a message to Congress acknowledging that the country had entered a period of increasing demand for energy and of growing problems of energy supplies. Scientific and technological factors account partially for the energy crisis, but much of the difficulty has arisen from social factors, especially public hostility stemming from fears of thermal pollution and radiation hazards and alarm over danger to the environment from older forms of energy applications.

[7] Similar possibilities are set forth in a more recent work by Glenn T. Seaborg and William R. Corliss, *Man and Atom: Shaping a New World Through Nuclear Technology.* E. P. Dutton & Co., Inc., New York. 1971.

Americans are demanding a quality environment. They are appalled at ugly strip mines, oil slicks from tanker spills and leaky offshore wells, denuded corridors of land for energy transmission lines, sulfur oxides and fly ash from power plants, noxious emissions from automobile exhausts, and the real or imaginary specter of radioactive perils from nuclear centers. Scientists and technologists engaged in the production and application of energy are thus faced with a major problem: how to protect the environment and still provide for the "good life."

That question poses basic issues about values. The value scheme implicit in our past profligate use of energy was based upon a human history of scarcity—scarcity of material goods to satisfy basic needs of food, clothing, and shelter. Now that we have the potentiality for a sufficiency of material goods, the environmental issue has become of overwhelming importance. Heretofore, American society, with its orientation toward material development, has always considered economic growth as essential to the nation's well-being. Yet if proper cognizance is taken of environmental factors, we might have to slow the pace of economic growth or change its direction.

What message, then, does the story of the development of energy and its impact on man's history have for us? It tells us of the great opportunities offered by human imagination and ingenuity in converting energy to man's use and how such uses inevitably affect our social destiny. With this knowledge in mind, we can face with confidence the current issues involving energy production and application. We can examine our values, we can decide how we want to live, and we can have due regard for the other peoples of the world and for future generations within our own country. We can then arrive at a comprehensive national policy which will take our resources, our science and technology, and our aspirations into account. The present "energy crisis" does not bring man into confrontation with his science and technology; it forces man to confront himself. □

Solar Energy Use and Litigation in Ancient Times

Energy, law, and lifestyles are connected in this description of ancient Greece and Rome and their early energy shortages. When fuel became scarce, human ingenuity responded to the crisis by using solar energy. Laws then grew and developed to accommodate the new reality.

SOLAR ENERGY USE AND LITIGATION IN ANCIENT TIMES†

Borimir Jordan* and John Perlin**

Short of firewood in their deforested lands and lacking other sources of fuel, the ancient Greeks and then the Romans turned to the sun for heat. Passive solar design kept the villas of the rich warm in winter and cool in summer and heated the great public baths of Rome. By the late Imperial period, Roman architects were surprisingly advanced in this art.

Solar heating required access to sunlight. A classical scholar and a solar energy historian describe the use of the solar resource by the ancients and review solar access law as set down in the sixth century Digest of Justinian.

I
SOLAR ENERGY USE IN ANCIENT GREECE

"The right sort of house," said Socrates, "must be pleasant to live in." "And is it not pleasant," he asked, "to have it cool in summer and warm in winter?"[1]

 This article will appear, in somewhat different form, in the forthcoming book *A Golden Thread: 2500 Years of Solar Architecture and Technology*, by John Perlin and Ken Butti, to be published by Cheshire/Van Nostrand-Reinhold Co., March 1980. The authors thank Ken Butti for his help.

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1. Xenophon, *Memorabilia* 3.8.8 ff. (B. Jordan trans.).

The Greeks had no air-conditioning and no adequate heating systems. The only sources of heat were the wood-fueled kitchen stove and portable charcoal braziers for the rest of the house.[2]

Over the millennia in which civilizations flourished in ancient Greece, the constant use of wood—practically the only source of energy—led to massive deforestation. In addition to residential heating, the development of trades, manufacture, mining, and smelting made heavy demands upon the timberlands of the Greek world.

The deforestation began as soon as the first permanent societies established themselves at the beginning of the Bronze Age (c. 2200-1000 B.C.), and it continued unabated through the Archaic (800-500 B.C.), Classical (500-300 B.C.), and Hellenistic (300-100 B.C.) Ages.

From the beginning of the Archaic Age, the industrial use of wood continued to grow, along with population pressures. Wood was needed in the construction of dwellings for more and more people, while technologies such as mining and smelting required quantities of wood in the form of charcoal. Additionally, timber provided the supports and scaffolding in the shafts of iron and silver mines, with which Greece was well-endowed. As navigation increased and the art of naval warfare was developed, timber was required for the construction of merchant marines and ships of war.[3]

These demands were met at heavy cost. By the fifth century B.C., the first signs of coming fuel shortages began to appear. Faced with a growing fuel crisis, the Greeks resorted to the importation of wood from overseas, just as they were gradually forced to import grains. As the distance of the fuel sources increased, the price also rose. Originally rich in primeval forests, Greece soon became a land poor in wood. By the fourth century B.C., the scarcity of timber was general.[4]

Shortages and rising costs of imported wood and charcoal forced the Greeks to think of substitutes and alternatives. The problem was particularly acute with respect to the heating of private houses. Although winters in Greece are comparatively mild, the weather can become cold enough to be uncomfortable. The ubiquitous braziers, besides being smoky and consuming expensive charcoal, simply did not heat ancient houses well enough.

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2. *See* R. J. Forbes, *Studies in Ancient Technology*, vol. VI, Leiden: E. J. Brill, 1966, at 1-87; Borimir Jordan, *Servants of the Gods*, Göttingen: Vandenhoeck and Ruprecht, 1979, 103 ff.
3. *Cf.* Thucydides 6.90, 7.25; Plato, *Laws* IV, 705 c.
4. *See* K. Sklawounos, "Über die Holzversorgung Griechenlands im Altertum," *Forstwissenschaftliches Centralblatt*, vol. 52 (1930), at 268-274, citing the ancient Greek evidence fully and in detail.

For domestic heating, the Greeks turned to the sun. They were aware that the sun, deified, personified, and worshipped as the god Helius, was the supplier of all earthly heat. The great fourth century naturalist Theophrastus wrote: "The sun supplies the life-giving heat in animals and plants; and it is also possible that the heat of our earthly burning arises through the sun's agency. Certainly many people think that they are catching rays from the sun when starting a fire."[5] Theophrastus further pointed out that the heat of the summer sun is so great that it causes grain to pop on the threshing floor as though it were being roasted.[6] Moreover, certain contrivances invented for practical purposes, notably the sundial, or *gnomon*, constantly reminded the Greeks of the regularity of the sun's course.[7]

Knowing the position of the sun with precision, builders in ancient Greece could adjust the orientation of houses so as to profit from the sun's natural heat. There is evidence that the possibilities of passive solar heating in private houses were understood as early as the fifth century B.C. According to Xenophon, Socrates observed that "in houses which look toward the south the winter sun shines into window openings, while in summer it passes high above our heads and over our roofs, and throws them (the windows) in shadow."[8]

Excavation of ancient sites in Greece has revealed that, beginning in the fourth century B.C., houses and even entire towns, Olynthus and Priene, for example, were designed to make use of the sun's heat.[9] Living rooms of houses occupied the north sides of courtyards, with windows facing south. Thus they could catch the winter sun, which remained in the south for much of the day, just as Socrates says. The southern part of the house was built lower than the northern part so as not to block the solar exposure of the main living rooms. That is to say, the northern part of the house was built up to two stories, while the southern part was only one story high. If two stories had to be built in the southern part, an attempt was made to keep at least the side directly opposite the windows down to one story. Another floor plan placed the main living rooms higher than the other three

5. Theophrastus, *De Igne* (V. Coutant trans.), Assen: Van Grocum, Ltd., 1971, at 6.
6. *Id.* at 44.
7. *See* Herodotus 2.109.3; Athenaeus, *Deipnosophistae* 1.7-8; Sir Thomas Heath, *Aristarchus of Samos*, Oxford: Clarendon Press, 1966, at 21, 38.
8. Xenophon, *supra* note 1, 3.8.8.
9. David M. Robinson & J. Walter Graham, *Excavations at Olynthus*, vol. 8, Baltimore: Johns Hopkins Press, 1938, at 142-51; Theodor Wiegand & Hans Schrader, *Priene, Ergebnisse der Ausgrabungen und Untersuchungen in den Jahren 1895-1898*, Berlin: G. Reimer, 1904, at 290-91; Philippe Bruneau & Jean Ducat, *Guide de Délos*, Paris: E. de Boccard, 1965; Joseph Chamonard, *Exploration Archeologique de Délos*, vol. 8, Paris: E. de Boccard, 1922-24.

sides of the house. Examples of this scheme have been excavated on the island of Delos.[10]

In these solar houses, the low winter sun penetrated beneath the eaves and streamed into the rooms, warming their floors and walls. When the rooms began to cool, floors and walls radiated the heat that they had absorbed during the day, keeping the living quarters warm at night. Whenever possible, walls were built of adobe,[11] which provides excellent insulation and retains the sun's heat far into the night. In some localities where clay was scarce, the more abundant stone was used in construction. The north side was sheltered to keep out cold winds.

During the summer, with the sun directly overhead between the hours of 10 a.m. and 2 p.m., the protruding eaves shaded the facades of the rooms facing south. The west and east walls of the houses, where the sun was for the rest of the day, lacked windows, so that the houses remained relatively cool. Adobe, being a poor conductor of heat, also helped the houses remain cool.

The best example of a whole city planned for solar heating was Olynthus, on the Chalcidic Peninsula of Thrace, in northern Greece.[12] Olynthus and another solar city, Priene, on the coast of Asia Minor, were planned cities. Unlike most other ancient cities, they did not grow organically but were laid out at one time. Olynthus was refounded after the Persian Wars, in the fifth century B.C., Priene in the middle of the fourth century B.C. This gave the opportunity for a city plan to use solar heat.[13]

Excavators of Olynthus found the remains of a city in which the houses were laid out with a north-south orientation. The excavators observed a general principle of planning: "[T]he house plan and the city plan exercised a strong influence upon one another, for the regular rectangular shape and the approximate identity of area of all the houses on the North Hill [of the city] were at least facilitated by the regularity of the city plan. . . ."[14]

By the standards of antiquity, Olynthus was by no means a small town. In its heyday the city had a population of perhaps 12,000-15,000.[15] The solar plan of such an urban center was a great achievement which has not been equalled since.

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10. Bruneau & Ducat, *supra* note 9; Chamonard, *supra* note 9.
11. *See* Robinson & Graham, *supra* note 9, at 224-29.
12. *Id.* at 142-51.
13. Olynthus was destroyed by Philip II of Macedon in the year 348 B.C., and, as the site was not rebuilt, the excavated remains are those of the Classical (fifth and fourth century) city. *Id.* at vii.
14. Robinson & Graham, *supra* note 9, at 142.
15. *Id.* at 44.

The solar design of cities like Olynthus and Priene represents the practical application of concepts and ideas which were in the air in the Greek Classical period (500-300 B.C.). Like Socrates and Theophrastus, Aristotle and the writers of the time, such as the playwrights Aeschylus and Eupolis, saw the utility of solar heat.[16]

In the early part of the fifth century, Aeschylus wrote that the civilized house took advantage of the sun. This distinguished it from the dwelling of primitive and barbarous people, "who had neither knowledge of houses built of bricks and turned towards the sun, nor yet of work in wood."[17]

II
SOLAR ENERGY USE IN ROME

As in many other fields of human endeavor, the Romans learned from and, in this particular craft, improved upon the Greeks.

Like Greece, Roman Italy came to suffer the consequences of deforestation. The peoples of Italy began to exploit the primeval forests which covered thousands of acres in the early centuries of the Republic. With the entry of Rome upon the world as a military and political power of the first magnitude, the woods were ruthlessly exploited. Timber was required for fuel and for building, particularly of the rapidly growing Roman fleets. The forests were cut down to make room for orchards, grain fields, and pastures. Region after region suffered this fate. The people of ancient Italy used up their natural resources of timber and fuel perhaps more rapidly than the Greeks.[18]

By the first century B.C., Rome had to import pine and other timber from the fringes of the ancient world, such as the Alpine regions.[19] The wealthy, whose numbers grew with the increase in Roman power and dominion, owned luxurious villas, which they heated centrally by means of *hypocausts*. The *hypocaust* was a heating system which burned wood in a furnace beneath the house; the heat was conducted through hollow bricks built into the floors and walls. To heat a large villa could require 300 pounds of wood an hour, or more than 48 cubic feet every two days.[20]

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16. Aristotle, *Oeconomicus* 1.6.7. Aeschylus, *Prometheus Vinctus* at 450 ff.; Eupolis, *Fragment* 378.
17. Aeschylus, *supra* note 16, at 450 ff.
18. *See* Arnold Toynbee, *Hannibal's Legacy*, vol II, London: Oxford Press, 1965, at 585-98.
19. *See* Livy 9.36. *Cf.* H. J. Loane, *Industry and Commerce of the City of Rome*, Baltimore: Johns Hopkins Press, 1938, at 42-43 (with references to the ancient sources); Ernst Pulgram, *The Tongues of Italy*, Cambridge, MA: Harvard University Press, 1958, at 36.
20. *See* Forbes, *supra* note 2, vol. VI at 36-57.

The bathhouses, which the Romans loved as no other people in history except perhaps the Japanese, consumed enormous quantities of fuel. These public baths, which numbered 800 in Rome alone during the third century A.D., were very large buildings; the largest could hold nearly 2,000 visitors at one time.[21]

As in Greece, the growth of industry and manufacture put additional heavy strains on a fuel supply that was steadily diminishing. Occasionally workshops and factories had to shut down because of lack of fuel. The inhabitants of Elba stopped producing iron before the first century A.D., although their mines still had the best ore in Italy. The islanders had used up Elba's indigenous supplies of wood and so were compelled to cease smelting operations.[22]

Prices of wood, charcoal, and small firewood rose steeply. To avoid the growing shortages and expense, the Romans, like the Greeks before them, turned to solar heat.

We first hear of "sun-spaces" as integral features of houses in the time of the early Republic in the second century B.C. Appropriately called *solaria,* these spaces were open or partially enclosed verandas facing the sun. Modest houses lacked *solaria;* more than two centuries later, however, the emperor Nero conceived a scheme to create *solaria* for the poor by equipping the apartment houses where they lived with porches. A porch would be built out from the facade, its roof to serve as a *solarium* as well as a platform for bucket brigades of fire fighters.[23]

Nero's scheme provides a good illustration of a new approach to building. In the time of Augustus, the first emperor, Roman architects had begun to pay special and deliberate attention to sunlight and to climate in general. The best of these architects, Vitruvius, laid down the principle that the construction of private houses and public buildings must take a particular climate into account. The Phrygians, he observed, built their dwellings in mounds which they hollowed out and covered with logs, reeds, and straw. Thus they were protected from the searing heat of summer and the piercing cold of winter. Taking his cue from the Phrygians, Vitruvius established this doctrine:

> We must design houses according to climate. One type of house is suitable for Egypt, another for Spain, a different kind for the Pontic region,[24] or Rome and so on with

21. Pulgram, *supra* note 19, at 36.
22. *See* Forbes, *supra* note 2, vol. VI at 18 ff. *Cf.* Pliny, *Natural History* 34.96, 34.67. The geographer Strabo tells of the same experience on Cyprus. Strabo 14.6.5.
23. Plautus, *Miles Gloriosus* 2.3.69, 2.4.25; Suetonius, *Nero* at 16; *cf.* Suetonius, *Claudius* at 10.
24. The northern coast of Asia Minor along the Black Sea.

> lands and countries of other characteristics. This is because one part of the earth is directly under the sun's course, another is far away from it, while another lies midway between these two. Hence, as the position of the heavens with regard to a given tract on earth leads naturally to different characteristics owing to the course of the sun, it is obvious that designs for houses ought to conform similarly to the diversities of the climate. In regions where the heat is oppressive and which are scorched by the sun, buildings should be open, always facing north and away from the sun.[25]

With respect to building in more temperate climates, Vitruvius' professional opinion paralleled the construction practiced centuries before at Olynthus when he said: "Buildings should be thoroughly shut in rather than exposed to the north, and the main portion should face the warmer south side."[26]

Vitruvius' advice appears to have been followed by a large class of Romans wealthy enough to own private houses and sumptuous villas along the western coast of Italy from Tuscany to the bay of Naples. In the literature of the Imperial period we hear about these country estates and luxurious residences of the rich, most of all from Pliny the Younger, a rich Roman who lived at the end of the first century after Christ. A prolific letter writer, Pliny owned a villa in Tuscany, where, he says, "The winters are severe and cold, and the summer quite temperate."[27] Pliny describes his Tuscan villa in the following terms:

> The exposure of the main part of the house is south; thus it seems to let the sun in from midday in summer, but much earlier in winter. Sunlight enters into a wide and proportionally long portico containing many divisions. From a wing of the portico you enter a very spacious chamber, which is extremely warm in winter, being well exposed to the sun.[28]

Pliny was rich enough to have a second villa. This villa stood in Laurentum, to the south of Rome, and it was especially designed to use the sun's heat. The villa had duplicate sets of rooms that were evidently

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25. Vitruvius, *De Architectura* 6.1 (B. Jordan trans.).
26. *Id.*
27. Pliny, *Epistulae* 5.6 (B. Jordan trans.).
28. *Id.* 5.6.

meant for alternating use in winter and in summer. Pliny speaks of winter and summer rooms in a passage in which he also mentions his "winter retreat," a chamber with windows facing southeast to southwest and closed off from the north. He boasts that this room "collects and increases the heat of the sun."[29] He goes on to say: "The house has a large drawing room, and also a second drawing room of smaller size, which has one window facing the rising sun, and another facing the setting sun. This arrangement makes the room quite hot; it serves as a winter retreat."[30]

The windows of Pliny's winter reading room were arranged to follow the low arc of the winter sun. Such an orientation of winter rooms seems to have been general; a similarly designed "winter retreat" was found in a house excavated at Pompeii.[31]

Sometimes these "winter retreats" appear to have been called *heliocamini*,[32] literally "solar furnaces." Their shape was often semicircular, they had two or three large windows facing south, and these windows were probably covered by clear glass or some other transparent material such as thin, clear mica. In the ancient world, glass was produced at least from the year 3000 B.C.; but, until about the birth of Christ, it was used chiefly in ornaments, vases, and statuettes. Although translucent materials such as talc, alabaster, shell, and horn were used as window coverings,[33] the use of baked glass in windows appears to have been a Roman invention made sometime in the first century A.D. Seneca, an avid letter writer like Pliny, about the year 60 A.D. wrote to his friend Lucilius: "Certain inventions have been made only within our own memory—the use, for example, of window panes which admit the clear light through transparent glass."[34]

Glass has the property of admitting sunlight but trapping the heat inside the space that it covers—the so-called greenhouse effect. Visible shortwave light passing through glass windows is absorbed by the surfaces inside and is reradiated as longwave energy or heat. Since longwave energy cannot penetrate glass easily, heat is trapped inside. The Romans made this discovery empirically and exploited it to heat dwellings, baths, and greenhouses.[35]

The temperatures thus achieved were considerable. They surely rose far above the warmth in the less sophisticated houses at Olynthus.

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29. *Id.* 2.17.
30. *Id.*
31. *See* Hugo Blümner, *Die Römischen Privataltertümer,* München: C. H. Beck'sche Verlagsbuchhandlung, 1911, at 80, reproducing Mau's schematic drawing of that house, the famous House of Diomedes at Pompeii.
32. *Id. See also Digest* 8.2.1-41.
33. *See* Forbes, *supra* note 2, vol. V at 184.
34. Seneca, *Epistulae* 90.25 (B. Jordan trans.).
35. See Blümner, *supra* note 31, at 89.

Rooms so heated could actually become very hot, fully justifying the term *heliocaminus*—"solar furnace."

Rich Romans had gymnasia and baths in their villas; Pliny the Younger used the winter rooms of his villa as a gymnasium.[36] Since Romans exercised nude, they required a warm space in the wintertime, when the temperature could fall near freezing.

Roman architects always sought to place a villa's baths where they could get the most sunlight in the winter, as Vitruvius makes plain when he says that

> the site for the bath must be as warm as possible and turned away from the north. The windows of the warm and hot baths should face the southwest. If the building site prevents this orientation, the windows should at least face south since the time for bathing is fixed between midday and evening.[37]

This principle is repeated by Faventinus, another Roman architect, who lived in the later Roman Empire.[38] Seneca tells us that a man could linger in his bath until he practically boiled.[39] Pliny the Younger too mentions with considerable pride the baths in his Tuscan villa, which were largely heated by the sun: "The warm bath enjoys the kindly warmth of the sun, but not as intensely as the hot bath, which projects from the house in such a manner as to catch the full sun."[40]

Pliny's reasons for relying on the sun's heat to warm his houses are clear. He wanted a villa to be "large enough for convenience without being expensive to maintain."[41] The winter rooms of his Tuscan villa never required conventional heating except when it was very cloudy. That Romans of the wealthier class should attempt to save money in this fashion underscores the expense of fuel and its shrinking supply, while providing a graphic illustration of the advantages of solar heating, even in antiquity.

While for Pliny and his contemporaries solar heat was a means primarily of reducing fuel costs, for Romans living several centuries after him, its use became a necessity. The Empire was falling into disarray. Declining Roman power could no longer keep open the supply lines from the distant wooded parts of the known world. The large

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36. Pliny, *Epistulae, supra* note 27, 2.17.
37. Vitruvius, *supra* note 25, 5.10.1, 6.4.1.
38. Faventinus, *De Diversis Fabricis Architectonicae 16.*
39. *See* Seneca, *supra* note 34, at 86. Seneca's bathing room had glassed windows which trapped solar heat. *Id.*
40. Pliny, *Epistulae, supra* note 27, 5.6.
41. *Id.* 2.17.

estates and farms in the Roman countryside were forced toward self-sufficiency.

Faced with uncertain supplies of fuel, the owners of villas came to rely even more on the sun's heat. This is borne out by the work of two Roman architects of the third and fourth centuries, Faventinus and Palladius, both of whom stressed the importance of methodical and scientific orientation of buildings so as to take full advantage of the sun's heat. Their recommendations extend particularly to the proper positioning of hot baths and of the winter drawing and dining rooms which Pliny also mentions. Faventinus even devised an ingenious method of making the floor of a dining room absorb the greatest possible amount of the sun's heat. This process required the following steps:

1. Excavate the earth to a depth of two feet, and pound it.
2. Put in a flooring of rubble or earthenware.
3. Gather cinders, trample them into a thick mass, and apply a layer containing a mixture of dark sand, ashes and lime, six inches thick. The surface of this mixture leveled with a square, gives the appearance of a black floor.

"The floor's warmth," Faventinus concludes, "will please the bare feet of your servant."[42]

III
SOLAR RIGHTS IN ROMAN LAW

The Greeks, with their less formal legal system, apparently had no system of legally enforceable solar rights. The Romans did. Roman sun rooms were common enough to provoke disputes over solar rights and judicial decrees to settle them. The right to solar heat was associated with the general right to light. (In an ancient society, with only dim, smoky oil lamps for artificial light, the sun's light was vital.) An entire section of the Digest, the great compilation of Roman civil law prepared under the emperor Justinian, deals with access to sunlight.[43]

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42. Faventinus, *supra* note 38, at 14, 26. The black surface absorbs heat from sunlight, and the layer of rubble absorbs and stores the heat, which is radiated into the room when the air becomes cooler than the mass of rubble. *Cf.* Palladius, *De Re Rustica* 1.40; Vitruvius, *supra* note 25, 7.4. Vitruvius says this method of storing solar heat was a Greek invention adopted by the Romans.
43. *Digest*, *supra* note 32, 8.2.1-41.

Although the dominant view has been that there is no right to light in classical law, a close study of the Digest finds otherwise.[44] Briefly, the legal scheme appears to have been as follows.

A property owner had a right to a reasonable amount of daylight. To build without leaving a neighboring house a minimum of light, a builder had to have a servitude (*altius tollendi*) over the neighboring land. Without that, he could be legally forced to tear the building down. On the other hand, to have the right to more light than the bare minimum, a neighbor had to have a servitude (*altius non tollendi*) against the builder to prevent him from building higher. The decision as to what constituted a reasonable amount of light was left to the judge or arbiter.[45]

A landlord who failed to protect the building against loss of light became liable to the tenant if the leased room were darkened. The tenant could abandon the lease; and, if the landlord demanded the rent, some reduction must be made.[46]

The 50-volume Digest, commissioned by Justinian and completed in 533 A.D., is a compilation of selected legal opinions rendered by Roman jurists over the preceding three centuries.[47] Thus it represents a body of law that grew up over time.

Of some 40 cases compiled in the section on the right to light, one deals with the right to solar heat. In general, private rights were not conferred by legislation, but by praetorian edicts. In order to bring a lawsuit, a litigant had to go to the *praetor*[48] for permission. Applying the rules of law, the *praetor* granted or denied the action. *Praetors* and judges consulted jurists, professional legal scholars. The *praetor* not only applied the rules of existing law, but created new actions and defenses,

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44. Alan Rodger, *Owners and Neighbours in Roman Law*, Oxford: Clarendon Press, 1972, esp. 38-39, 89-91.
45. *Id.* at 38-40, 51, 89-91. *See also* David Daube, "Interference with Light in Roman Law," 93 LAW J. 180, 180-81, 189-90 (1943). For a general discussion of servitudes in Roman law, *see* F. Schulz, *Classical Roman Law*, Oxford: Clarendon Press, 1969, at 381-99.
46. Rodger, *supra* note 44, at 87-95.
47. An editorial commission of professors and advocates under Tribonian collected and excerpted statutes and decisions. Tribonian records that 2,000 texts with three million lines were read; but only a twentieth, 150,000 lines, were selected, including the works of 38 jurists. J. B. Moyle, *Imperatoris Iustiniani Institutionum, Libri Quattuor*, Oxford: Clarendon Press, 1923, at 74-75.
48. *Praetor urbanus*, an annual office. *Id.* at 30-32.

thus changing the law. The jurist's opinion to the judge, at least during the Imperial period, seems usually to have been followed.[49]

Ulpian, the third century jurist generally acknowledged as the ablest of the Imperial period (his work makes up about one-third of the Digest), rendered the ruling on access to solar heat that is preserved in the Digest.[50] He begins by granting an action to an owner whose light has been blocked by a tree, on the grounds that a "tree too [as well as a building], makes the sky less visible." The discussion next moves beyond ordinary daylight; for Ulpian makes a subtle distinction between sunlight, for which he uses the Latin word *lumen*, and the sun's heat, *sol*. Suppose any object is so placed as not to block ordinary light (*lumen*) but as to block the sun's heat (*sol*). If the object blocks the sun where its heat was not wanted, no action is granted. If, however, that object is so placed as to block the sun's heat and create a shadow in a space where the sun's heat is essential, a *heliocaminus* or a *solarium*, there is a violation of the easement and an action is granted. On the other hand, the removal of buildings and trees, resulting in increased heat from the sun, is not actionable since no servitude is violated.

This long, complex ruling comes from the period (second and third centuries A.D.) when *heliocamini* and *solaria* had become especially popular, probably because of the availability of baked glass. The fact that Ulpian's ruling was carried over into the Digest in the sixth century shows that solar access litigation continued into the final days of the Roman Empire. After that it disappeared, to be revived only in our own time.

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49. *Id.* at 58-59.
50. *Digest*, *supra* note 32, 8.2.17.

When the People Gather

The importance of the Sun Dance in the religious rituals of many Native American societies is well documented. The interest of this article lies in its reminder that the dance is a living, growing phenomenon today.

Notes on the Teton
Dakota Sun Dance

When the People Gather

David W. Zimmerly

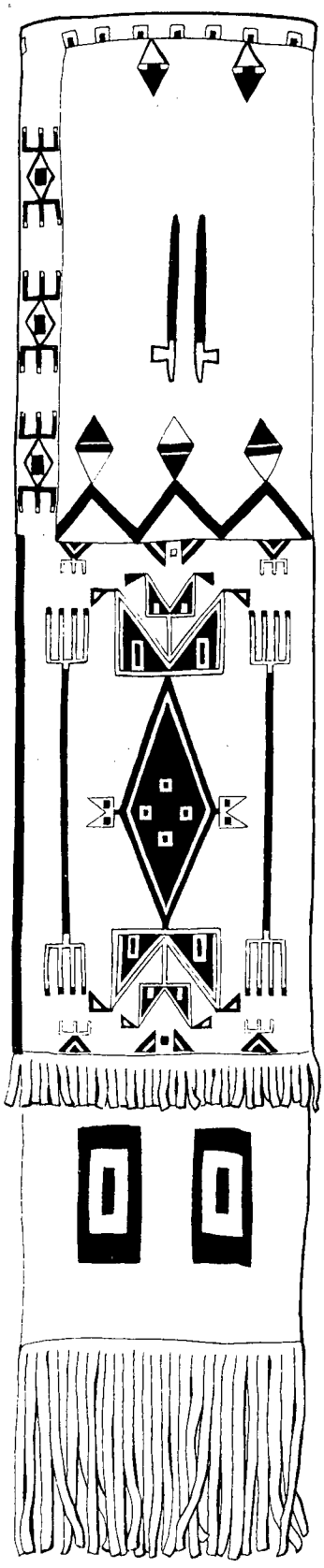
"Oyate Kawita au cana," an old Lakota story begins . . . "When the people gather." The people have been gathering for over a week under the blazing sun; they have come to this dusty parched place. They have even come this very night. But the camp conveys a feeling of uneasiness, of apprehension, for with the dawn comes the day. A special day, the day of truth. Today is the day for the fulfillment of vows.

The tourist with his camera, the anthropologist with his notebook, the missionary in white shirt and tie, the young Sioux mother with her lively family, the shriveled old Oglala woman supported by a cane -- all have gathered to witness the piercing of the flesh.

It is now dawn, and this great gathering of people is astir.

The Sun, the Light of the world
I hear Him coming.
I see His face as He comes.
He makes the beings on earth happy,
And they rejoice.
O Wakan-Tanka, I offer to You this world of Light

Preparations for this day were begun many weeks ago. Such a gathering as this cannot be set up overnight. There were wells to be repaired, outhouses to be dug, publicity to be prepared, electricity and public address systems to be strung and a host of other details that needed attention. The Sioux are no longer a people living in tipis. Their needs are no longer simple. The luxuries of the last century are today's necessities. Thus outwardly, the Sioux seem much like any rural people. But we cannot know what is in their hearts. We can only guess that it may be different from what is in ours for their history and our history do not coincide. Rather they clashed head on. But that was a hundred years ago. By now should they not be concerned with getting ahead and acquiring the possessions that progress has bestowed upon mankind? The answer, of course, is yes. But it is a qualified yes. For it to be otherwise would mean becoming a wasicu or White man, and that cannot be.



The past is not that easily forgotten. And along with memories of the past are values of the past, values which are being taught to the present generation. Many, however, have eroded away, but some still persist such as the old patterns of sharing and sociability. These persistent values are most often manifest in the many native religions, rituals and societies. One of these native rites is the Sun Dance, called by the Sioux wiwanyag wachipi (they dance gazing at the sun).

Until 1883 the Sun Dance was one of the most important annual rites held by the Sioux. At that time its suppression was ordered by the United States government on the grounds that it was barbaric and detrimental to the hoped-for acculturation of these people. Although it was sporadically practiced during the first part of this century, it was not officially sanctioned by the Bureau of Indian Affairs until the 1930s. It was as though the words to this sacred Sun Dance song had been answered:

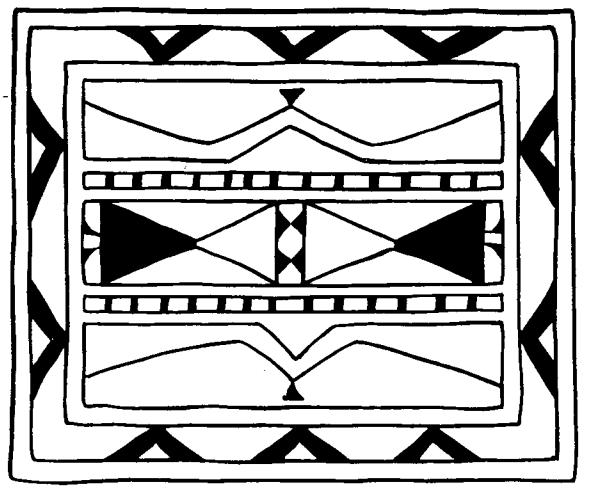
Wakan-Tanka, have mercy on us,
That our people may live!

Living to the Sioux, means more than mere existence. It means a way of life with elements that are uniquely Sioux, some that are uniquely "Indian" and some that belong to the dominant society and to all mankind. The Sun Dance fits into all three of these categories. As Leslie Spier showed in 1921, this rite diffused widely throughout the Great Plains, and although many aspects belonged generally to the Sun Dance, others were unique to a certain tribe. Edgar Red Cloud, descendant of Chief Red Cloud, saw parts of the Sun Dance as having certain parallels with Christian symbolism when he said that "the crown our dancers wear is like the crown of thorns that Christ wore. The piercing of the chest once, reminds us that Christ was pierced once while on the cross."

There are numerous other descriptions of the Sun Dance of the Sioux, and while all are similar in some ways, they are different in others. They all agree, however, that the medicine man, or holy man as he is often called, was free to innovate. Pueblo Indian religious practitioners did not have this freedom for their religion's efficacy depended upon execution of prescribed ritual formulas.

Plains Indians were under no such strictures. Their religions have always been more individualistic. Yet it is precisely these allowable changes and innovations which constitute the major argument of Indian and White alike when they describe the Sun Dance as a secular affair. "They don't do it like they did in the old days" is a frequently heard phrase. Of course they don't. The Sun Dance, or for that matter almost any religious rite, was never done the way it had been done fifty years ago, or even two years ago.

Some of the early descriptions mention the colored flags that are placed on the Sun Dance tree. Certain colors were used, such as red to represent the light of the rising sun, and black to represent the darkness of night. These colors and their meanings are apparently not very important because even the early descriptions are not consistent and of the four times I have seen the Sun Dance, the colors and placement of the flags varied from one year to the next. Thus the most consistent part of the many Sioux rituals is the fact that change has always been present. This is the most difficult part to understand by one accustomed to a European religion.

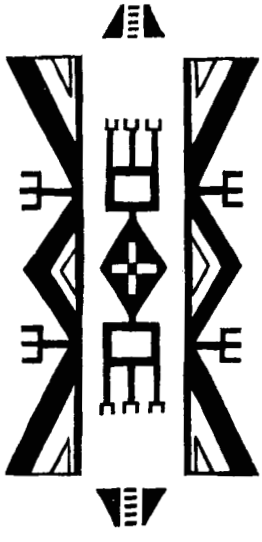


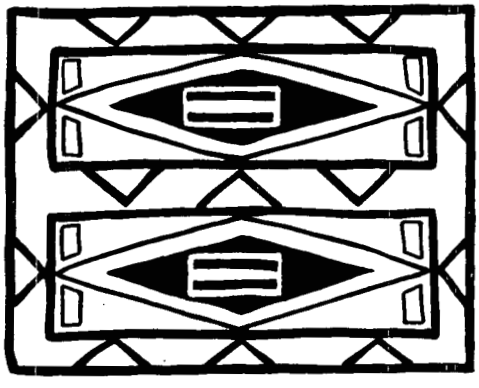
Religion to the Indian is not the same as it is to the non-Indians in this country. There are parallels to be sure, but preciseness of ritual formula is not one of them. Some Indian informants have described their Sun Dance as the "Sioux Flesh Circus." It may be, however, that these people are really probing for opinions from the outsider before they commit themselves to saying what they really think. The Sioux are as sensitive to criticism as anyone else and after years of experience of being laughed at and looked down upon for their "different" beliefs, it seems perfectly obvious that there would be many protective layers around that which is hidden in their hearts. To know the Sioux takes long-term exposure; you must prove yourself, prove you are genuinely interested in their problems, their desires, their culture. More importantly, you must be interested in them as people per se, and not as living museum specimens.

Frank Fools Crow, the Sun Dance Chief or Holy Man has often been criticized for accepting money, as have the participants and singers who receive minimal compensation. They are paid enough to cover their expenses for transportation and preparation of items and clothing needed for the dance. Also, the patterns of sharing, as mentioned before, are still important, and the larger amount of money that Fools Crow receives ($150.00) is used and distributed among his relatives who provide him with assistance when needed. Contrary to Anglo practices, higher status as an individual is still given on the basis of generosity and not on accumulation of goods and money.

An important way to understand the Sun Dance and its relevance to the modern Sioux is through the actual dance participants. Their reasons for dancing are as varied as their individual backgrounds. One had just completed one hundred missions in a jet over the torn fields of Viet Nam. He danced, thankful that he was able to return to the quiet hills of Pine Ridge. Attended by a small boy, he danced with all his heart, his red-painted face glistening in the warm rays of the morning sun. He, as well as every other Sun Dancer, had personal reasons for subjecting himself to the hardships of the dance, but to a man, they danced also for the well-being of all the people.

A good day has been set upon my forehead as I stand before You, and this brings me closer to You, O Wakan-Tanka. It is Your light which comes with the dawn of the day, and which passes through the heavens. I am standing with my feet upon Your sacred Earth. Be merciful to me, O Great Spirit, that my people may live!





One old woman danced for the safety of a son in Viet Nam; a man danced to fulfill a vow he had taken when his sister was ill. He had vowed that upon her recovery he would participate in the next four Sun Dances, and would sacrifice himself by being pierced through the breast. Pete Catches, another dedicated and religious man, had his own personal reasons for dancing. Each had his separate intentions, but now they all stood together around the Sun Dance Pole -- the sacred cottonwood tree which just two days before had stood in a small thicket along a nearby creek bottom. This tree had a song of its own:

> There was a time when I stood, holy, in the midst of the day.
> There was a time when I stood, holy, recognizing people here and there.
> There was a time when I stood, holy, in the center of the camp circle in the tribe.

This sacred pole, symbolic center of the universe, would receive the attention of all gathered as it tried to restrain the violent pulling of the men linked to it through rawhide ropes. The men in turn would try to break through their bonds of ignorance represented by their skewered flesh.

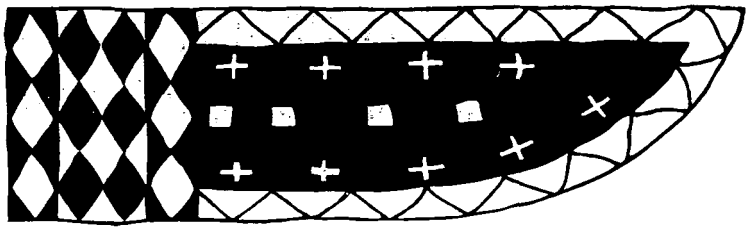
Before straining against these earthly ties, the devotees leaned heavily on the tree, gathering strength for the ordeal to come. We can almost hear them as they pray:

> Great Mystery, turn your eyes earthward and look on me pityingly and aid me.

Testing their bonds, gently at first, they strained and pulled backwards until their flesh was visibly distended. Some broke through by steadily increasing pressure, while others hurled themselves backwards so violently that when they broke away, they almost lost their balance.

Of all the dancers, Pete Catches appeared to be the most unwavering in his devotion to this sacred rite. He never looked for crowd support as some others may have; he kept up a steady, hard dance pace at all times while maintaining a constant gaze to the heavens. During intermissions he remained quiet and outside the conversational groups of the other dancers. He seemed to be in constant meditation with things religious. He had a raptured look on his face when he danced, but it was always in a humble and unassuming manner.

Seeing this one man among all others was sufficient to know that no matter how many electric water fountains were installed within the arbor, no matter how much the dancers were paid, no matter how many critical comments concerning the religiosity of the Sun Dance were made by tourist and Indian alike, here was a Sioux who lived in the true sense of the word, who transcended ordinary earthly bounds, who lived and felt his religion in his heart.



Myths and Tales

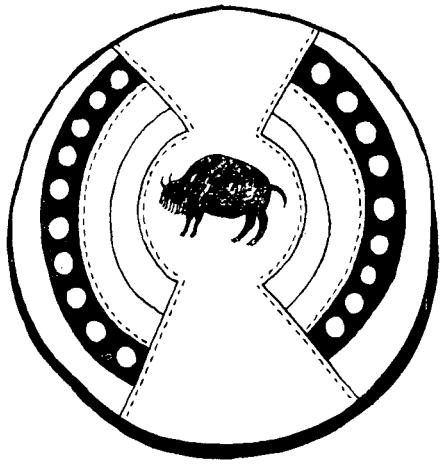
Scarface

The sun is but one of the powers at work in this tale, and the hero finds that to obtain what he desires from one power he must give something up to another.

Scarface

from Jack Holterman's "Blackfeet Stories"

Once in the very North of time, ** there lived in the camp of the Ancient Piegans a very poor young man with a very ugly scar on his cheek. He had, perhaps, received this wound in battle, but no matter: the girls would have little to do with him. In vain did he borrow a love flute. Quite in vain did he go about the camp looking for a girl who would marry one so poor and ugly. People just laughed at him and called him Scarface.*



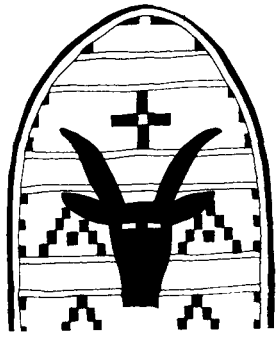
Now there was a lovely girl, a chief's child, who caught his eye. But alas, she was one dedicated to the Sun or to the son of the Sun, and therefore she must turn away all her suitors. Yet when Scarface came to ask for her, she could not say No. She only said, "You must go to the Sun. If he releases me from my bond, he will give me a sign: he will take away your scar. Then I shall marry you."

Go to the Sun? How does one go to the Sun? Or was this girl too just laughing at him? But poor Scarface set out, not knowing which way to go. He sought the help of the great ones, the wise, the old people, the little birds and the hawks and the cottonwood tree that stood on the shore of the lake. He tried the North, but the wise ones told him, "Go that other way. Over there it looks blue . . ." And they pointed to a range on the horizon. He tried the East, but the wise ones said, "Go that way. Over there it looks blue." He went to the South, but again the wise ones said, "No. Go over that way where it looks blue. And wherever he went, each one told him to ask someone else. But the old cottonwood tree by the lake bade him build a sweathouse. And there he spent four days till he heard something singing. Two swans appeared and carried him into the West over the great lake. Over there it looked blue.

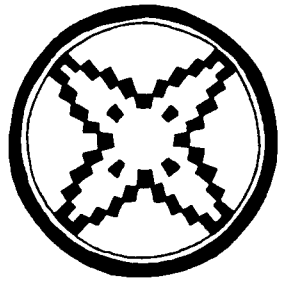
And so it was that Scarface reached the other earth, the one up there where the Sun and the Moon live with their son Early Riser the Morning Star. Ah! What a fine and handsome young man was that Morning Star! And he found Scarface near the shore and took him home to the red-black lodge of the Sun and the Moon.

But when the Sun came home in the evening, he refused to enter his lodge. "I shall not go in," declared he, " for there's a person in there!" So Morning Star had to take his friend away. But in the evening, when the Sun came back, it was the same thing all over again. This happened four nights.

The fourth time, though, the Sun relented. He said, "Now I shall help that person." So he took Scarface into four sweatlodges, and he painted his face with holy red paint. The scar was gone. "Now," said the Sun, "you must go back to the earth and to your people."



So Scarface, now clean and handsome too, set out to return to his own country. But first he must take leave of the Morning Star. And Early Riser gave him a love flute and said to him, "My friend, I want that woman, that chief's child. I do not want to give her up to you. Now you must give her up to me."

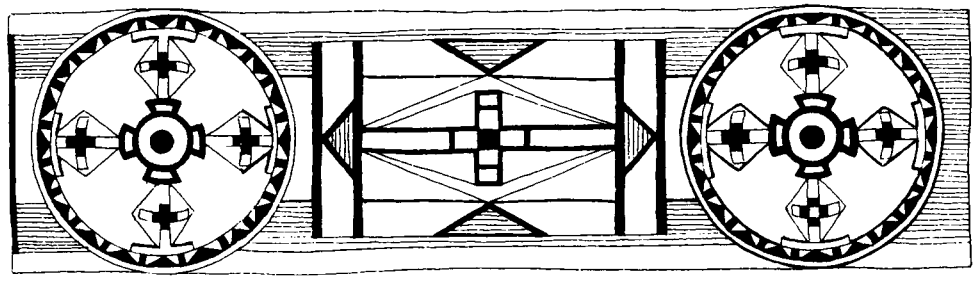


And Scarface descended by the Wolf's Trail, the Milky Way, and returned to his own country and his own camp of the Ancient Piegans. And he played the flute for the lovely girl, the chief's child. He took her to the lake, to the head of the lake, to the giant rock at the head of the lake which is the Sun's own rock. And there he looked into the sky and said, "Morning Star, my friend, here is the woman."

And he saw her no more. Kyene.

* Pai, Poia, Akski are the various forms of this name.

** The traditional way to begin a story is "(omil) apatohsik" and the root APAT - relates to "back," "old-time" and "north."



Phaethon

Like the well-known myth of Icarus, this is a story of youthful rashness. The myth of Phaethon goes further, however, by using a credible tale of human weakness to discuss one of the great natural phenomena, the daily journey of the sun.

Phaethon

adapted from Ovid's Metamorphoses

Up the long, broad stairway to the palace of the Sun came a young man. It was very early morning, and dark. Phaethon, Clymene's son, had come from Earth to ask the Sun god a question.

When he was admitted to the presence of the god, Helios, he shrank back in awe. The god was so radiant that Phaethon's eyes were dazzled. Could it be true, what his mother had told him? Could the Sun be his own father?

The next moment the boy was amazed to hear Helios cry out to him encouragingly, "What do you seek, O Phaethon, my son?"

Then it was true! But was it? Boldly, but trembling, the boy declared, "Oh light of the universe, if you are indeed my father, give me proof and free my mind from doubt."

The god put off his crown of light and drew near and embraced him. "Doubt no more. I will grant you any proof you ask."

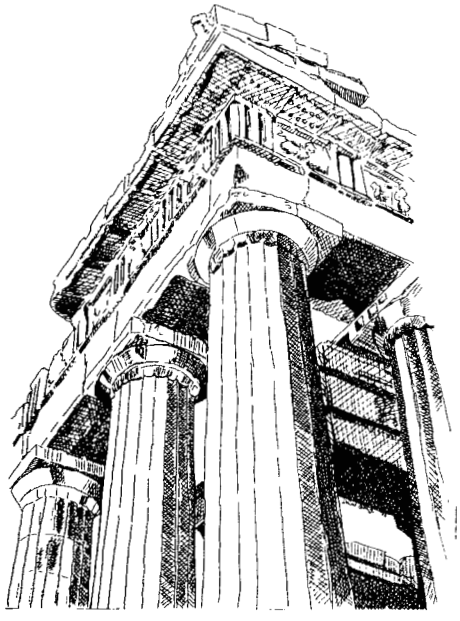
Quickly Phaethon seized this opportunity to satisfy his long-held ambition. "Let me drive the chariot of the sun, with the winged horses, across the sky for one day . . . just once," he pleaded.

The Sun's face darkened. "Do you know what you are asking? Don't be rash. I alone can control the fiery steeds. The road is full of perils; the savage Lion, wicked Scorpion, and angry Bull will attack you. The way is long, and the distance of earth below will dizzy you 'til you fall. I beg you to reconsider. This favor will be your death."

The boy insisted, and sadly his father knew that he must make good his promise.

Dawn was approaching. As Helios led Phaethon to the golden chariot of the Sun, the fiery horses were led from their stalls and harnessed. Phaethon put on his father's radiant crown, only half-listening to Helios' parting warnings. Even as his father was begging him to change his mind, Phaethon urged the horses to a trot.

Not that they needing urging. Snorting and pulling at the reins, the restless animals soon realized that the strong hands that usually guided them were missing. Soon they were beyond control. Before Phaethon could gather his wits, the horses were careening about the heavens, far from their usual path.



In a panic, Phaethon looked down and with a shudder saw the distance of the earth below. Dazed, he looked around and saw the sky filled with strange and threatening shapes. Overcome with fear, he dropped the reins.

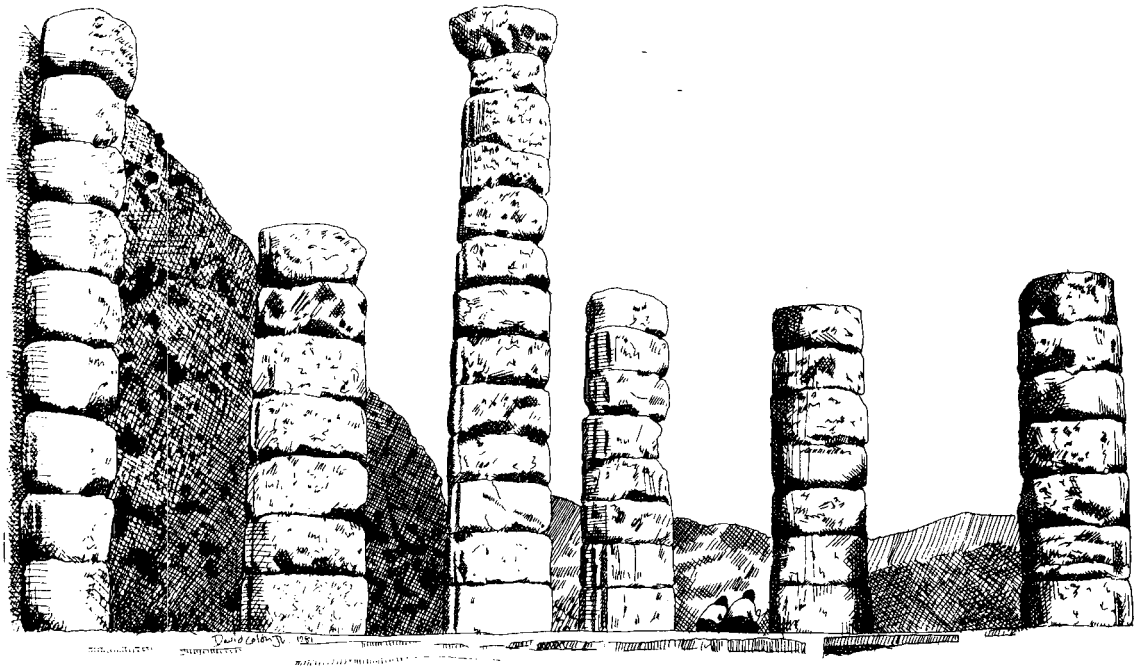
Given their head, the horses bolted, plunging wherever they would. The clouds were scorched, the mountains caught fire, rivers dried up, trees and fields burned, and cities perished. The horses had their way and left a smoking trail behind them.

Finally the suffering Earth cried out to Zeus and begged that he look down and end the destruction. Zeus, greatest of the gods and master of storms, saw what he must do. All his clouds and rainfall were gone, dried up by the fiery devastation, but he still had thunder and lightning.

Taking aim at the wildly racing chariot, he hurled a bolt of lightning which cut the harnesses, smashed the chariot to wreckage, and hurled Phaethon into the sea like a comet.

The Naiads of the Western Sea, finding his burnt and broken body, took pity and buried him with this epitaph:

"Here lies Phaethon, son of Helios
He tried to drive the Sun's chariot,
And died of his splendid daring."



A Luba Story

This African tale repeats themes common to many sun myths: the importance of the sun and the need to explain its movements.

A Luba Story

Lufùmò lwà Sendwe wa lubunda na kanwa

1. Mulopwè wa kipàngidilà wàne·na wa ntandà nà ntàndà àmba: wi mupika kùdîpo na kwènù.

2. Nândì wàendèlè kwàbò nyâka makùmi ànâ. Kùno ko bǎsyèlè bǎmwènè malwa nè kufwà mwândà wà kipùpò kya nzala.

3. Pêne·po mulopwè wa kipàngidilà pa kumòna nàmìno, wǎtùmìnè diwǐ kùdì Sendwe wa kubunda na kanwa àmba: Iyà, tubǎfu.

4. Bàno bônsô bǎdì bàtùmwa kukanwîta kebǎdì po bàfika ko. Kwàndi kwǎdì kukomò.

5. ỳno ayè mwînè wǎdì ùyu·kìle kala àmba: kěbǎnsàke.

1. Chief Immovable said to the One-always-on-the-move: "You are a slave; you have no home."

2. Thereupon the latter went home for forty years. Calamities and death befell those who stayed behind because of the ensuing famine.

3. Chief Immovable seeing all this sent a message to the Smith-who-forges-with-his-mouth, saying: "Come back, we perish."

4. Of all those who were sent to call him back nobody succeeded. It was impossible to get to his place.

5. He, however, knew already that they wanted him back.

6. Pêne·po Sendwe wa lubunda na kanwa wămwèkènè kùdì muntu umô mu nzìbo, watùmìnwê na mulopwè wa kipàngidilà mu kìmonwâ, kàfikìlè ko pò.

7. Wàmunènè àmba: Selà bàno banyona bàbìdì ne toni tùbìdì, sî ùtalè ba·nyoma bàno kĕbàlòkòtà ne toni kĕtwìsàmbe, nănkyo kèndi kubwîpi.

8. Nkìkìtàmbe pò dyo nàîlè, kĕntàmbe dĭngì.

9. Kà·dì ketùke·kàlà po nôbè nyêke nzyokela kwètù.

10. Pêne·po muntuw àfikìlè kwà mulopwè bufùku nè toni nè banyoma' bà. Wàtu·la.

11. Pêne·po bônkâ abwà bufùku toni kĕtùdilà nè banyoma mônkâ kĕbàdilà: bẽ! bẽ!

12. Pàno mulopwè pa kumòna nàmìno, toni nè banyoma kĕbàdilà wàkònga bakùlumpè. Kĕbàlângàlàngà awà mwânda.

13. Na bàtalè kùtùndukà kwătàmbìlè kintu kìcìla pyã. Bàfùkata abò bônsô kĕbàmutôtà:

14. Vìdyê, Vìdyê kalombò pa kwiya na kito·kezi, awà keye bătàmbe, Kafùla môba, Sendwe wa lubunda makumbi, bàbunda makàsa bàpya mudilo.

6. Thereupon the Smith-who-forges-with-his-mouth appeared in a house in the dream of a man who had been sent by Chief Immovable but who also had failed.

7. He told him: "Keep these two animals and these two fowls. When you hear these animals speaking and these fowls talking, then I will be near.

8. I am not coming the way I went, I will appear from the other side.

9. Moreover, I will not stay with you. I will go home again."

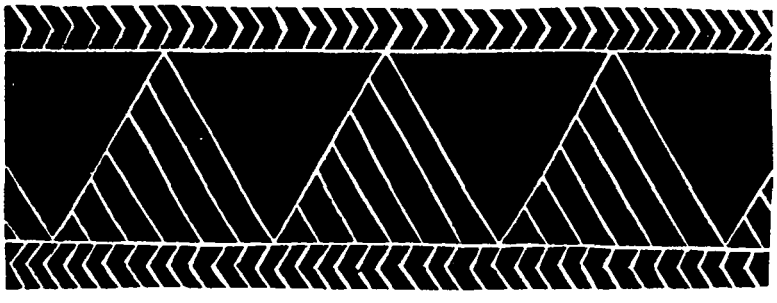
10. That very night the man went to the Chief with the fowls and animals. He left them there.

11. The same night the roosters started crowing and the sheep began to bleat: *"Baa! Baa!"*

12. The Chief seeing this and the fowls and the animals beginning to crow and to bleat, called the Elders. They pondered and pondered over this thing.

13. Suddenly in the East they saw something rising, flaming red. They knelt down and worshipped him:

14. "Lord! Lord Kalombo, coming with light! Look, now He comes, the Forger-of-suns! The Smith-who-forges-the-clouds! Those who forge with their hands will be caught by the fire."



Ceres, Persephone, and Pluto

With this beautiful story of a family love triangle -- mother, daughter, and husband -- the ancient Romans explained the change of seasons and the bursting forth of new life in spring. For an interesting twist, see Jeannette Maino's poem "Persephone to Pluto " in the poetry section of this collection.

Ceres, Persephone, and Pluto

from the classical myth

All loved Ceres, for she was the goddess who nurtured all green, growing things to harvest. And all loved her daughter Persephone, merriest and gentlest of maidens. But no one loved Persephone as much as did her mother.

Spring was at its height one day when Persephone went with her friends to gather flowers in the fields. They danced and sported, each vying with the others to make the best flower crown.

Suddenly Persephone saw an especially magnificent flower on the hilltop. Off she ran and, reaching the flower, stooped to pluck it. Suddenly the earth opened and there was a chariot drawn by four black horses, bearing a dark and unsmiling man. Without a word he caught Persephone into the chariot and the earth closed over them.

The other girls, missing their friend, sought her for hours but without success. Ceres, on hearing the bad news, was wild with grief. Donning a dark robe and taking a torch, she wandered everywhere, asking all she met for news of her daughter. Finally she came to Phoebus Apollo, god of the sun, and cried:

"O Phoebus, you who see everything on earth, tell me what has become of my child."

Apollo replied, "You will not find her above the ground. Pluto has taken her to be his wife in his dark kingdom beneath the earth."

This was terrible news. Pluto was lord of the underworld and brother to Jove, the greatest of the gods. What could Ceres do against such power?

Overcome with grief and anger, Ceres went away and mourned for a year. No plants grew, and no fruit ripened. The flowers would not bloom, and there was no corn in the fields. Unknown to Ceres, Persephone too was mourning underground. The god Pluto praised and petted her, but no food would she eat. Separately, mother and daughter pined and the earth sickened for lack of food.

Finally Jove saw that the earth would die if Ceres continued in her grief and anger. He sent messengers to Pluto, bidding him to let Persephone visit her mother. Pluto submitted, but offered Persephone a pomegranate before her departure, knowing that if she tasted but one seed, she must return to him.

When the sad woman in the dark robe saw her daughter's face, she was transformed. Kissing and holding her child, she vowed, "I shall never let you go away again."

But Persephone confessed "That cannot be, mother. I ate six seeds of Pluto's pomegranate, and I must return to him for six months every year. In truth, he is kind and he loves me."

So Ceres was forced to be satisfied with six months of her daughter's company each year. During those six months the earth glowed with life: flowers bloomed, fruit ripened, and corn waved in the wind. But when the time for Persephone's departure neared, her mother became sad. During their separation nothing grew and the earth seemed to sleep for six months. Yet, always Persephone came again, and with her, spring.

How Maui Made the Sun Slow Down

In many mythologies, the greatest benefactor is the person who brings nature into subjection for the good of humanity. Maui is seen here as a mischief-maker, but a hero nonetheless, in his taming of the sun.

How Maui Made the Sun Slow Down

from Antony Alpers' Maori Myths and Tribal Legends

One day Maui said to his wife: "Light a fire and cook some food for me." She did so, but no sooner had she heated her cooking stones in the earth-oven than the sun went down, and they had to eat their food in the dark. This set Maui to thinking how the days might be made longer. It was his opinion that they were shorter than they needed to be, and that the sun crossed the sky too quickly. So he said to his brothers: "Let us catch the sun in a noose and make him move more slowly. Then everybody would have long days in which to get their food and do all the things that have to be done."

His brothers said it was impossible. "No man can go near the sun," they said. "It is far too hot and fierce." Maui answered: "Have you not seen all the things I have done already? You have seen me change myself into all the birds of the forest, and back again into a man as I am now. I did that by enchantments, and without even the help of the jawbone of my great ancestress, which I now have. Do you really suppose that I could not do what I suggest?"

The brothers were persuaded by these arguments, and agreed to help him. So they all went out collecting flax, and brought it home, and sat there twisting it and plaiting it. And this was when the methods were invented of plaiting flax into tuamaka, or stout, square-shaped ropes, and paharahara, or flat ropes; and the method of twisting the fibre into round ropes. When they had made all the ropes they needed, Maui took up the jawbone of Muri ranga whenua, and away they went, carrying their provisions with them, and the ropes. They travelled all that night, having set out at evening lest the sun should see them. When the first light of dawn appeared, they halted and hid themselves so that the sun should not see them. At night they resumed their journey, and at dawn they hid themselves again, and in this way, travelling only when the sun could not observe them, they went far away to the eastward, until they came to the edge of the pit from which the sun rises.

On each side of this place they built a long high wall of clay, with huts made of branches at either end to hide in. There were four huts, one for each of the brothers. When all was ready they set their noose and saw that it was as strong as they could make it. The brothers lay waiting in the huts, and Maui lay hiding in the darkness behind the wall on the western side of the place where the sun rises. He held in his hand the jawbone of his ancestress, and now he gave his brothers their final instructions:

"Mind you keep hidden," he said. "Don't go letting him see you or you'll frighten him off. Wait until his head and his shoulders are through the noose. Then when I shout, pull hard, and haul on the ropes as fast as you can. I will go out and knock him on the head, but do not any of you let go your ropes until I tell you. When he's nearly dead we'll let him loose. Whatever you do, don't be silly and feel sorry for him when he screams. Keep the ropes good and tight until I say."

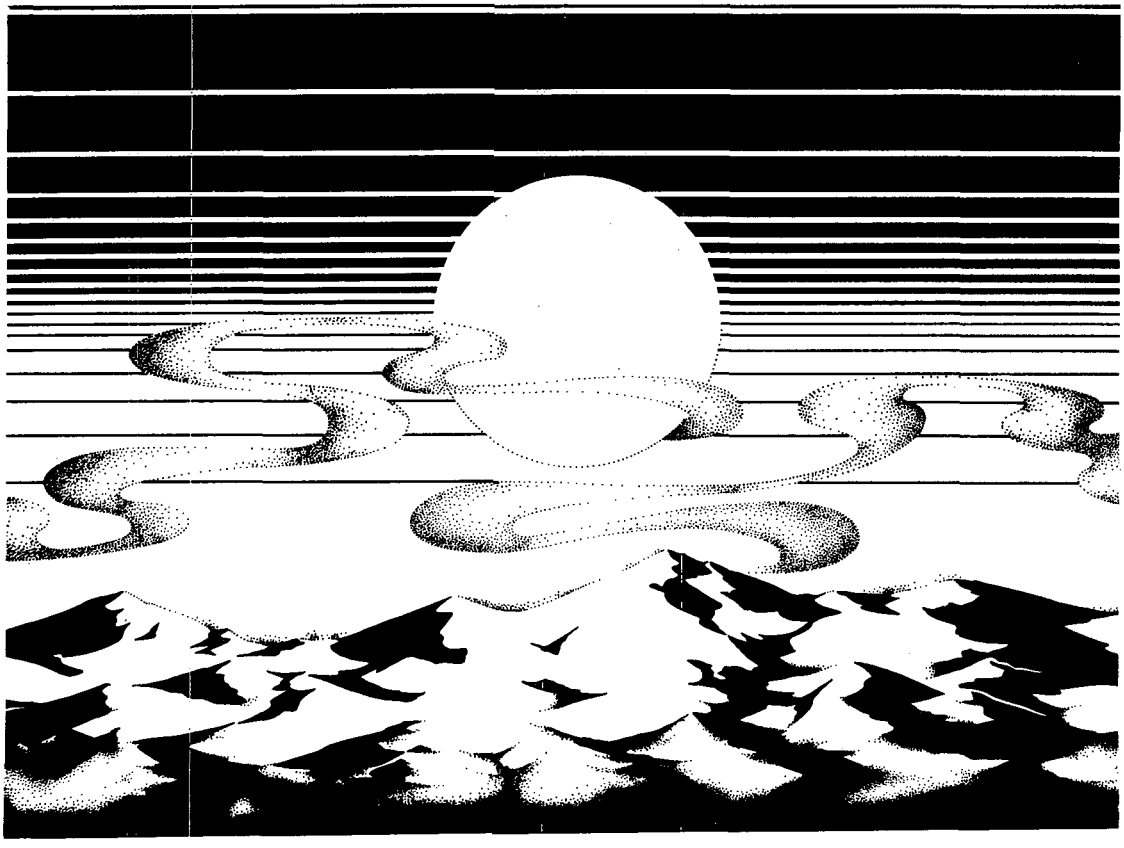
And so they waited there in the darkness at the place where the sun rises. At length the day dawned, a chilly grey at first, then flaming red. And the sun came up from his pit, suspecting nothing. His fire spread over the mountains, and the sea was all glittering. He was there, the great sun himself, to be seen by the brothers more closely than any man had ever seen him. He rose out of the pit until his head was through the noose, and then his shoulders. Then Maui shouted, and the ropes were pulled, the noose ran taut. The huge and flaming creature struggled and threshed, and leapt this way and that, and the noose jerked up and down and back and forth; but the more the captive struggled, the more tightly it held.

Then out rushed Maui with his enchanted weapon, and beat the sun about the head, and beat his face most cruelly. The sun screamed out, and groaned and shrieked, and Maui struck him savage blows, until the sun was begging him for mercy. The brothers held the ropes tight, as they had been told, and held on for a long time yet. Then at last when Maui gave the signal they let him go, and the ropes came loose, and the sun crept slowly and feebly on his course that day, and has done ever since. Hence the days are longer than they formerly were.

It was during this struggle with the sun that his second name was learned by man. At the height of his agony the sun cried out: "Why am I treated by you in this way? Do you know what it is you are doing, O you men? Why do you wish to kill Tama nui te ra?" That was his name, meaning Great Son the Day, which was never known before.

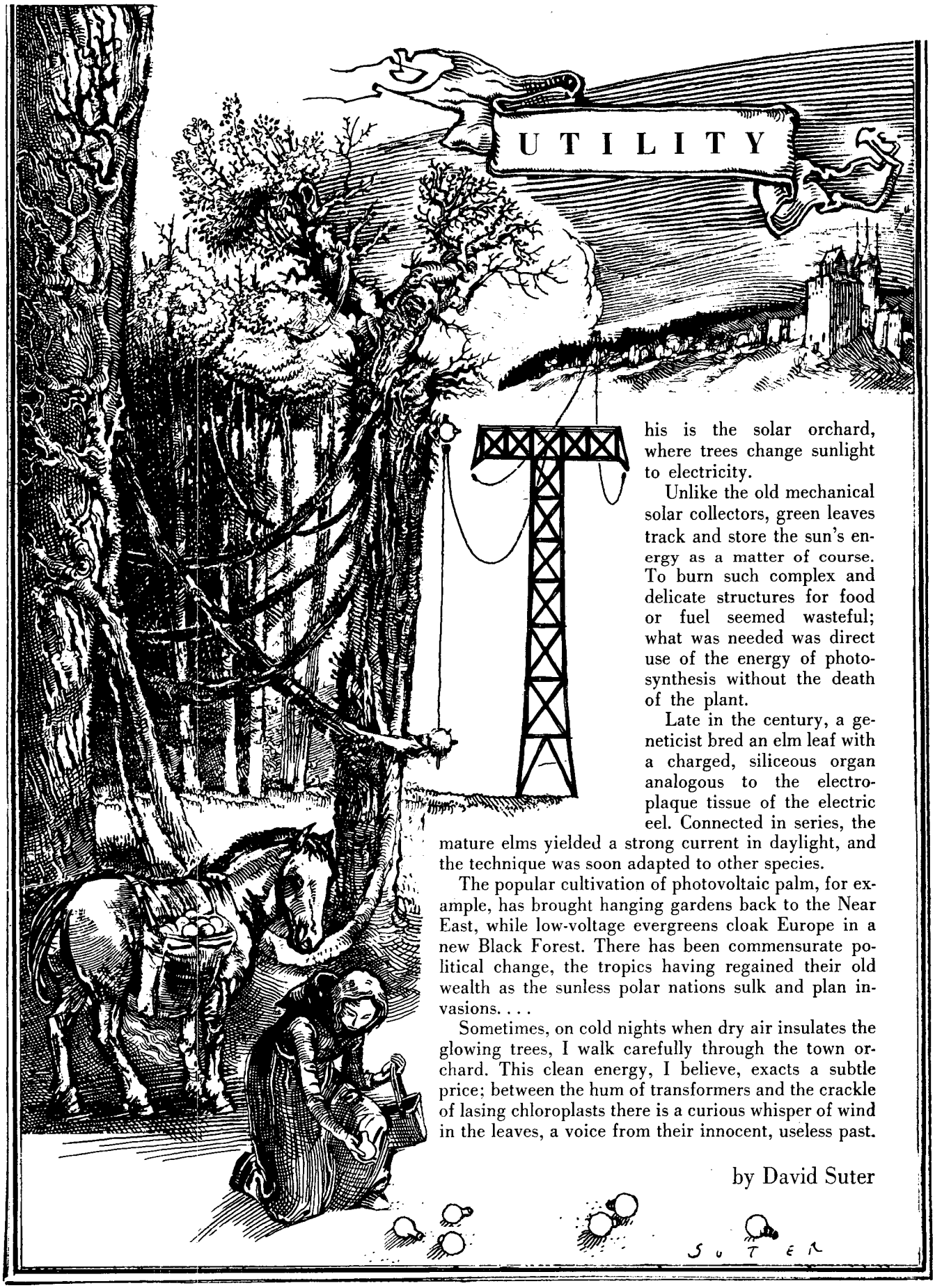
After this feat of laming the sun, Maui and his brothers returned to their house and dwelt there.

It is said that one day Maui was exceedingly thirsty. No doubt this was after his visit to the sun. He asked the tieke, or saddleback, to fetch him a drink, but the bird paid no attention, so he threw it in the water and called another bird, the hihi, or stitch-bird. The hihi also took no notice, so he threw it in the fire and its feathers were singed, which accounts for the colour of that bird. He next tried the totoara, or robin, and when it also disobeyed him he placed a streak of white near its beak as a mark for its incivility. At last the kokako, the crow, complied with his request. It went to the water and filled its ears, and returned to Maui. He drank, and as a reward he pulled kokako's legs to make them long, because it had done as he asked. This is true.



Utility

In this brief and ironic fantasy, we are reminded that energy changes may shape our future in unpredictable ways.



This is the solar orchard, where trees change sunlight to electricity.

Unlike the old mechanical solar collectors, green leaves track and store the sun's energy as a matter of course. To burn such complex and delicate structures for food or fuel seemed wasteful; what was needed was direct use of the energy of photosynthesis without the death of the plant.

Late in the century, a geneticist bred an elm leaf with a charged, siliceous organ analogous to the electroplaque tissue of the electric eel. Connected in series, the mature elms yielded a strong current in daylight, and the technique was soon adapted to other species.

The popular cultivation of photovoltaic palm, for example, has brought hanging gardens back to the Near East, while low-voltage evergreens cloak Europe in a new Black Forest. There has been commensurate political change, the tropics having regained their old wealth as the sunless polar nations sulk and plan invasions. . . .

Sometimes, on cold nights when dry air insulates the glowing trees, I walk carefully through the town orchard. This clean energy, I believe, exacts a subtle price; between the hum of transformers and the crackle of lasing chloroplasts there is a curious whisper of wind in the leaves, a voice from their innocent, useless past.

by David Suter

Poetry

Choices and Paradoxes

In this meditative poem, Sandburg seems to be reminding us to take time to think, imagine, and invent.

Moods

by Carl Sandburg

The same gold of summer was on the winter hills,
the oat straw gold, the gold of slow sun change.

The stubble was chilly and lonesome,
the stub feet clomb up the hills and stood.

The flat cry of one wheeling crow faded and came,
ran on the stub gold flats and faded and came.

Fade-me, find-me, slow lights rang their changes
on the flats of oat straw gold on winter hills.

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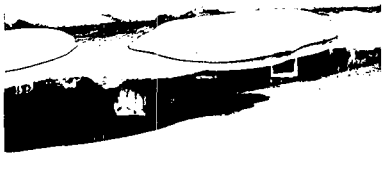


Use your skypiece.
Let the works of your noggin run.
Try one way, try another, throw away
and throw away, junk your first,
your second, junk sixty-six.
Keep your skypiece going, your noggin
running, sit with your eyes shut
and your thumbs quiet as two
sleeping mice.

If there were no winter, there could be no spring. The darkness and cold heighten the anticipation of new light and warmth. We welcome the contrasts.

Persephone to Pluto

by Jeannette Maino

When you seized me, all my flowers fell
Behind me in a trail of fragile hues
And were crushed beneath the grazing cattle . . .
Yet I left them there for clues.

I missed the springtime, missed my meadows,
Longed to see the sun once more;
Dark my eyes in your dark country,
Underground my soul was sore.

When Ceres found me, oh King Pluto,
Sadly I knew my heart loved black.
I went with her, my dark darling . . .
But I promise to be back.

Everything is revealed at true value in its own time and place . . .

Values

by Margaret Hillert

A winter sun is silver.
A summer sun is gold.
But the lesser gains in value
When winter days are cold.

A summer sun is golden,
But winter's silver gleams
Can light the eye and warm the heart
However cold it seems.

Birth,
Death,
and Renewal

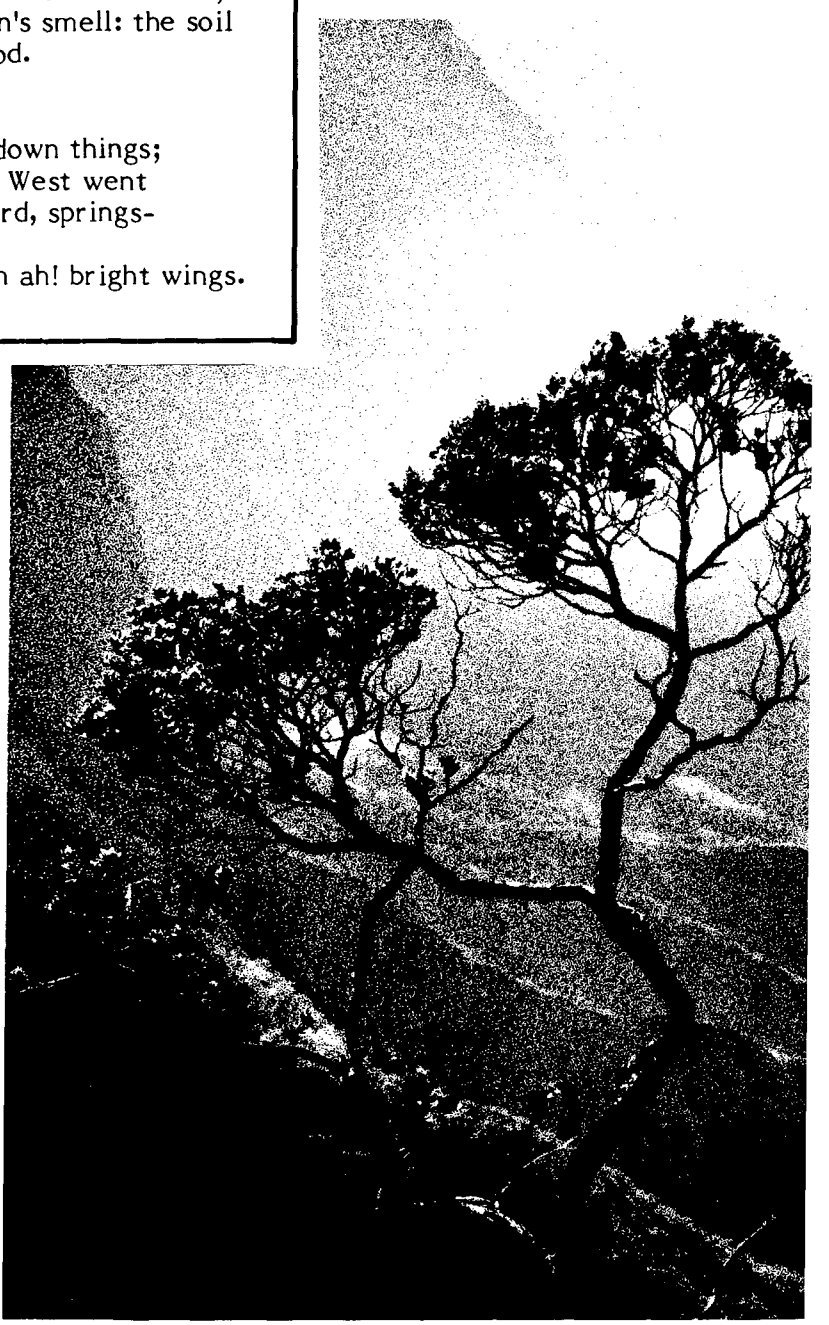
Hopkins shares his vision of the world as soiled and ruined and yet, "deep down", always renewable and fresh.

God's Grandeur

by Gerard Manley Hopkins

The world is charged with the grandeur of God.
It will flame out, like shining from shook foil;
It gathers to a greatness, like the ooze of oil
Crushed. Why do men then now not reck his rod?
Generations have trod, have trod, have trod;
And all is seared with trade; bleared, smeared with toil;
And wears man's smudge and shares man's smell: the soil
Is bare now, nor can foot feel, being shod.

And for all this, nature is never spent;
There lives the dearest freshness deep down things;
And though the last lights off the black West went
Oh, morning, at the brown brink eastward, springs-
Because the Holy Ghost over the bent
World broods with warm breast and with ah! bright wings.



Energy is never lost. What is waste to us gives up its heat somewhere, somehow, to light the universe.

Harvest

by Carl Sandburg

When the corn stands yellow in September,
A red flower ripens and shines among the stalks
And a red silk creeps among the broad ears
And tall tassels lift over all else
and keep a singing
to the prairies
and the wind.

They are the grand lone ones
For they are never saved
along with the corn:

They are cut down
and piled high
and burned.

Their fire
lights the west in November.

Emily Dickinson was often at her best with such brief observations as these. Short as they are, they are not fragments; each is a full, perfectly rounded moment of awareness.

The Sun and Fog contested

by Emily Dickinson

The Sun and Fog contested
The Government of Day -
The Sun took down his Yellow Whip
And drove the Fog away -

It rises — passes — on our South

by Emily Dickinson

It rises - passes - on our South
Inscribes a simple Noon -
Cajoles a Moment with the Spires
And infinite is gone -

The wind often seems to symbolize to us the power of nature. The wind drives the poet's imagery from budding spring to summer dreams to dead leaves, from waves to woods to clouds -- with the final hope that the wind will be the breath of new life.

Ode to the West Wind

by Percy Bysshe Shelley

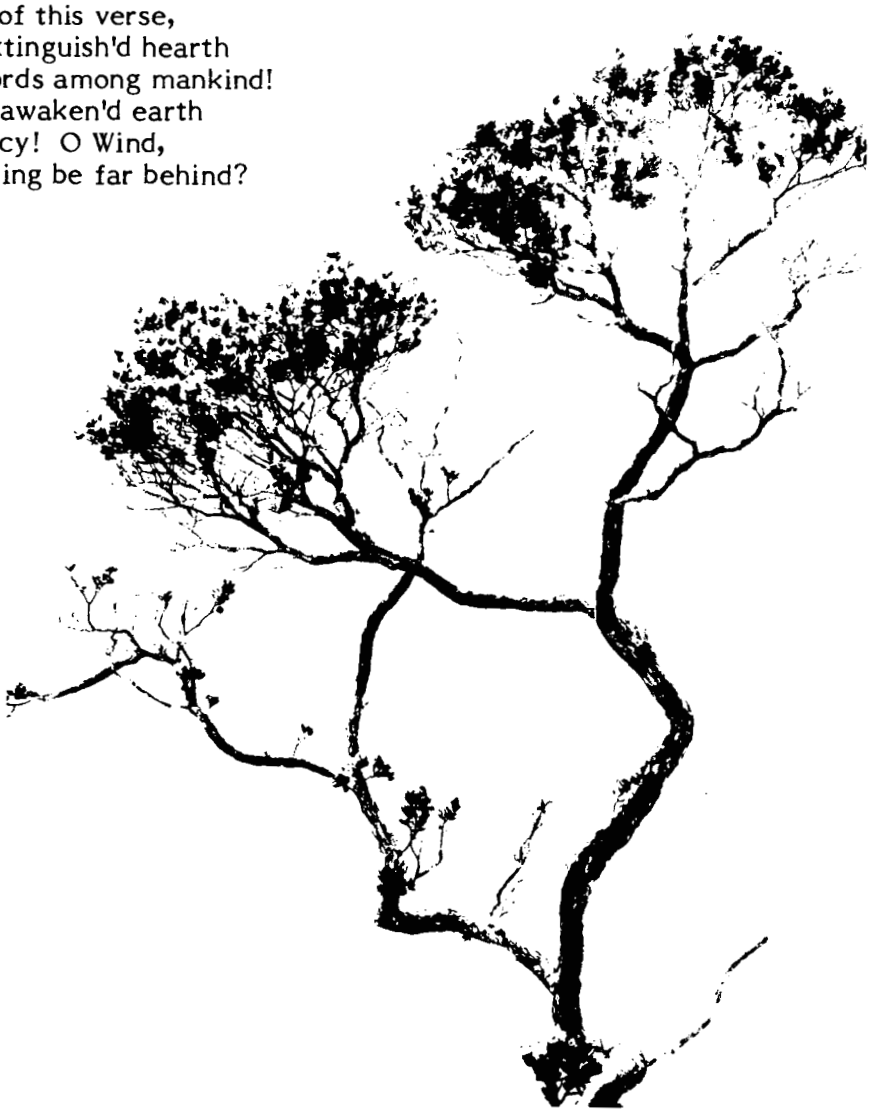
O wild West Wind, thou breath of Autumn's being,
Thou, from whose unseen presence the leaves dead
Are driven, like ghosts from an enchanter fleeing,
Yellow, and black, and pale, and hectic red,
Pestilence-stricken multitudes: O thou
Who chariotest to their dark wintry bed
The winged seeds, where they lie cold and low,
Each like a corpse within its grave, until
Thine azure sister of the Spring shall blow
Her clarion o'er the dreaming earth, and fill
(Driving sweet buds like flocks to feed in air)
With living hues and odours plain and hill:
Wild Spirit, which art moving everywhere;
Destroyer and Preserver; Hear, oh, hear!

Thou on whose stream, 'mid the steep sky's commotion,
Loose clouds like earth's decaying leaves are shed,
Shook from the tangled boughs of Heaven and Ocean,
Angels of rain and lightning; there are spread
On the blue surface of thine airy surge,
Like the bright hair uplifted from the head
Of some fierce Maenad, ev'n from the dim verge
Of the horizon to the zenith's height--
The locks of the approaching storm. Thou dirge
Of the dying year, to which this closing night
Will be the dome of a vast sepulchre,
Vaulted with all thy congregated might
Of vapours, from whose solid atmosphere
Black rain, and fire, and hail, will burst: oh, hear!

Thou who didst waken from his summer-dreams
The blue Mediterranean, where he lay,
Lull'd by the coil of his crystalline streams,
Beside a pumice isle in Baiae's bay,
And saw in sleep old palaces and towers
Quivering within the wave's intenser day,
All overgrown with azure moss and flowers
So sweet, the sense faints picturing them! Thou
For whose path the Atlantic's level powers
Cleave themselves into chasms, while far below
The sea-blooms and the oozy woods which wear
The sapless foliage of the ocean, know
Thy voice, and suddenly grow grey with fear
And tremble and despoil themselves: oh, hear!

If I were a dead leaf thou mightest bear;
If I were a swift cloud to fly with thee;
A wave to pant beneath thy power, and share
The impulse of thy strength, only less free
Than thou, O uncontrollable! If even
I were as in my boyhood, and could be
The comrade of thy wanderings over heaven,
As then, when to outstrip thy skiey speed
Scarce seem'd a vision, I would ne'er have striven
As thus with thee in prayer in my sore need.
Oh, lift me as a wave, a leaf, a cloud!
I fall upon the thorns of life! I bleed!
A heavy weight of hours has chain'd and bow'd
One too like thee: tameless, and swift, and proud.

Make me thy lyre, ev'n as the forest is:
What if my leaves are falling like its own?
The tumult of thy mighty harmonies
Will take from both a deep autumnal tone,
Sweet though in sadness. Be thou, Spirit fierce,
My spirit! be thou me, impetuous one!
Drive my dead thoughts over the universe
Like wither'd leaves to quicken a new birth;
And, by the incantation of this verse,
Scatter, as from an unextinguish'd hearth
Ashes and sparks, my words among mankind!
Be through my lips to unawaken'd earth
The trumpet of a prophecy! O Wind,
If Winter comes, can Spring be far behind?



In the flickering and the smoke of a wood fire is a reminder of where we and the wood come from, and where we are going.

Firewood

by James Applewhite

After the axe head has flashed
And the maple log is sawed,
He lingers on the hearth,
Anticipating light, for this sun

In wood is somehow in his blood,
As his eyes flicker clearly
Their spark in the thicket
Of a world not understood.

It is not only a golden
Living descended to wood
That the child's struck match
Frees to dancing,

There are October's odors
Veined into foliage, which a boy
And his man of flame
Exhale as smoke to the cold.

This story he thinks, a blond
Prince lost in a forest,
Is as tragic and old
As a chemical formula.

Not only fire descended
To water and fiber, but wonder
At the union he senses,
That to the earth's antennas

Of living branches, sun should
Signal through clearness,
To maple leaves and apples,
Coloring with sugar,

For a meeting more than either.
He senses how flame returned
From leaves toward sun
Musks air with mortal October.

The sea and its changes are an endless source of fascination to poets. In this poem the sea is wild and powerful, but then gentle and ebbing again.

I'm as the Sea

by Ethel A. Patkotak, Eskimo

I'm as the sea, I'm as its ever fluid beauty . . .
I'm as the tide that ebbs and flows.
I'm as the stillness, the calm that falls before
a storm . . .
I'm as the moment before it breaks!
I'm as the crest that steadily rises, I'm as the
wave that forms . . .
I'm as the wind, free and wild . . . I'm as a spirit
flying high!
I'm as the breaker that suddenly remembers the sea
that is its home--
I'm as its thunder, I'm as its impact on the
mocking beach . . .
I'm as the gentle laughing of the swirls. I'm as
the remnants of the wave . . .
I'm as I was again . . . the sea.

Whitman's disturbing and provocative poem makes us marvel at the earth and its capacity to repeatedly refresh itself in spite of civilization's abuses.

This Compost

by Walt Whitman

Something startles me where I thought I was safest,
I withdraw from the still woods I loved,
I will not go now on the pastures to walk,
I will not strip the clothes from my body to meet my lover the sea,
I will not touch my flesh to the earth as to other flesh to renew me.

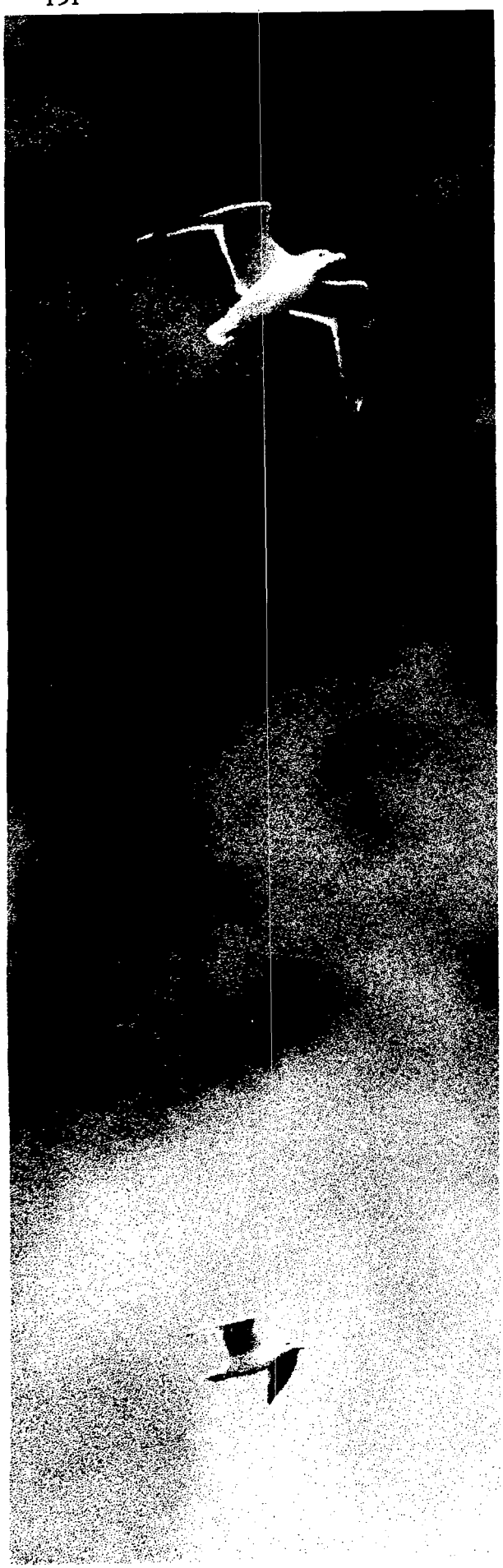
O how can it be that the ground itself does not sicken?
How can you be alive you growths of spring?
How can you furnish health you blood of herbs, roots, orchards,
grain?
Are they not continually putting distemper'd corpses within you?
Is not every continent work'd over and over with sour dead?

Where have you disposed of their carcasses?
Those drunkards and gluttons of so many generations?
Where have you drawn off all the foul liquid and meat?
I do not see any of it upon you to-day, or perhaps I am deceiv'd,
I will run a furrow with my plough, I will press my spade through
the sod and turn it up underneath,
I am sure I shall expose some of the foul meat.

Behold this compost! behold it well!
Perhaps every mite has once form'd part of a sick person--yet
behold!
The grass of spring covers the prairies,
The bean bursts noiselessly through the mould in the garden,
The delicate spear of the onion pierces upward,
The apple-buds cluster together on the apple-branches,
The resurrection of the wheat appears with pale visage out of its
graves,
The tinge awakes over the willow-tree and the mulberry-tree,
The he-birds carol mornings and evenings while the she-birds sit
on their nests,
The young of poultry break through the hatch'd eggs,
The new-born of animals appear, the calf is dropt from the cow,
the colt from the mare,
Out of its little hill faithfully rise the potato's dark green leaves,
Out of its hill rises the yellow maize-stalk, the lilacs bloom in the
dooryards,
The summer growth is innocent and disdainful above all those
strata of sour dead.

What chemistry!
That the winds are really not infectious,
That this is no cheat, this transparent green-wash of the sea which is so amorous after me,
That it is safe to allow it to lick my naked body all over with its tongues,
That it will not endanger me with the fevers that have deposited themselves in it,
That all is clean forever and forever,
That the cool drink from the well tastes so good,
That blackberries are so flavorous and juicy,
That the fruits of the apple-orchard and the orange-orchard, that melons, grapes, peaches, plums, will none of them poison me,
That when I recline on the grass I do not catch any disease,
Though probably every spear of grass rises out of what was once a catching disease.

Now I am terrified at the Earth, it is that calm and patient,
It grows such sweet things out of such corruptions,
It turns harmless and stainless on its axis, with such endless successions of diseas'd corpses,
It distills such exquisite winds out of such infused fetor,
It renews with such unwitting looks its prodigal, annual, sumptuous crops,
It gives such divine materials to men, and accepts such leavings from them at last.



Shelley's vision of the cloud vividly describes the atmosphere's beauty and purpose.

The Cloud

by Percy Bysshe Shelley

I bring fresh showers for the thirsting flowers,
From the seas and the streams;
I bear light shade for the leaves when laid
In their noon-day dreams.
From my wings are shaken the dews that waken
The sweet buds every one,
When rocked to rest on their mother's breast,
As she dances in the sun.
I wield the flail of the lashing hail,
And whiten the green plains under;
And then again I dissolve it in rain,
And laugh as I pass in thunder.

I sift the snow on the mountains below,
And their great pines groan aghast;
And all the night 'tis my pillow white,
While I sleep in the arms of the blast.
Sublime on the towers of my skiey bowers,
Lightning, my pilot, sits;
In a cavern under is fettered the thunder,
It struggles and howls at fits;
Over earth and ocean, with gentle motion,
This pilot is guiding me,
Lured by the love of the genii that move
In the depths of the purple sea;
Over the rills, and the crags, and the hills,
Over the lakes and the plains,
Wherever he dream, under mountain or stream,
The Spirit he loves remains;
And I, all the while, bask in Heaven's blue smile,
Whilst he is dissolving in rains.

The sanguine Sunrise, with his meteor eyes,
And his burning plumes outspread
Leaps on the back of my sailing rack,
When the morning-star shines dead;
As on the jag of a mountain crag,
Which an earthquake rocks and swings,
An eagle, alit one moment may sit
In the light of its golden wings.
And when Sunset may breathe, from the lit sea beneath,
Its ardors of rest and love,
And the crimson pall of eve may fall
From the depths of Heaven above,
With wings folded I rest, on mine airy nest,
As still as a brooding dove.

That orbed maiden, with white fire laden,
Whom mortals call the Moon,
Glides glimmering o'er my fleece-like floor,
By the midnight breezes strewn;
And wherever the beat of her unseen feet,
Which only the angels hear,
May have broken the woof of my tent's thin roof,
The stars peep behind her and peer;
And I laugh to see them whirl and flee,
Like a swarm of golden bees,
When I widen the rent in my wind-built tent,
Till the calm rivers, lakes, and seas,
Like strips of the sky fallen through me on high,
Are each paved with the moon and these.

I bind the Sun's throne with a burning zone,
And the Moon's with a girdle of pearl;
The volcanoes are dim, and the stars reel and swim,
When the whirlwinds my banners unfurl.
From cape to cape, with a bridge-like shape,
Over a torrent sea,
Sunbeam-proof, I hang like a roof,
The mountains its columns be.
The triumphal arch through which I march
With hurricane, fire, and snow,
When the powers of the air are chained to my chair,
Is the million-colored bow;
The sphere-fire above its soft colors wove,
While the moist earth was laughing below.

I am the daughter of Earth and Water,
And the nursling of the Sky;
I pass through the pores of the ocean and shores,
I change, but I cannot die.
For after the rain when with never a stain
The pavilion of Heaven is bare,
And the winds and sunbeams with their convex gleams
Build up the blue dome of air,
I silently laugh at my own cenotaph,
And out of the caverns of rain,
Like a child from the womb, like a ghost from the tomb,
I arise and unbuild it again.

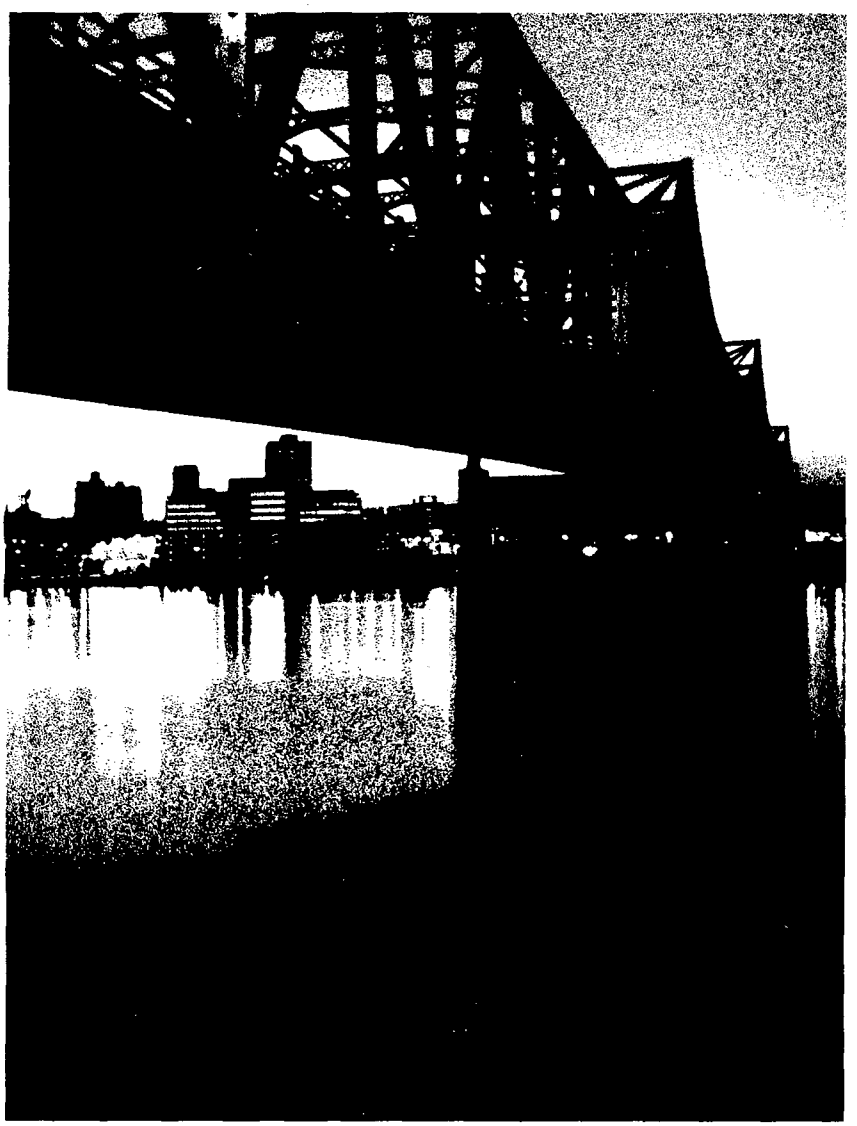
Watch the simple experiences: shoveling snow, picking up a sheet of paper, looking at light through a prism. See how they break up into the parts, the colors, the continuous moments of life.

Sunray

by Emery George

Winter and Sunday: you take to the walk, the aluminum
spade: this
snow is a crystal of gifts
everywhere silent; the air is as blossoming mild as in April;
brilliant, a violet light
reaches your eye when your mind isn't sure which of over a
thousand
needlepoint colors rebound,
just as it feels when you're holding a quarto of watermarked
paper
up to a source of your light,
be it the lamp on your desk or a shaft of the winterdamp
lifelight,
falling diagonal beam,
afternoon sun. You perceive tiny dots, fine stars; it's a
spray of
colors so jewel-precise;
so does it blind on the last fresh-fallen snow of the season
(or what you'd hoped was the last):
festival lights dot a landscape, these brilliants of blue, red,
and green pierce
blinding, recall but an hour.
Daylight teaches how light breaks. Look through a prism.
At edges
polychrome strips give a sign:
here you've arrived at a place where a physical world
separating
areas: light from the dark,
will generate these bands, and a visual music, like pigments,
vibrant, dispenses its joy.
Pure white descends into yellow, then orange, hot scarlet
and purple,
until it reaches a depth;
black, breaking up, then ascending from indigo, blue and to
blue-green
cools to a surface in mint,
light through a depth of the sea. And see, how descending,
refracted,
innocent pure on the white
surface, a light beam, quiver of beams hitting earth and
exploring
color dots, make up a pure
sheet of the white, while you think a complex, homoge-
neous surface
is yet a trillion bright
local moments, responses to half-metaphysical movement
starting in quanta and dense.

Dare I say more? It is late. In the city, their lights are
rekindled
-neon signs, ink-blue and pink-
old red brick walls: here sunlight lingers. Out further are
houses
(out, looking over the road,
where that eternal treadmill carries the traffic in tail-lit
safety, in isochrony);
someone is bound to be lighting a fire and muttering secrets:
how, in an earlier life,
circling our minds, all possible fires were kindled, and quanta,
light rays, abstractions, and print
taught in an instant a truth about solider surfaces made of
nothing but colors as sharp,
as simulated a depth as a single point on a huge, round
lamp base now pierces its way
straight from the sun; it won't cheerfully go down, either,
and one last
salvo shall be its good day,
lightning-quick, as it sends one missile in glory, to answer
light in a kindler with light.



The Sun and Human Society

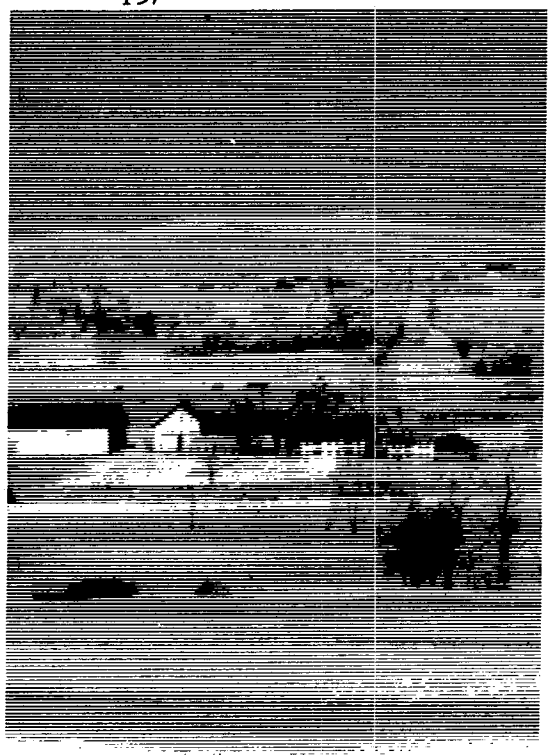
The sunrise reveals a scene that may later become busy, mundane, and even sordid but that, in the dawn, is innocent and beautiful.

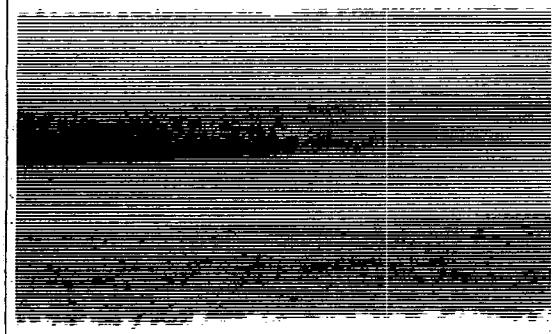
Composed upon Westminster Bridge

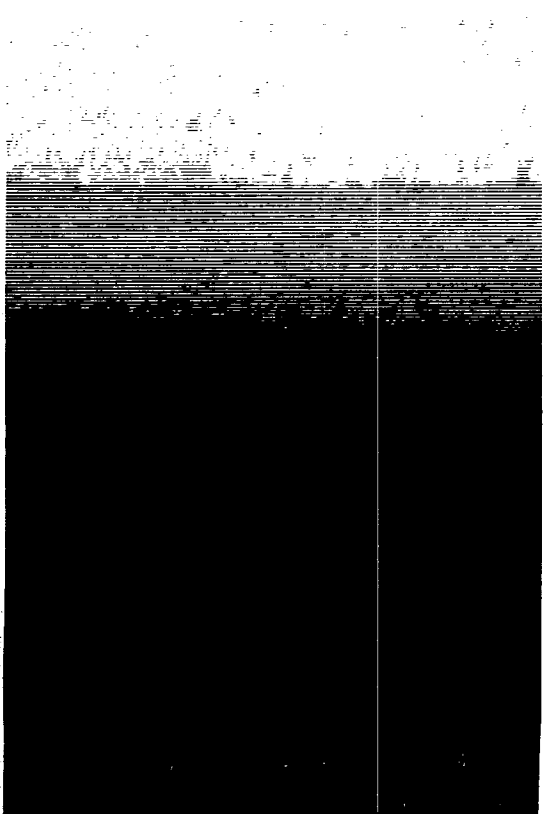
by William Wordsworth

Earth has not anything to show more fair:
Dull would he be of soul who could pass by
A sight so touching in its majesty:
This city now doth like a garment wear
The beauty of the morning; silent, bare,
Ships, towers, domes, theaters, and temples lie
Open unto the fields, and to the sky;
All bright and glittering in the smokeless air.

Never did sun more beautifully steep
In his first splendor valley, rock, or hill;
Ne'er saw I, never felt, a calm so deep!
The river glideth at his own sweet will:
Dear God! the very houses seem asleep;
And all that mighty heart is lying still!







Whitman articulates the ever present conflict of our society: the peace and health of a natural life vs. the seductive drama and stimulation of the city.

Give Me the Splendid Silent Sun

by Walt Whitman

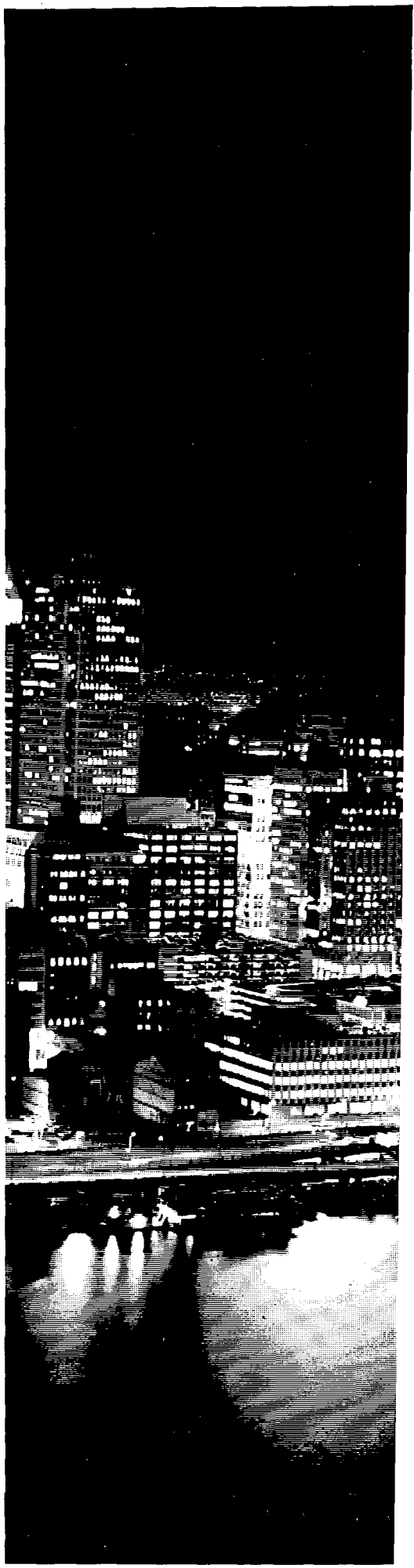
Give me the splendid silent sun with all his beams full-dazzling,
Give me juicy autumnal fruit ripe and red from the orchard,
Give me a field where the unmow'd grass grows,
Give me an arbor, give me the trellis'd grape,
Give me fresh corn and wheat, give me serene-moving animals teaching content,
Give me nights perfectly quiet as on high plateaus west of the Mississippi, and I looking up at the stars,
Give me odorous at sunrise a garden of beautiful flowers where I can walk undisturb'd,
Give me for marriage a sweet-breath'd woman of whom I should never tire,
Give me a perfect child, give me away aside from the noise of the world a rural domestic life,
Give me to warble spontaneous songs recluse by myself, for my own ears only,
Give me solitude, give me Nature, give me again O Nature your primal sanities!

These demanding to have them, (tired with ceaseless excitement, and rack'd by the war-strife,)
These to procure incessantly asking, rising in cries from my heart,
While yet incessantly asking still I adhere to my city,
Day upon day and year upon year O city, walking your streets,
Where you hold me enchain'd a certain time refusing to give me up,
Yet giving to make me glutted, enrich'd of soul, you give me forever faces;
(O I see what I sought to escape, confronting, reversing my cries,
I see my own soul trampling down what it ask'd for.)

Keep your splendid silent sun,
Keep your woods O Nature, and the quiet places by the woods,
Keep your fields of clover and timothy, and your corn-fields and orchards,
Keep the blossoming buckwheat fields where the Ninth-month bees hum;
Give me faces and streets--give me these phantoms incessant and endless along the trottoirs!
Give me interminable eyes--give me women--give me comrades and lovers by the thousand!
Let me see new ones every day--let me hold new ones by the hand every day!
Give me such shows--give me the streets of Manhattan!

Give me Broadway, with the soldiers marching--give me the sound of the trumpets and drums!
(The soldiers in companies or regiments--some starting away, flush'd and reckless,
Some, their time up, returning with thinn'd ranks, young, yet very old, worn, marching, noticing nothing;)
Give me the shores and wharves heavy-fringed with black ships!
O such for me! O an intense life, full to repletion and varied!
The life of the theatre, bar-room, huge hotel, for me!

The saloon of the steamer! the crowded excursion for me! the torchlight procession!
The dense brigade bound for the war, with high piled military wagons following;
People, endless, streaming, with strong voices, passions, pageants,
Manhattan streets with their powerful throbs, with beating drums as now,
The endless and noisy chorus, the rustle and clank of muskets, (even the sight of the wounded),
Manhattan crowds, with their turbulent musical chorus!
Manhattan faces and eyes forever for me.



The poet uses the scale of earthly and human endeavors to dramatize the power of the sun.

To interrupt His Yellow Plan

by Emily Dickinson

To interrupt His Yellow Plan
The Sun does not allow
Caprices of the Atmosphere -
And even when the Snow

Heaves Balls of Specks, like Vicious Boy
Directly in His Eye -
Does not so much as turn His Head
Busy with Majesty -

'Tis His to stimulate the Earth -
And magnetize the Sea -
And bind Astronomy, in place,
Yet Any passing by

Would deem Ourselves - the busier
As the Minutest Bee
That rides - emits a Thunder -
A Bomb - to justify -

When I have seen the Sun emerge

by Emily Dickinson

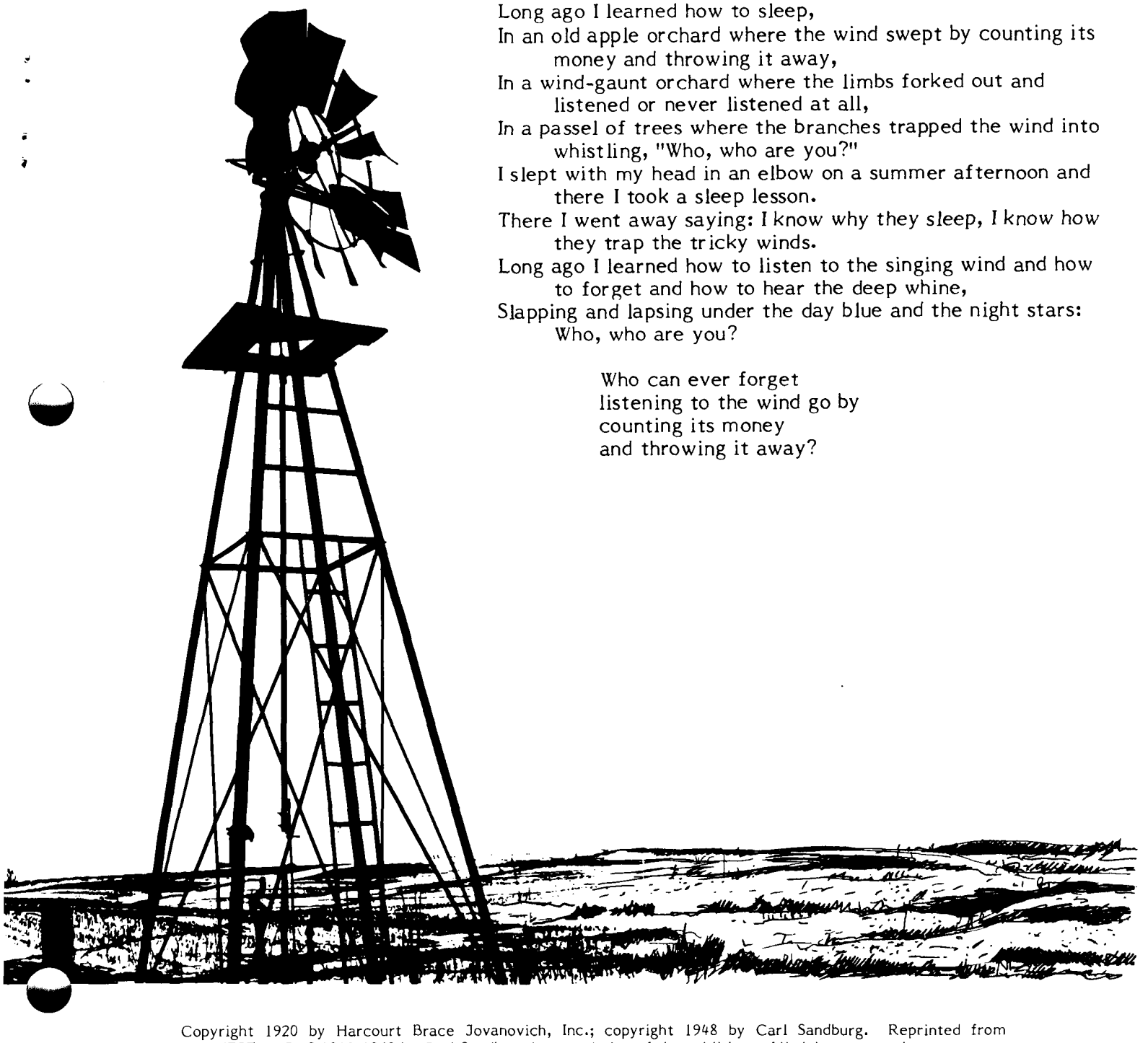
When I have seen the Sun emerge
From His amazing House -
And leave a Day at every Door
A Deed, in every place -

Without the incident of Fame
Or accident of Noise -
The Earth has seemed to me a Drum,
Pursued of little Boys

This whimsical poem asks "Who are you?" and "What is the wind?"

Wind Song

by Carl Sandburg



Long ago I learned how to sleep,
In an old apple orchard where the wind swept by counting its money and throwing it away,
In a wind-gaunt orchard where the limbs forked out and listened or never listened at all,
In a passel of trees where the branches trapped the wind into whistling, "Who, who are you?"
I slept with my head in an elbow on a summer afternoon and there I took a sleep lesson.
There I went away saying: I know why they sleep, I know how they trap the tricky winds.
Long ago I learned how to listen to the singing wind and how to forget and how to hear the deep whine,
Slapping and lapsing under the day blue and the night stars:
Who, who are you?

Who can ever forget
listening to the wind go by
counting its money
and throwing it away?

To Teachers

WHO PLAN TO USE THE READER WITH STUDENTS

Whether you are teaching young people or adults, whether you use this reader for classroom reading or for student assignments, there are a few facts that you should be aware of.

1. You have certain rights to and restrictions on your use of the material in this reader under the copyright law.

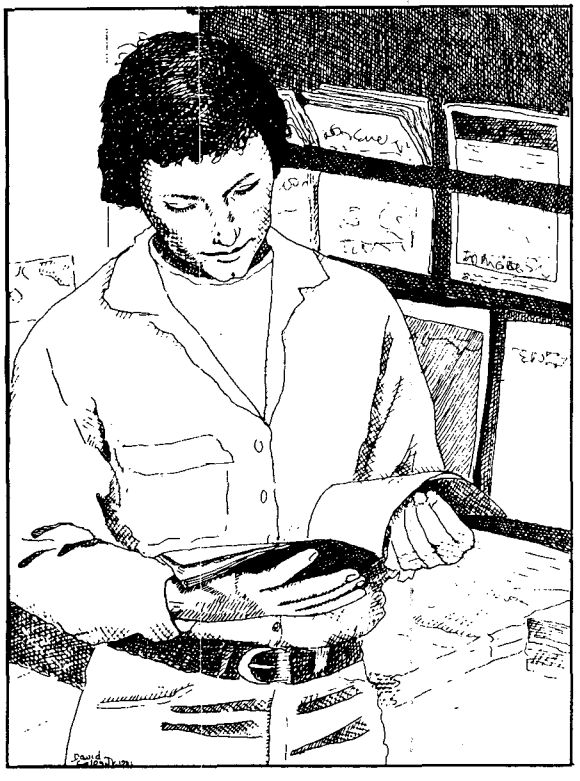
2. The statements and opinions contained in this material should be weighed and evaluated carefully.

3. In using readings with students, preparation and follow-up are as important as the reading itself.

Let's look at each of these points more closely.

Your Right to Use the Reader

The articles included in this reader are reprinted here by the generosity of a number of writers, artists, editors, and publishers. Where the material is copyrighted (and most of it is), the copyright appears with the article, poem, or story. The copyright law does allow teachers to reproduce such material; however, there are limitations on that right. To make your rights as an educator clear, and to encourage you to use the reader, we have included the Congressional Guidelines for Classroom Copying. These guidelines appear on pages 147-9.



Point of View

No magazine article can give you the full energy story; writers and publishers, like everyone else, have points of view. We can't guarantee that the articles included here are completely objective or all-inclusive. What this reader does attempt to do is to give a broad sampling. For suggestions on how to read thoughtfully and how to help students do the same, read on.

Reading: Preparation and Follow-Up

To profit from a reading, the person doing the reading must begin with

motivation,
background,
reading ability and vocabulary, and
critical skills

How can you be sure that you and your students get the most from your energy reading? Below are some suggestions for preparation and follow-up on reading assignments.

Motivation

Students today know that their future literally depends on energy. It's not hard to motivate them to read about energy, if you remind them that energy knowledge gives them more control over that future. To motivate,

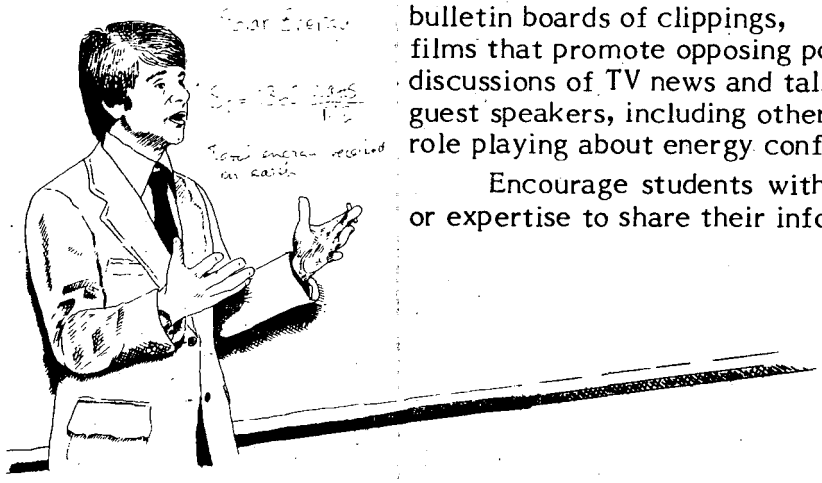
discuss sources of anxiety for them and their families, such as:
rising costs,
blackouts and shortages,
political and strategic barriers to energy supply, and
daily necessities and comforts that depend on energy;

use questions to encourage imagining and sharing, like:
"Have you ever been in a greenhouse? What was it like?"
"What would happen to utility companies if everyone used solar energy?"
"Do you remember how you felt when you first became aware of an energy crisis?"
"How do you think a person in a developing country might feel about energy use in the United States?"
"How would you design a completely self-sufficient house?"

or do a pre-reading activity, for example:
try a simple experiment or demonstration related to the article's subject,
take a poll or survey,
plan a debate or writing assignment based on the article's information, or
consider various energy futures and raise questions about the probable outcomes.

Background

Students care about the energy future, but they often lack specific information. They tend to get their opinions by hearsay, and talk in generalities and slogans. They need more context for their reading. You can break through oversimplified thinking with



bulletin boards of clippings,
films that promote opposing points of view,
discussions of TV news and talk shows,
guest speakers, including other faculty members, or role playing about energy conflicts.

Encourage students with special knowledge or expertise to share their information.

Reading Ability and Vocabulary

Not every reading is intended for every student. In fact, some of the articles in the reader are only appropriate for teachers and advanced students. Stack the deck for reading success:

1. Select articles at the appropriate reading level. (They are keyed in the table of contents with color tabs; one for easy, two for intermediate, and three for difficult.)

2. Introduce new words before beginning the reading. Students can use the glossary (page 151) or they can try to figure out the meanings of the words from their context.

3. Attack the reading at the easiest (informational) level first, and then lead students to the more difficult levels:
   First, search for and recall facts.
   Second, consider what the writer is trying to communicate.
   Third, apply what the writer says to one's own experience.
   Fourth, analyze how the writer presents his/her ideas.
   Fifth, suggest new ways of presenting or adding to these ideas.
   Last, evaluate and express opinions on the material.

Critical Skills

Students like magazine readings because they perceive magazines as "adult" reading. But reading like an adult requires 1) desire for objectivity and 2) tolerance for ambiguity.

Desire for Objectivity

Help students to generate questions about the reading that encourage objectivity:

Who is the author?
Is he/she associated with some special interest group?
What are his/her claims to expertise?
Where does he/she use facts and where, opinions?
What is the quality of the evidence?
How can the assertions be verified or compared with opposing views?
Is the information up-to-date?
Is the style objective and balanced?
Does the author use propaganda techniques and emotional appeals?
Does the article leave out or gloss over certain points?

Tolerance for Ambiguity

Encourage students to be aware of ambiguities in their reading and discuss them:

Are there things the author has left out (intentionally or unintentionally)?
Are there other possible points of view on the subject?
May time and events alter the validity of what the author says?
Is the real situation more complex than the author suggests?
Does the author admit to uncertainty on some points?

With this kind of thoughtful preparation and follow-up, a reading becomes more than just another assignment. It becomes an opportunity to expand vocabulary, sharpen thinking, and develop more mature skills in evaluating ideas.

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Agreement on Guidelines for Classroom Copying

in Not-for-Profit Educational Institutions with Respect to Books and Periodicals

The purpose of the following guidelines is to state the minimum and not the maximum standards of educational fair use under Section 107 of H.R. 2223. The parties agree that the conditions determining the extent of permissible copying for educational purposes may change in the future; that certain types of copying permitted under these guidelines may not be permissible in the future; and conversely that in the future other types of copying not permitted under these guidelines may be permissible under revised guidelines.

Moreover, the following statement of guidelines is not intended to limit the types of copying permitted under the standards of fair use under judicial decision and which are stated in Section 107 of the Copyright Revision Bill. There may be instances in which copying which does not fall within the guidelines stated below may nonetheless be permitted under the criteria of fair use.

Guidelines

I. Single Copying for Teachers

A single copy may be made of any of the following by or for a teacher at his or her individual request for his or her scholarly research or use in teaching or preparation to teach a class:

A. A chapter from a book;
B. An article from a periodical or newspaper;
C. A short story, short essay or short poem, whether or not from a collective work;
D. A chart, graph, diagram, drawing, cartoon or picture from a book, periodical, or newspaper.

II. Multiple Copies for Classroom Use

Multiple copies (not to exceed in any event more than one copy per pupil in a course) may be made by or for the teacher giving the course for classroom use or discussion; provided that:

A. The copying meets the tests of brevity and spontaneity as defined below; and,
B. Meets the cumulative effect test as defined below; and,
C. Each copy includes a notice of copyright.

Definitions

Brevity

(i) Poetry: (a) A complete poem if less than 250 words and if printed on not more than two pages or, (b) from a longer poem, an excerpt of not more than 250 words.

(ii) Prose: (a) Either a complete article, story or essay of less than 2,500 words, or (b) an excerpt from any prose work of not more than 1,000 words or 10% of the work, whichever is less, but in any event a minimum of 500 words.

Each of the numerical limits stated in "i" and "ii" above may be expanded to permit the completion of an unfinished line of a poem or of an unfinished prose paragraph.

(iii) Illustration: One chart, graph, diagram, drawing, cartoon or picture per book or per periodical issue.

(iv) "Special" works: Certain works in poetry, prose or in "poetic prose" which often combine language with illustrations and which are intended sometimes for children and at other times for a more general audience fall short of 2,500 words in their entirety. Paragraph "ii" above notwithstanding such "special works" may not be reproduced in their entirety; however, an excerpt comprising not more than two of the published pages of such special work and containing not more than 10% of the words found in the text thereof, may be reproduced.

Spontaneity

(i) The copying is at the instance and inspiration of the individual teacher, and,

(ii) The inspiration and decision to use the work and the moment of its use for maximum teaching effectiveness are so close in time that it would be unreasonable to expect a timely reply to a request for permission.

Cumulative Effect

(i) The copying of the material is for only one course in the school in which the copies are made.

(ii) Not more than one short poem, article, story, essay or two excerpts may be copied from the same author, nor more than three from the same collective work or periodical volume during one class term.

(iii) There shall not be more than nine instances of such multiple copying for one course during one class term.

The limitations stated in "ii" and "iii" above shall not apply to current news periodicals and newspapers and current news sections of other periodicals.

III. Prohibitions as to I and II Above

Notwithstanding any of the above, the following shall be prohibited:

A. Copying shall not be used to create or to replace or substitute for anthologies, compilations or collective works. Such replacement or substitution may occur whether copies of various works or excerpts therefrom are accumulated or reproduced and used separately.

B. There shall be no copying of or from works intended to be "consumable" in the course of study or of teaching. These include workbooks, exercises, standardized tests and test booklets and answer sheets and like consumable material.

C. Copying shall not:

(a) substitute for the purchase of books, publishers' reprints or periodicals;
(b) be directed by higher authority;
(c) be repeated with respect to the same item by the same teacher from term to term.

D. No charge shall be made to the student beyond the actual cost of the photocopying.

Publications Address List

ANTHROPOS
Anthropos Institute
Editions Saint-Paul
30 Perolles
CH-1700 Fribourg
Switzerland

HARCOURT BRACE JOVANOVICH, INC.
757 Third Avenue
New York, New York 10017

HARPER'S
Two Park Avenue
New York, New York 10016

HOUGHTON MIFFLIN COMPANY
Two Park Street
Boston, Massachusetts 02107

THE INDIAN HISTORIAN
1451 Masonic Avenue
San Francisco, California 94117

THE LYRIC
307 Dunton Drive, S.W.
Blacksburg, Virginia 24060

POETRY
Box 4348
Chicago, Illinois 60680

SATURDAY REVIEW
150 East 58th Street
New York, New York 10155

THE SCIENCE TEACHER
National Science Teachers Association
1742 Connecticut Avenue, N.W.
Washington, D.C. 20009

SOLAR LAW REPORTER
Solar Energy Research Institute
1617 Cole Boulevard
Golden, Colorado 80401

Glossary

a

automation
the condition of controlling and operating equipment and systems automatically, and the techniques and equipment used to do so; also, the replacement of human or animal labor by machines, or of human control by mechanical or electric control.

b

c

conservation
making the best use of natural resources by reducing waste, improving efficiency, and slowing the rate of consumption.

d

deforestation
the process of removing trees or clearing forest from an area.

e

energy
the ability to do work or make things move; the application of a force through a distance. Energy exists in a variety of forms (electrical, kinetic or motion, gravitational, light, atomic, chemical, heat) and can be converted from one to another. Common units are calories, joules, Btu, and kilowatt-hours.

energy transition
a time in history when there is a significant change in the mix of energy resources on which people depend. An example is the transition in the U.S. from use of coal and wood primarily (as in 1900) to widespread use of gas and petroleum, in addition to coal, by 1950. Another example is the entry of nuclear power generation on the commercial scene and its increased contribution to total energy needs, up from 1% in 1973 to 4% in 1979. If the future brings greater reliance on renewable resources and less dependency on fossil fuels, OR if fission/fusion processes generate the major share of commercial electricity, either of these scenarios would be another "energy transition".

environment
the sum of all external conditions and influences affecting the life, development, and ultimately the survival of an organism.

f

fossil fuels
coal, petroleum, and natural gas; this term applies to any fuels formed from the fossil remains of organic materials (plants and animals) that have been buried for millions of years. The ultimate source of energy for those plants and animals was the sun.

g

h

i

internal combustion engine
an engine which uses fuel burned within the engine itself to produce heat or pressure to do work. Examples are the gasoline piston engine and the diesel engine.

j

k

kilowatt
a measure of power, usually electrical power or heat flow; equal to 1,000 watts or 3,413 Btu per hour.

l

m

mechanization
production by machine; also, the substitution of machinery for human or animal labor.

n

nonrenewable resources
energy resources that are not being replaced during the time span of human history. Examples are coal, oil, natural gas, and uranium.

nuclear energy
energy from radioactive decay or from fission or fusion reactions. In a controlled situation it can be used to produce electricity.

o

p

passive solar energy system
an assembly of natural and architectural components which converts solar energy into usable or storable thermal energy (heat) without mechanical power. Current passive solar energy systems often include fans, however.

photosynthesis
green plants' process of using solar energy to convert simple molecules into complex ones with high potential energy. Carbon dioxide and water are combined, in the presence of sunlight and chlorophyll, into carbohydrates such as sugars, starches, oils and cellulose.

photovoltaic cell
a device which converts solar energy directly into electricity. Sunlight striking certain materials (silicon is most common) causes the release of electrons. The migration of these released electrons produces an electrical current. The conversion process is called the photovoltaic effect.

pollutant
an impurity or contaminant emitted to the ambient air. It may be a solid (particulate matter), liquid (mist), or gas (such as carbon monoxide).

q

r

radiation
the method by which heat is transferred through open space. About 60% of the heat transferred to a room from a wood stove is by radiation. Sunlight travels to us by radiation through space at "the speed of light", 299,728 kilometers per second.

renewable resources
materials that are recycled by natural processes within a relatively brief span of time (a human lifetime). Fresh water, wind, sunshine, and trees are some examples of resources that replace or recycle themselves within human time frames.

s

solar access or solar rights
the right to receive direct sunlight without interference. The protection of solar access is a legal issue.

solar energy
the electromagnetic radiation emitted by the sun. The earth receives about 4,200 x 10^{15} kilowatt-hours of solar radiation per day.

solar furnace
a device using mirror reflectors or lenses to produce very high temperatures at a focal point or "hot spot." Small backyard furnaces generate temperatures as high as 1,100 degrees Celsius; the largest solar furnace in the world reaches 3,100 degrees Celsius.

steam engine
an engine which uses steam to drive a piston to produce mechanical power.

strip mining
mining for coal or useful ores by removing the soil and rock found above them, rather than by tunneling underground.

sunspace
a living space enclosed by glazing; a sunroom or greenhouse.

t

technological
relating to the application of scientific knowledge to industrial, commercial and other practical processes.

thermal pollution
degradation of water quality by the introduction of a heated effluent. Primarily a result of the discharge of cooling waters from industrial processes, particularly from electrical power generation.

thermodynamics
the relationship between the various forms of energy, and the transformations from one form to another.

u

v

w

wastes, radioactive
by-products of producing power by splitting atoms in a nuclear power plant; some of these materials are highly radioactive and remain radioactive for long periods of time.

water wheel
a wheel turned by flowing water to drive machinery.

x y z

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