WINTER 2008
Asia/Pacific – Summer 2008

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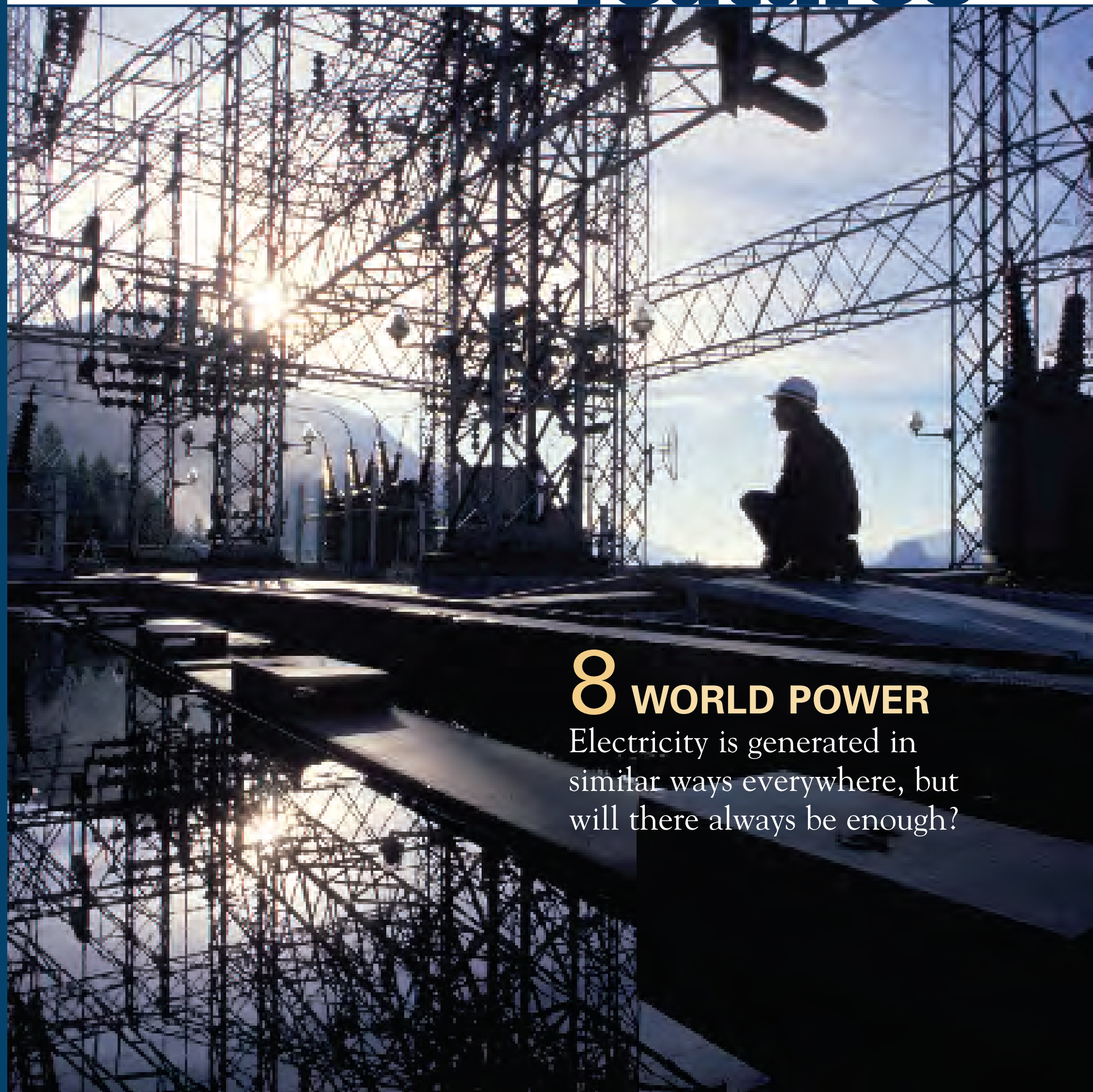
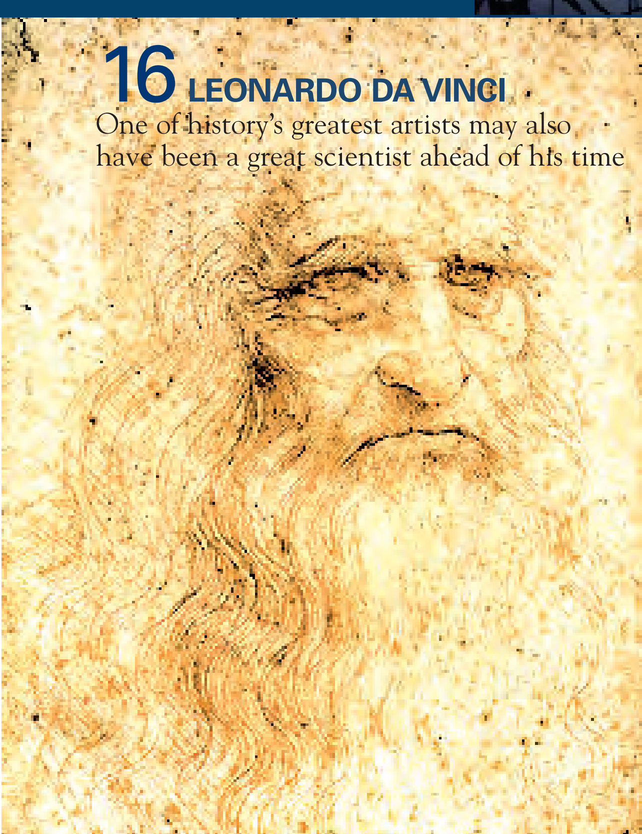
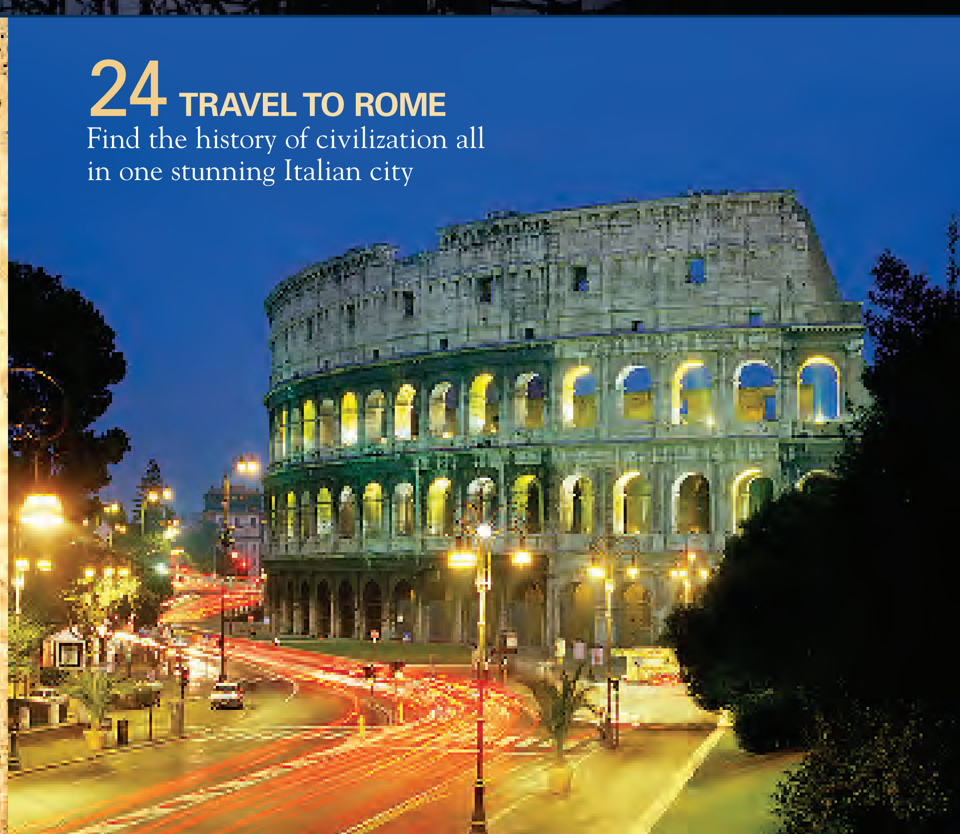
departments

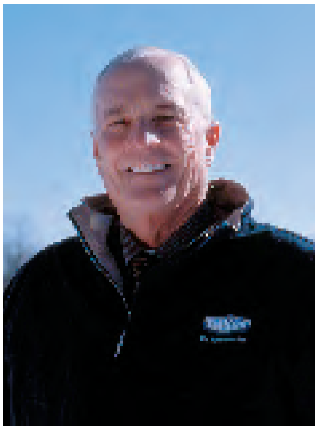
features







The Demand for Power



The feature article in this quarter's BOSS magazine is about world power. Not the kind that one nation exerts over another, but the vital resource that is so critical to a global economy: electrical power. The article focuses on its source, its use and our industrialized world's insatiable need for more and more of it. There are some great challenges here, and some very promising ideas on the table.

Operating a foundry, as well as manufacturing and distribution facilities, requires a great deal of power. Making metal hot enough to mold into castings and then machining those castings plus bar, pipe and tube to meet precise specifications uses a lot of electricity. Even maintaining warehouses around the globe so that product is readily accessible to our customers is a drain on energy resources.

To meet these power demands, Dixon is involved in a never-ending process to increase efficiency. We continually invest in new, more efficient equipment, and take Total Productive Maintenance (TPM) programs and the training required to make them work very seriously. We also work closely with local power companies to ensure that lighting throughout our facilities is effective and efficient. We believe that this is part of acting responsibly as a corporate citizen and, in the end, it costs less to do things right the first time.

Enjoy our magazine and thank you for your business.

Dick Goodall

Dick Goodall

Are you an amateur photographer with an interesting shot of an industrial landscape? Send us your best photos by Feb. 1, 2008. If your shot is selected, we'll run it in the spring 2008 issue of *BOSS* magazine*. Digital photos should be 5-by-7 inches and 300 dpi minimum. We also will accept slides mailed to BOSS Photo Contest, Alter Communications, 1040 Park Ave, Suite 200, Baltimore, MD 21201. E-mail photos or any questions about the contest to BOSS@dixonvalve.com. Good luck!

*By submitting photographs, entrants give Dixon Valve & Coupling Company the rights for unlimited use.

Correction

In our story "Why the World Trade Center Fell" in the fall 2007 issue of *BOSS*, we incorrectly reported how long the WTC towers stood and the order in which they fell after being hit on 9/11 by two jet planes.

According to the official 9/11 Commission Report, the first tower to be hit, the north, actually stood for 1 hour and 42 minutes. Although the south tower was hit 17 minutes after the north, it was the first to fall, standing for 56 minutes after impact.

BOSS magazine regrets the error.

BOSS

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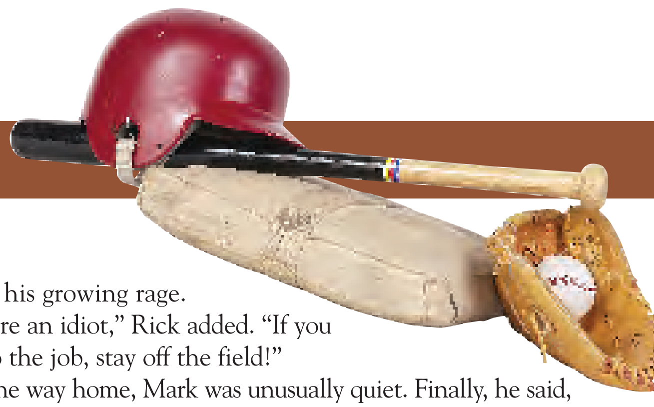

We Should Expect More From Adults

By Michael Josephson

Rick's 11-year-old son Mark was in a youth baseball league. He was not highly skilled and was easily discouraged, but Rick urged him to stay with the program. "Just do your best," he said. "That's all anyone can ask and your best is good enough." So the boy persisted.

The league had a rule that everyone plays. Mark played but regularly struck out at the plate and made errors in the field. When Mark struck out his first time at bat, Rick struggled to look positive. Later, Mark hit a hard grounder to third. It was close, but Rick was sure Mark beat the throw to first. When the umpire, a volunteer parent, called Mark out, Rick went wild. "Hey Zebra!" he yelled. "Are you blind, stupid or is the other team paying you?"

The umpire looked over at Rick, who couldn't seem to control his growing rage.

"You're an idiot," Rick added. "If you can't do the job, stay off the field!"

On the way home, Mark was unusually quiet. Finally, he said, "Dad, I thought you said, 'Doing your best is good enough.'"

"It is," Rick assured him. "You were safe that last time. You were robbed by a bad call."

"I wasn't talking about me," Mark replied. "I was talking about the umpire, Billy's dad. I know he was doing his best, but you got really mad at him."

"Yeah, son, but he's an adult and we should expect more out of adults."

Mark looked his dad right in the eye and said, "That's what I thought too. By the way, I was out."

Rick's good intentions just weren't enough. We expect more from adults—more fairness and respect, more sportsmanship and more self-restraint. If your kids play sports, be a model, not a problem.

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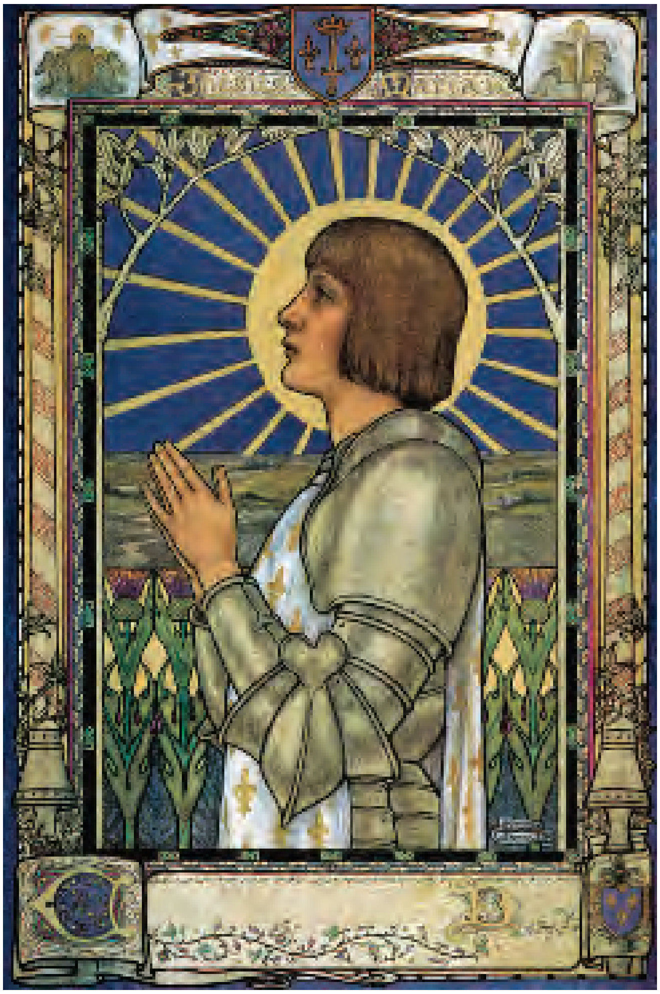


A Teenage Hero

Joan of Arc was a 15th-century peasant girl who drove the English out of France

By Lisa De Nike

Few historical figures have captured and held the public's imagination as has Joan of Arc, the teenage peasant girl who—instructed by the voices of saints—left her home in the French countryside to lead her country's army to an amazing victory over the invading English in 1429 during the Hundred Years' War.

Joan may have lived and died—burned at the stake as a heretic—almost 600 years ago, but her story and courage in the face of astounding odds still resonates today. Not only is Joan a Catholic saint (she was canonized in 1920), but her tale also has served as inspiration for many of the world's most famous writers, composers and filmmakers.

Born "Jeannette" to a farm family in the town of Domremy on the border of the French provinces of Lorraine and Champagne, in 1412, Joan lived an ordinary life until the age of 12, when something extraordinary happened: she heard the voices of Saint Michael the Archangel and Saints Margaret and Catherine telling her to "be good and attend church often."

Four years later, the voices were speaking to her daily, revealing that it was her divine mission to free France from the English by taking up arms to help Charles VII, the French dauphin, regain the throne. (The "dauphin" is the name given to the eldest son of a king of France, the heir apparent to the throne.)

At this time, the English—with the help of allies from the French region of Burgundy—had occupied Paris and all of France north of the Loire River. Henry VI of England was claiming the throne.

Despite the fact that she was an uneducated farm girl who knew much about sheep but nothing of warfare, Joan's voices were insistent: she must shear off her hair, put on men's clothing and pick up arms in order to drive the English from French soil.

Believing in her heart that her "voices" came from God, Joan obeyed. In May 1428, she traveled with her cousin Durand Lassois to the town of Vaucouleurs where she appealed to Robert de Baudricourt, the captain of the royal garrison there, to allow her to see Charles VII. Baudricourt was skeptical and rude, telling Lassois: "Take her home to her father and give her a good whipping."

Chastened, Joan returned to her village, but her voices continued to plague her until she could no longer resist, and she returned to Vaucouleurs in January 1429. This time, she was able to convince Baudricourt of the veracity of (and divine inspiration for) her mission by her prescience: she predicted the stunning defeat that the French had suffered outside Orleans at the Battle of the Herrings, which was reported days later.

As a result, Joan was allowed to go to the castle in Chinon to see Charles VII. Charles was skeptical at first, but Joan reportedly convinced him of the veracity of her mission by revealing secrets only he would know. Charles also had Joan examined by a church council—headed up by the Archbishop of Reims—and she apparently passed muster, because he gave her a suit of white armor and a sword and allowed her to lead his army.

Joan and her army entered the city of Orleans on the evening of April 29, 1429, and by May 8 had liberated that city. She began the "Loire campaign" on June 9, and drove the English out within 10 days. Next, she headed for Reims, and on July 17, Charles VII was crowned king of France there.

Following the coronation, fighting continued elsewhere in the country, and Joan was captured in a skirmish on May 23, 1430. Joan's family did not have the means to ransom her (a common practice in those days), and for reasons that are unclear, Charles VII did nothing to help, despite the fact that he owed her his crown.

Seeing an opportunity, the English purchased Joan from her captors on November 30, 1430. Their objective was clear from the first: to discredit Charles VII as a "false king" by condemning Joan—the young woman responsible for placing him on the throne—as a witch and a heretic.

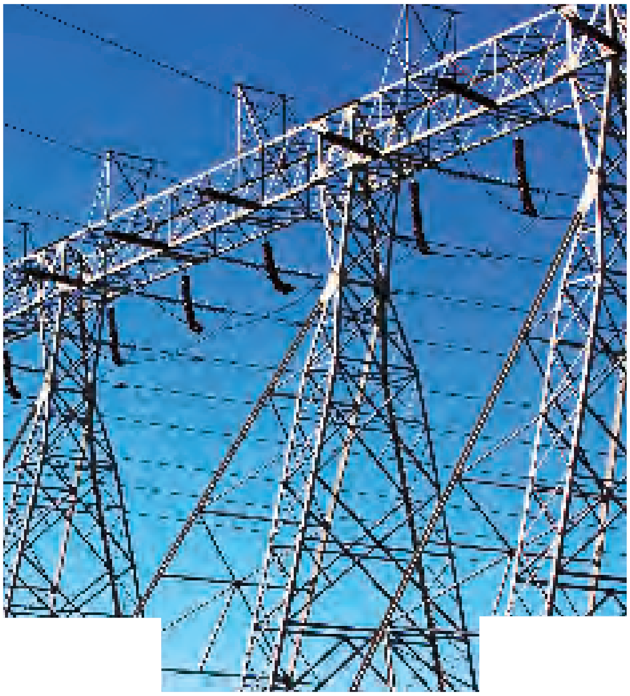
According to historical records, the case against Joan was stacked from the start. The English employed church authorities who were under their influence. Historians contend that trial transcripts reveal Joan's amazing intellect: despite the fact that her inquisitors did their best to confuse and confound her, she remained calm.

Regardless, Joan was condemned as a heretic (both for her visions, which her inquisitors deemed false, and for her habit of dressing in men's garments, which went against church doctrine) and was sentenced to death.

She was only 19 when she was burned at the stake in the Rouen market square on May 30, 1431. Eyewitnesses reported that the small peasant girl stood bravely as she was fastened by ropes to a pillar and flames were ignited at her feet. Her only request was that two clergymen raise a crucifix before her, so she could see it. She reportedly cried out the name of Jesus as the flames consumed her. Her ashes were scattered in the Seine River.

Twenty-five years later, the court's findings were nullified by a different church court, and in 1920, the Catholic Church officially declared Joan a saint. Her feast day is celebrated on May 30, the day of her death.


WORLD



BY VIRGINIA HUGHES

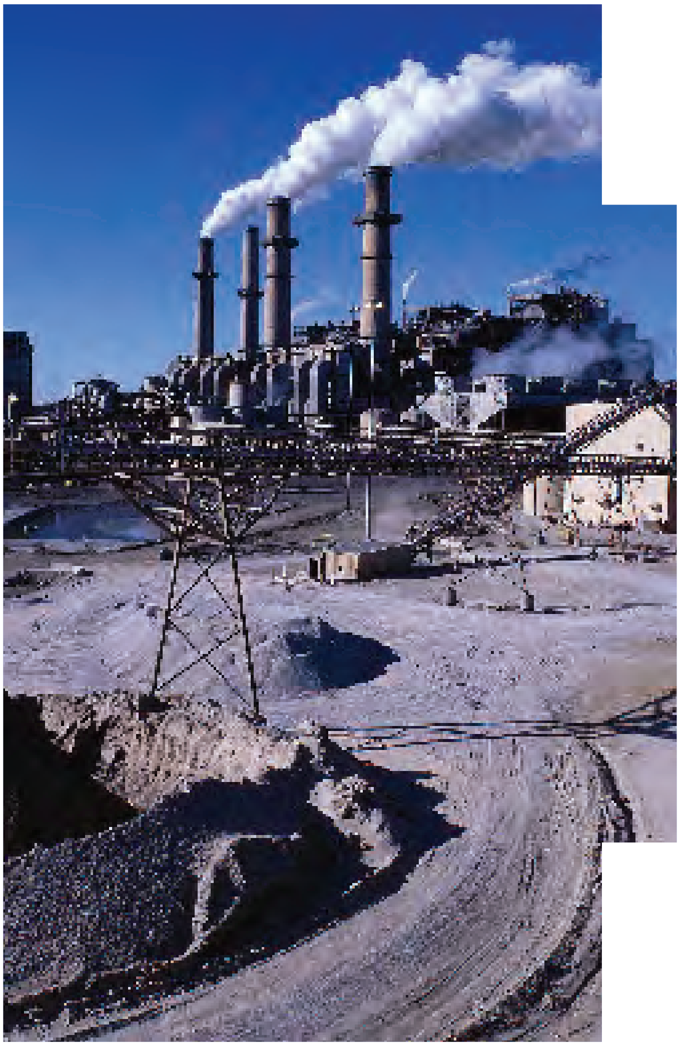
POWER

Coal, natural gas, oil, wind and water can all be made into electricity to feed an enormous grid that satiates the world's hunger for power.

THE TRILLION-DOLLAR ELECTRICAL INDUSTRY that keeps milk from spoiling, mechanical hearts pumping and the Internet abuzz would never have been possible if, in 1831, English physicist Michael Faraday hadn't noticed a tiny movement in his cluttered laboratory.

Eleven years earlier, Danish scientist Hans Christian Oersted had shown that electrical current flowing through a wire caused a compass needle to swing about—that is, that flowing electricity could create a magnetic force. But Faraday wondered if the opposite was true: Could magnets create electricity?

To find out, he placed a wire near a magnetic source, hoping to see that the magnet induced a current in the wire (which was attached to a current-detecting meter). To his great frustration, nothing happened. But one day,



Coal is transported from mines (photos above) to coal-fired power plants, which produce the majority of the world's power.

just as he was turning off his laboratory magnet, Faraday happened to notice the current meter's pointer flicker. Curious, he turned the magnet back on, and saw the pointer flicker again, this time in the opposite direction. With a few more tinkerings, Faraday discovered a physical law that would change the world: A change in magnetic force can induce electricity.

In 2004, global electricity generation was 16.4 trillion kilowatt-hours, according to the U.S. Department of Energy. (For comparison, a 100-watt light bulb operated for 10 hours uses one kilowatt-hour.) And Faraday's law of induction underlies every non-battery electrical power generator in the world, including coal- and gas-fired power plants, hydroelectric dams and nuclear reactors. At the heart of each, metal coils rotating between large magnets induce electrical currents to flow into an enormous power "grid" that doles it out to our lamps and refrigerators. The difference between the various types of power plants lies in how to get those coils moving.

From Rock to Grid

About 87 percent of the world's energy consumption starts by digging up fossil fuels such as oil, natural gas and coal. Coal—million-year-old fossilized rocks of mostly carbon, with traces of sulfur and heavy metals—is abundant in many places throughout the world, most famously in China (with more than 21,000 mines), the United States, Australia, Germany and Siberia. The world consumes 5.3 billion tons of coal each year, and about 75 percent of that is used to make electricity.

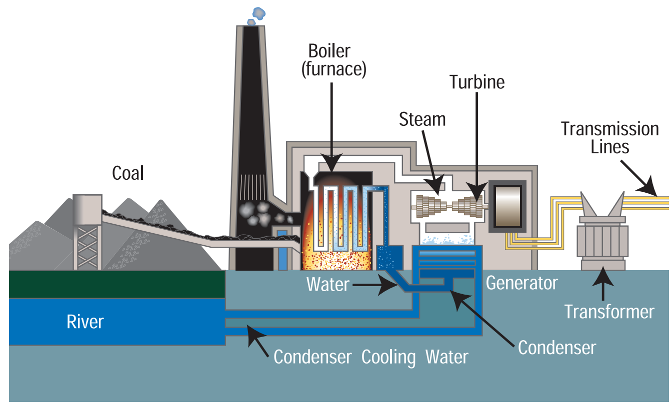
Once uprooted at a coal mine, the rocks are transported by rail to individual power plants, where they are pulverized into a fine powder and thrown into a furnace. To burn the precise combination of carbon and oxygen that produces the most heat, extra air is blown into the furnace, creating a vacuum so strong that, according to Michigan State University chemical engineer Carl Lira, "when you walk into the plant, the door immediately slams shut behind you."

The coal and oxygen, once burned, turn into carbon dioxide and heat. The carbon dioxide is discarded, along with excess nitrogen and oxygen, creating the familiar smoke billowing from chimneys on top of the plant.

"Almost three-quarters of the air that you put through the burner comes out the other side," Lira says. The heat, however, is used to turn water, pumped into the plant from nearby reservoirs, into high-pressure steam. (The water that's pumped into the boiler is first treated with softeners and anti-corrosive chemicals to remove all of the minerals that could clog the pipes, just like the crud that tap water, once boiled, leaves at the bottom of a teakettle.) The steam is then shot through a series of steel pipes that lead to the large blades of a giant pinwheel, called a turbine. "The overall process is to make the water into steam, use the steam to drive the turbine, condense the water back into liquid, and then pump it back into the boiler again in as much of a closed loop as you can," Lira explains.

When first made, the steam is pressurized at about 850 pounds per square inch (for comparison, your car tires are kept at about 30 psi). This high-pressure steam is then pushed through uniquely shaped, small-diameter nozzles, which causes the pressure of the steam to drop and the velocity to rise. The high-velocity steam is then powerful enough to push blades of the turbine. Lira says the process is akin to blowing on a pinwheel with a straw. "If you blow through a straw, you end up with a much stronger gust than if you just blew on the wheel without the straw."

The turbine blades, once set in motion, turn a shaft that causes large coils of wire to rotate inside of large magnets. This "dynamo" thus induces electricity on a large scale in much the same way that Faraday did on his laboratory table-



Once mined, coal is burned to heat water into steam. The steam then drives a turbine to ultimately produce electricity.

Capturing Carbon

Coal, when burned, releases more carbon dioxide into the atmosphere than anything else on Earth. But since coal is also the cheapest and most abundant source of energy in many parts of the world, engineers are now developing technology that traps the carbon dioxide emitted from traditional coal-fueled power plants and pumps it deep into the ground.

"When people talk about how filthy and dirty coal is, there's something wrong," says chemical engineer Gary Rochelle of the University of Texas at Austin, whose research focuses on carbon-capture technology. "It's not the coal, but the old plants that are filthy and dirty."

Rochelle's team is working on a process that captures carbon dioxide by first dissolving it in a liquid chemical solution containing ammonia. Then, a series of other chemical reactions isolate pure carbon dioxide from the solution, and compress it into liquid form. Finally, the liquid carbon dioxide is pumped 3,000 to 5,000 feet underground, "and it stays down there forever," he says. This is an especially practical solution in places that have already been drilled for oil or natural gas.

What are the drawbacks to using carbon-capture power plants? For one thing, they're about 30 percent less efficient, according to Rochelle. If a normal coal-burning plant was designed to produce about 800 megawatts, then a carbon-capture plant that burned the same amount of coal would only produce about 560 megawatts. "That's a major hit," he says. "Nobody's going to do that voluntarily."

Another problem is scale. The typical carbon-fueled power plant produces about 800 megawatts, and the largest carbon-capture systems built so far, Rochelle says, produce only about 30 megawatts. That's

because the "scrubber"—the cylindrical, steel vessel where the ammonia solution first comes in contact with the emitted gases—has to be about 60 feet in diameter. "So we still need to learn how to build big plants," says Rochelle, who estimates it will take at least five more years of research.

When the Lights Go Out

Most of us take electricity for granted—until we don't have it. Given the size and complexity of the power grid, what causes the electricity to suddenly shut off?

The power distribution grid is simply all of the power plants in a particular region and the wires that connect them. Because a power grid cannot store power, to be most efficient it must supply exactly enough to satisfy demand—no more, no less.

The interconnectivity of the grid makes it dependable: If a power company needs to take a tower offline for maintenance, for instance, then the others in the grid can crank up production to pick up the slack. But the grid can be a curse in times of overuse.

During an especially hot summer, homes and businesses supplied by a particular power plant may all be blasting their air conditioners, so that the demand exceeds the capacity of the plant. The plant may temporarily lower voltage to conserve power—called a "brownout"—or, to prevent serious damages, may shut down completely (much like a household fuse).

To meet the region's energy demand, nearby power plants will try to "spin up" production. But if the homes and businesses connected to these plants are also demanding excess power, these plants will also disconnect from the grid and exacerbate the problem even further. In a serious blackout, dozens of power plants might shut down in this kind of "cascading failure," leaving millions of people in the dark.

top. The current is then distributed away from the power plant and into the world at large. For this power "grid," we can thank 19th-century American inventor Thomas Edison.

By 1878, 31-year-old Edison was famous in America for inventing the telegraph, phonograph and a rudimentary telephone. In early September, while visiting a manufacturing plant in Connecticut, Edison saw "arc lights" powered by a noisy dynamo, where arcs of white light were made when electricity hopped between a series of carbon electrodes. Edison was inspired by the arc process: What if he could make, like the chain of electrodes, mass-produced lamps, distributed throughout a community but powered by a centralized source? By the end of December, Edison had made a mini-grid on the property of his laboratory in Menlo Park, N.J. He invited New York City planners to come by for dinner, and dazzled them with the bright lights that illuminated the grounds and dining hall. They granted him permission to dig up city streets, and two years later he switched on a grid that, via wires buried underground, powered 400 lamps across Manhattan.

Today, every major city has its own power grid. One problem with the grid system is that it can't store electricity. So if generated power isn't used, it's wasted. For that reason, the grids of nearby cities are usually linked; if one region is only using a relatively small amount of power, it can be sold to a nearby region that needs it. This mass linkage sometimes presents its own problems; a blackout started in one city, for instance, may easily spread to others. (See sidebar this page.)

From a Different Kind of Rock

Coal-fired power plants produce the bulk of the world's electricity, but not all. About 6 percent of the world's power (and 80 percent of France's) is generated by nuclear reactors, making steam not with fossil fuels, but fission fuels.

In a "pressurized water reactor," a common reactor in nuclear power stations, heat is created by splitting (fission-

In a nuclear power plant (photos page 12), a nuclear reaction is used to heat water into steam and drive turbines. Solar panels can harness the sun's energy to generate power (below).

ing) uranium atoms. Uranium is found in several forms, but only U-235—meaning that the number of neutrons and protons in its nucleus add up to 235—is fissile. To be useful in a reactor, U-235 rock is first formed into half-inch-wide pellets, which are then stacked inside of thin, pencil-like zirconium tubes about 2 feet long. The pencils are then grouped into 50-pound fuel bundles, about the size of a fire log. Each "fire log" has enough energy to supply 100 homes with electricity for one year. Because a nuclear reaction releases so much potent energy, one reactor could go for a year or more without stopping. (This is why military ships that stay at sea for long periods use nuclear power.)

The U-235 atoms inside of the fuel logs are then struck by subatomic particles called neutrons, which split apart the uranium and release huge amounts of energy. Just as in a coal-burning plant, this heat is used to make steam that will move the blades of a turbine.

Nuclear technology accelerated in the 1960s, as part of weapons research in the United States and the Soviet Union during the Cold War. Today there are 439 nuclear power plants in 31 countries. But because of its controversial past, the idea of nuclear plants leaves a bad taste in the public's mouth in some parts of the world. In fact, due to strict licensing regulations and political pressure, only a handful of new nuclear facilities have been built in the United States and England in the last few decades.

"It is heavily regulated, as it should be," says Christopher Harrop, a project director with the international nuclear consultancy AMEC. In both countries, he explains, companies must get a reactor design pre-licensed by governmental nuclear regulatory commissions (NRCs) before any building takes place. The process is expensive, and takes many years.

In the United Kingdom, the Nuclear Installations Inspectorate is currently reviewing four designs for nuclear reactors. Once the designs are approved, the sponsoring companies can submit applications to build reactors on specific sites. Between now and 2009, the U.S. NRC will review 21 such applications for new nuclear power plants.

Nuclear power is growing, especially in the Far East countries like India and China. Harrop, who has developed nuclear plants in China, says that though they have a lot of coal, it's usually low-quality coal that must often be transported long distances.

"It's an open market—everyone's building [nuclear plants] in China right now," he says. "They've been building them since 1985 … and haven't really stopped, whereas the U.K. and the USA have stopped." Part of the reason for that, he says, is that a nuclear plant takes about seven years to build, which is difficult in the ever-changing political climate in the U.S. and the U.K. "When the Chinese declare a 12-year plan, chances are the plan will go ahead because it's not open for political discussion every five years," he explains.

As for the dangers of nuclear power, advocates say the safety statistics speak for themselves. Because of respiratory diseases and coal-mining accidents, power generated by fossil fuels kills more people every year than the accumulated radiological effects of all fissile reactions in the past. Bruce Power, in Ontario—Canada's first private nuclear plant—cites that someone who eats one banana a day for a month will receive the same amount of radiation from naturally occurring potassium-40 as someone who spends a year living next to their site. "It's a very safe industry," Harrop says, "but there is still this public perception of danger of what you cannot see, touch, feel. I don't think that's completely gone away. Here in the United Kingdom, there's now a large public debate about using nuclear power," he says. "It's on TV most of the time, on everybody's minds. It's something that people are ready to discuss."

Renewables

Both fission fuels and fossil fuels are nonrenewable energy sources—a finite amount of uranium, natural gas and coal is buried deep within the Earth. Moreover, the use of both fission and fossil fuels brings a host of environmental problems. Nuclear plants produce thousands of tons of radioactive waste every year, and nobody really knows the safest way to dispose of it. (Most of it now goes to "cooling bays"—underground Olympic-size swimming pools filled with water—and stays there for at least 10 years.) And coal, along with being the largest single source of fuel for worldwide electricity generation, is also the largest single source of carbon dioxide emissions—which many climatologists say is the primary cause of the planet's recent warming. Some engineers are working on technologies that will trap these dirty emissions from existing plants, and pump them back into the ground. But others are turning their focus to renewable forms of energy, such as the long-established hydroelectric dam or, increasingly, solar farms and wind farms.

Renewable energy accounts for about 7 percent of power generation worldwide. And the bulk of this comes in the form of hydroelectric dams, where the pressure from water trapped in pipes, when released, can turn huge turbines. Solar and wind power, though now representing only a fraction of the world's power generation, are two of the fastest growing energy sectors, especially in Europe.

In Southern California, the Mojave Desert's unyielding sunlight, pouring down on miles of empty space, seems the perfect place to harness the sun's energy. At the end of 2005, a startup company and two large utility companies announced they would build the largest solar power plant in the world there, with a 500-megawatt energy capacity that would rival coal-burning plants.

With construction scheduled to begin in mid-2008, the 4,500-acre farm will have 20,000, 40-foot-tall curved dishes that each use a mirror array to focus the sun's energy onto a Stirling engine—an oil-barrel-sized heat engine filled with hydrogen. The 1,350-degree-Fahrenheit heat makes the hydrogen expand, and this drives the engine's four pistons. The pistons move a drive shaft, which then powers an electrical generator.

But the renewable commodity getting the most press of late is wind. Denmark is at the forefront of the industry, with one-fifth of its power generated by wind. (The United States, in contrast, relies on wind for just one-half of 1 percent of its power.) In places with steady breezes—usually on a coast or barren plain—wind turns the turbine blades, which then turn a rotor shaft and an electrical generator at the top of the tower. Wind turbines are only practical in places where wind speed is at least 10 miles per hour, without too many sudden powerful bursts.

Keith Lovegrove, energy engineer and the solar thermal group leader at Australian National University, in Canberra, says that the solar and wind technologies are already huge industries, and that a "renewable revolution" is absolutely feasible in the coming years. "A decade from now it will be very noticeable for everybody, but still a small percentage. In two decades, it will be quite a significant percentage," he says. That said, Lovegrove admits that renewable energy on its own doesn't make sense everywhere. "If you live in a part of the world with no wind and no sun, then you're in a bit of trouble," he says.

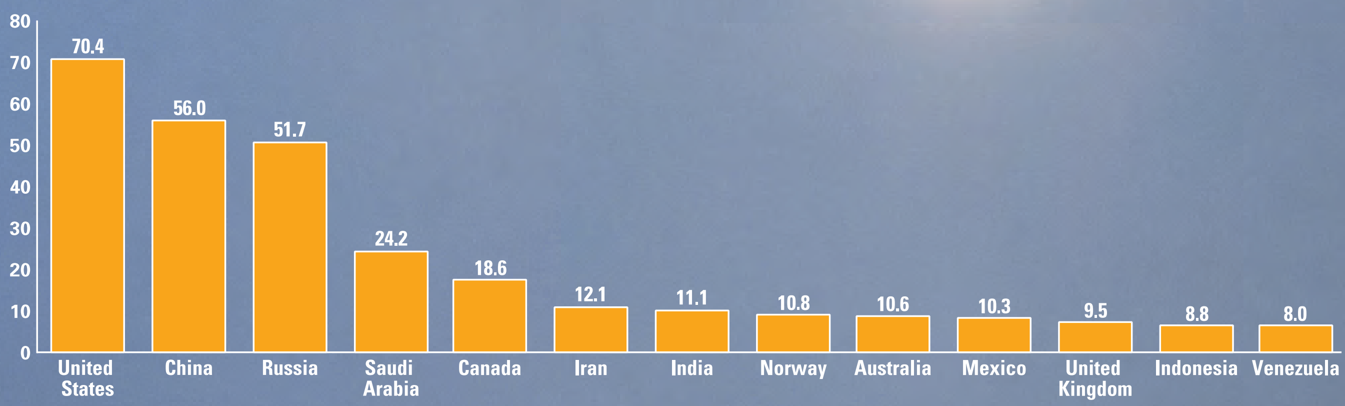
The choice of which kind of alternative energy source to invest in comes down to basic economics. "Countries develop power strategies around the fuel source that they have," Harrop explains, "because that's their basic economic driver." The United States, for now, has a lot of coal, while Europe's supply is running dry. The recent growth in the wind industry has thus largely been because of initiatives in Western Europe, Lovegrove says. "But even they see a limit to what they can do with wind, so they look to places like Spain and even northern Africa for solar plants."

As our fossil fuels diminish, a combination of many types of energy may be the ultimate solution.

Power Generation

Worldwide energy production by region

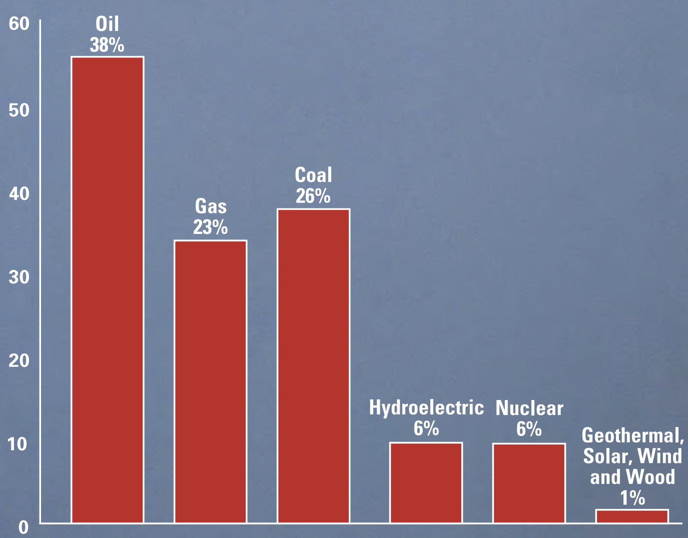
(U.S. Department of Energy 2004 figures)



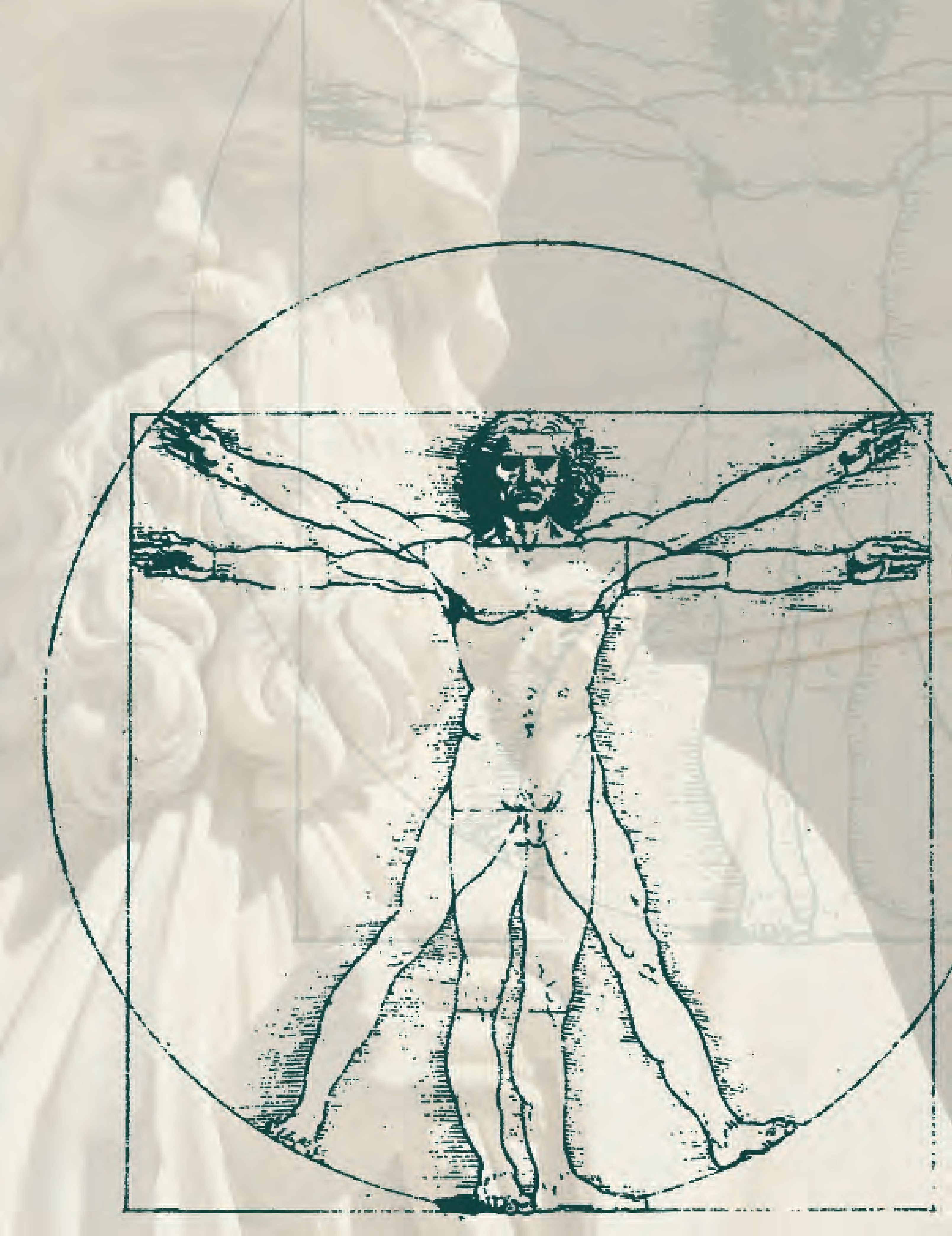
**Measured in Quadrillion British Thermal Units (BTU). A BTU is the amount of heat energy needed to raise the temperature of 1 pound of water by 1 degree Fahrenheit.

Worldwide energy production by type

(U.S. Department of Energy 2004 figures)



Source: http://en.wikipedia.org/wiki/Image:2004_Worldwide_Energy_Sources_graph.png



Leonardo da Vinci was indisputably one of history's great painters—but also one of the greatest scientists?

Centuries Ahead of His Time

By Kristi Birch

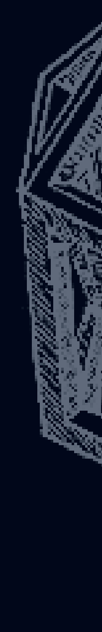
His ideas were centuries ahead of their time. In 1478, he created a blueprint for a self-propelled car. In 1487, he drew up plans for an armored tank lined with guns. In the early 1500s, he conceived of the idea for industrial solar power, using concave mirrors to heat water. He also drafted architectural plans for churches and other buildings, and drew complicated illustrations of human anatomy based on the many corpses he dissected for study. He's even been credited with inventing scissors.

He was Leonardo da Vinci, the quintessential Renaissance man. The Renaissance, the rebirth of culture following the Middle Ages, saw a transformation in math, science, arts and the humanities. Da Vinci seems to have mastered every discipline—from astronomy, architecture and engineering, to hydrodynamics, geology, even optics. Sixteenth-century da Vinci biographer Giorgio Vasari said the artist was also extremely handsome, kind, generous, and was said to be a musical prodigy.

And then there was the "Mona Lisa." Most remembered for his masterpiece paintings, da Vinci's "Mona Lisa" and "The Last Supper" are the most famous paintings in Western culture, perhaps in the world.

Not bad for the illegitimate son of a notary, Ser Piero, and a peasant girl named Caterina. Leonardo da Vinci was born in 1452 near the town of Vinci outside Florence, Italy. Because he was born out of wedlock, he did not inherit his father's surname—"da Vinci" means "of Vinci"—and he always signed his works simply "Leonardo." Da Vinci did not receive much formal education and, because he was illegitimate, he wasn't allowed to attend a university.

At the age of 14, when he demonstrated a talent for drawing and design, his father apprenticed da Vinci to the workshop of the renowned painter and sculptor Andrea del Verrocchio in Florence. The artists Verrocchio employed were considered craftsmen, producing dowry chests, christening platters, small portraits, altarpieces and statues. But da Vinci also would have been exposed to a vast range of technical skills and would have learned drafting, chemistry, metallurgy, metalworking, plaster casting, leather working, mechanics and carpentry, as well as the obvious artistic skills of drawing, painting, sculpting and modeling. Da Vinci relied on the skills he learned with Verrocchio for the rest of his career.



Da Vinci was a diligent note taker, producing some 4,000 pages of notes of every kind. Right: his drawings of a geared device and a giant crossbow.

Renaissance painters strived to make their painting as realistic as possible and, to that end, Verrocchio insisted that his pupils study human anatomy. Da Vinci learned to make sketches first of what he was going to paint, often from many angles, and became quite skilled in creating realistic figures. He worked with Verrocchio on one painting, the "Baptism of Christ," and legend has it that Verrocchio was so overwhelmed by da Vinci's work, particularly the sweet expression on the face of the angel he painted, that he put down his own brush and never picked it up again.

By 1476, da Vinci, 24, had his own workshop in Florence and had begun studying a diverse list of subjects, recording his notes and ideas dutifully on paper. He made drawings of his animal and plant studies, rock formations, wheels and bridges, and more, all intermingled with personal items. On one page in his notebook, for example, there are some geometry problems, a plan for building canals and the note, "Tuesday: bread, meat, wine, fruit, vegetables, salad." His drawings were usually accompanied by text, but oddly, he wrote his notations in "mirror writing," with the letters backward and from right to left, so that the only way to read the words is by holding the page up to a mirror.

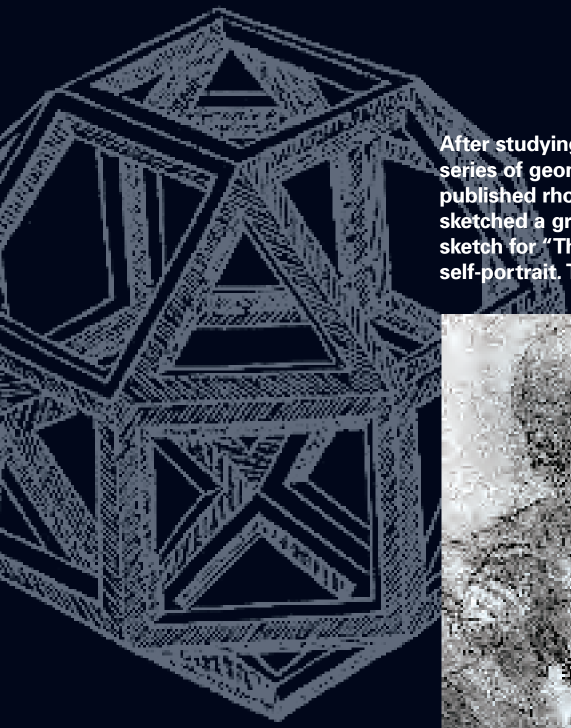
In 1483, da Vinci moved to Milan to work for Duke Ludovico Sforza and his family. When he applied for Sforza's patronage, da Vinci stressed his engineering knowledge as much as his artistic talent. He had drawn designs for submarines, catapults, armored tanks and various weapons. The designs were impressive, although they could not be realized because, as with most of his other inventions, the technology at the time was simply too crude to execute his often-detailed drawings. During his 17 years under the duke's patronage, not only did da Vinci paint and sculpt, but he also supervised the making of cannons, prepared floats and pageants for special occasions, and designed a dome for the Milan Cathedral and a heating system for the duchess' bath.

The Master of Invention

Da Vinci had a particular interest in locomotion, especially flight. He studied the movement of birds' wings and tails and tried to apply those principles to his many designs for flying machines. One was a wooden ornithopter, a one-person wooden aircraft powered by flapping wings. The aviator was to lie on a plank and move the wings using a hand lever, foot pedals and a pulley system. Da Vinci also designed a flying machine with a corkscrew-shaped propeller. The riders were to get into a basket made of wooden poles and stand with their feet on a platform that ended just before the blade of the propeller began. Da Vinci's notes called for a spring-loaded mechanism that would wind up the helicopter and release it, making the propeller spin fast enough to lift the machine off the ground. Many people consider this to be the world's first helicopter design.

Also fascinated with water, da Vinci watched pot lids jump when water boiled, and concluded that water must expand to become steam. He watched the waves form around a rock thrown into a pond, and realized that sound likely produces similar waves. Though these observations seem simple now, they were revolutionary for the time.

He designed water pumps and water wheels, and he even designed a water-powered clock. It was a stone jar from which water dripped into a second vessel. As the volume of water passed, people could see markings inside the second container to view how much time had elapsed, down to the minute.



After studying mathematics, da Vinci drew a series of geometric solids including the first published rhombicuboctahedron (left). The artist sketched a great deal before painting. Below, a sketch for "The Last Supper" is thought to be a self-portrait. The "Mona Lisa" (right).

Perfecting His Art

As a man of the Renaissance, da Vinci was obsessed with the natural world. He remained passionate about his anatomical studies and made detailed drawings of the heart and the brain based on the cadavers he dissected, which he did even after the bodies began to decompose. He wanted the natural world to be apparent in his art, and was determined to create realistic images that showed depth and distance and human expressions, unlike flat medieval paintings. He did this exquisitely in "The Last Supper," finished in 1498 when he was 46. Painted on the back wall of the dining hall in a convent in Milan, it depicts the last meal Jesus shared with his disciples, in particular the moment when Jesus declares that one of the disciples will betray him. What makes the painting a departure from earlier works is that the disciples are portrayed as real people, with identifiable emotions.

When the French army conquered Milan in 1499, da Vinci left the city to find a new patron. He spent the next 16 years working all over Italy, including a year spent as a military engineer for Gen. Cesare Borgia. Da Vinci traveled with him, making military maps, which laid the groundwork for modern cartography.

Around 1503, da Vinci began work on what is considered his masterpiece, the "Mona Lisa." The portrait is believed to be of Lisa Gherardini, the wife of wealthy Florentine businessman Francesco del Giocondo, hence the painting's other name, "La Gioconda." Renowned for its indistinguishable brush strokes and its use of light and shadow, the painting is perhaps most famous for the elusive smile worn by the subject. Using a technique he called "sfumato," which comes from the word "fumo" (smoke), da Vinci painted with translucent layers and shadowed the corners of his subject's mouth and eyes. If you look long enough, the smile seems to disappear.

Innovator Until the End

In 1516, after spending three years working in Rome, da Vinci left Italy for France, where he spent the rest of his life serving as premier painter, engineer and architect for Francis I. The king and da Vinci became great friends; Francis I paid him well and asked for very few paintings in return. Da Vinci spent the end of his life sketching what he wanted, including preliminary designs for scuba diving gear and movable bridges.

Da Vinci died in 1519 at the age of 67. His legacy today includes 17 surviving paintings, as well as some 4,000 pages of notes. Because da Vinci did not share his notebooks, the massive amounts of work in them did not really advance the science of his day. Had his notes been published, da Vinci's place as one of the great scientists of his day and in history would be certain. However, after his death, the notebooks were scattered and many were lost. It wasn't until the 19th century that some of them resurfaced, which is one reason da Vinci is remembered more as an artist than as an inventor or scientist.

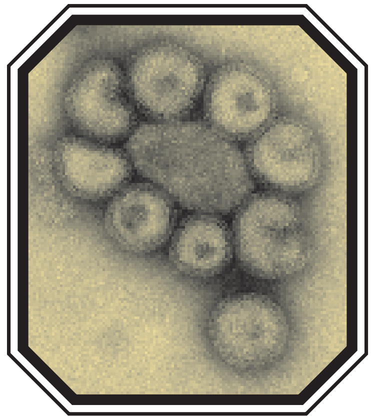
In 2000, a British skydiver named Adrian Nicholas decided to test one of da Vinci's parachute designs. The design resembled a kite, with the rider hanging from a structure made of linen and held together by poles in a pyramid shape. Five hundred years after da Vinci invented it, Nicholas jumped out of a hot air balloon at 10,000 feet and opened up a da Vinci-designed parachute made of canvas. Nicholas flew "for ages and ages and ages," he said. Although he used a modern parachute for the final landing (da Vinci's design had no steering mechanism), Nicholas landed safely and the da Vinci parachute floated to the ground next to him—completely intact and unscathed.

MILESTONES OF HISTORY

THE INFLUENZA

PANDEMIC OF 1918

How one strain of the flu virus killed 50 million people in just four months



BY EUGENE FINERMAN

In 1910, any physician in Vienna, London or New York would have boasted that epidemics were a thing of the past. Perhaps plagues were still a danger in backward cultures where medicine was rare or little more than witchcraft. But the industrialized societies of the 20th century had nothing to fear. Modern medicine was working wonders. It found the cures for smallpox, rabies and diphtheria, and was making major advances in the treatment of tuberculosis, yellow fever and malaria. Civilization had come too far to worry about plagues. … That sense of confidence would not survive the decade, and neither did 50 million people. The influenza pandemic of 1918 taught a costly and humbling lesson.

Influenza never had been considered a threatening disease. Hippocrates described it, and nothing had changed in almost 2,500 years. The disease certainly was infectious, easily spread by coughing and sneezing, but was regarded as just a common illness of winter. The coughing, fever, sore throat, muscle pains and fatigue added up to a week of misery. At worst, influenza could lead to pneumonia and so was dangerous to infants and the elderly, but the overall mortality rate was one in a thousand cases. The "flu" seemed so inconsequential that the U.S. Public Health Service did not monitor any outbreaks of the disease.

So when and where did this lethal form of influenza originate? A study, sponsored by the American Medical Association, traced the epidemic to Haskell County in western

Influenza victims crowd into an emergency hospital at Camp Funston, a subdivision of Fort Riley in Kansas.

Kansas. This was an agricultural community, population 1,720, and we can surmise that some animal virus mutated and infected a human. A sneeze or a cough did the rest. In January 1918, many of the county's young adults came down with a severe case of flu. Young adults were usually the least susceptible to the disease; but this strain seemed to target them. Worse, this influenza had a greater likelihood of leading to pneumonia. Some people were dying. But after two months, the outbreak appeared to be over. Influenza was only a disease of winter.

The United States had entered World War I in April 1917. Any soldiers from Haskell County would have reported to Fort Riley in eastern Kansas. On March 4, 1918, the first soldier reported ill with influenza. Within three weeks more than 1,100 soldiers were hospitalized; and 50 died. Their symptoms were so severe and atypical of influenza that the doctors initially misdiagnosed the disease, thinking it cholera, typhoid or meningitis.

Fort Riley had 56,000 soldiers. In the normal course of military operations, thousands had been transferred to other camps and now they were spreading the disease. On March 18, Army camps in Georgia reported the first cases of influenza. By the end of April, 24 of the 36 main Army bases had epidemics. The Army estimated that 36 percent of the soldiers were infected. Despite this, the Army was preparing to send 1 million soldiers—healthy or not—to fight in Europe.

In March, the Germans had begun an all-out offensive to break the British and French lines before American reinforcements arrived. The Americans were desperately needed. Even if a third of the Doughboys were sick: the healthy ones could help turn back the German tide. Besides, conventional wisdom reasoned, it was only the flu; within a week or two, the sick could be expected to recover. In late April, U.S. troops arrived in France. Our Doughboys proclaimed "Lafayette, we are here." So was influenza. American troops were rushed to the front, and they stopped the Germans with more than just courage. The Germans, too, came down with the flu. By June, the disease had sapped the German offensive and the kaiser's last hope of victory.

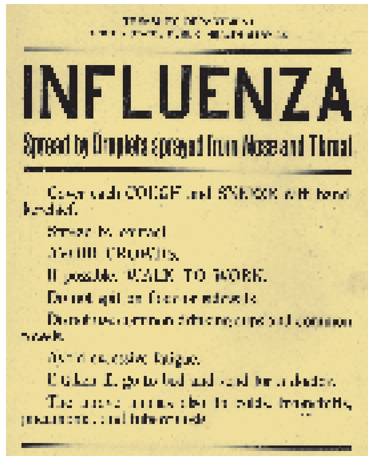
In May, the flu had spread to Britain. The royal navy curtailed its operations that month; 10,000 sailors were sick. By June, the disease was in Spain, where it acquired its notorious name: the Spanish Flu. Spain had not started the disease but it was the first to publicize it. The country was not involved in the World War, and so was free of the military censorship that suppressed news of influenza in France and Britain. Eight million Spaniards—including the king—had the flu. Business came to a standstill in Madrid; one-third of the populace was ill while the rest stayed home to avoid the disease. Yet, in one way Spain's bad name was also its good luck. Being stricken by the flu at this time, the Spaniards would be resistant to the disease in its more virulent phase that autumn.

During the summer of 1918, the flu virus mutated again and became far more deadly. Traditional influenza would kill one in a thousand; this Spanish Flu would kill one in 40. People could be suddenly stricken—within hours they were too feeble to walk. In addition to the usual afflictions of flu, the victims hemorrhaged and coughed up blood. Many developed pneumonia and suffocated.

This flu strain infected India; an estimated 17 million people died. It also returned to America. On August 31, the first cases of Spanish Flu were reported in a Navy yard of Boston: 26 sailors were dead. By September 11, the epidemic had reached Washington, D.C. The government should have declared a national health emergency, but the war effort seemed more important. In fact, the war encouraged crowds. Thirteen million men were required to report to government offices to register for the draft: long lines awaiting infection. Hollywood stars were appearing at war bond rallies; who wouldn't want to see Mary Pickford and Charlie Chaplin? Soldiers paraded through the streets of

New York and Philadelphia; and hundreds of thousands went to cheer them on. The spread of the disease was effortless.

Millions of Americans became ill: at least one-quarter of the population. The epidemic could no longer be ignored, and government belatedly responded but had little to offer but advice: avoid crowds and wear gauze facemasks. In fact, those masks were useless; the flu virus was so small that it easily passed through the porous gauze. However, there was one service that government could provide: burying the dead. More than 500,000 Americans died. In many communities, there were just too many bodies, and too few healthy or brave undertakers. The government would collect the corpses and dispose of them in mass graves.


INFLUENZA

If possible, WALK TO WORK.

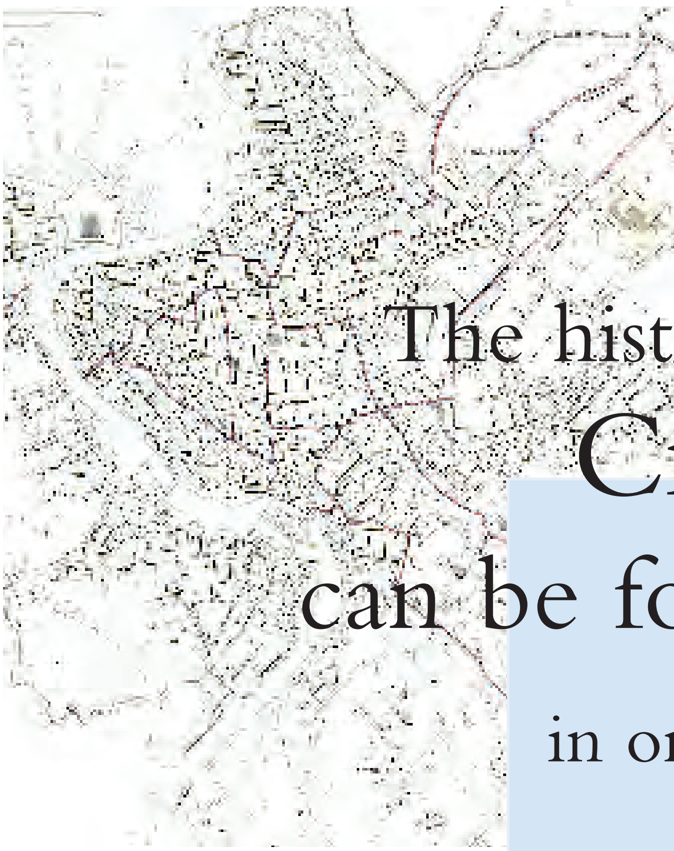
There was no cure or treatment for the flu: only fortitude, hope and luck. At the time, medicine had only the vaguest knowledge of viruses. The microbes were too small to be seen even by a microscope. In the face of this global epidemic, mankind was helpless. During the five years of World War I, 9 million men died. In 16 weeks in 1918, from September to December, 50 million people died of the Spanish Flu. An estimated quarter of humanity had become ill.

That winter, a time when influenza usually occurs, the pandemic slowed and then ended. Even now, we do not know why the Spanish Flu stopped. Had the virus mutated again into a less lethal strain? That is a matter of conjecture best left to physicians, statisticians and theologians.

Today, medicine has a strategy against influenza, using vaccines derived from killed viruses. However, viruses mutate so the vaccines then have to be reformulated—and medicine always seems to be a step behind. Another health care measure is to quarantine and kill flu-infected livestock. The fear of Avian Flu or Swine Flu is that the animal virus could mutate into a form deadly to humans. Isn't that what happened in 1918?

Modern medicine has learned its limitations against the virus. The prospect of a new pandemic, perhaps one as dangerous as the Spanish Flu, is not an abstract hypothesis. Today, any physician would say that it is only a matter of time.

Explore Rome



The history of Civilization can be found in one city

By Greg Rienzi

Photo page 24: the Colosseum. The majestic interior of St. Peter's Cathedral at the Vatican (left); the Pantheon (below).

In Rome, the history of civilization is quite literally at your fingertips.

The Italian capital, also known as the "Eternal City," retains vestiges of every period in its 2,700-year history, from ancient times to the Renaissance (A.D. 1350-1600), and the Baroque period (A.D. 1600-1750) to modern day.

The city features such national treasures as the Colosseum (built in 80 A.D.), the Forum, Vatican City and the Pantheon. It also boasts some of the world's most spectacular museums, which show off works from the times of Julius Caesar, Nero and Mussolini and the hands of Raphael, Caravaggio and Michelangelo.

The city sits on the Tiber River in the Lazio region of Italy. As Roman mythology has it, the twin brothers Romulus and Remus (sons of the god Mars and the priestess Rhea Silvia) founded the city and built it on and about seven hills: Aventine, Caelian, Capitoline, Esquiline, Palatine, Quirinal and Viminal.

Capitoline, the smallest of the hills, is the center of the city's municipal government, housed in several Renaissance palaces. The hill famously features the Piazza del Campidoglio, designed by Michelangelo as were the palaces that flank it, and the Temple of Jupiter. It also offers perhaps the best view of the city.

At just 580 square miles in size, Rome is not the largest of cities, so with a population of 2.8 million people the downtown area can get quite noisy and congested—major intersections can become an adventure even on foot.

Perhaps the most breathtaking landmarks in Rome (and useful as a meeting place) are its signature squares, or piazzas. To stroll from one to the next would make a fine day's itinerary.

Piazza Navona, in the Baroque portion of the city, stands on the remains of an old church and Domitian's Stadium, where ancient sports were held. The square features three fountains, the most famous of which is the Fountain of the Four Rivers, built by Gian Lorenzo Bernini in 1651. The fountain, designed for Pope Innocent X, boasts exquisitely carved figures arranged on a steep rocky reef that is topped by a massive pillar.

Fontana dei Quattro Fiumi (Fountain of the Four Rivers), below, was built in 1651 by Gian Lorenzo Bernini.

essentials

When to go: Rome boasts a mild climate and you can visit year-round, although recent Roman summers have been dry and sweltering. Perhaps the best time to visit is early fall as the weather is still warm but very bearable. Many shops and restaurants close in August and on August 15 (The Feast of the Assumption, a national holiday) Romans en masse head for the beaches and mountains. Most locals return by September 1.

The winter months, January to March, offer a break from the crowds and give you a better chance to avoid long lines.

What to see and do: Whether you're Catholic or not, Vatican City has to rank among the top spots in Rome to see. Here you can stroll the elegantly sculpted Vatican gardens, walk across iconic St. Peter's Square, and tour St. Peter's Basilica and the Sistine Chapel, home to some of the most famous artwork in the world.

Rome is home to many magnificent fountains, perhaps the most famous is Trevi Fountain, which dominates Trevi square. The 85-foot Baroque fountain took 30 years to complete and has Neptune riding a shell-shaped chariot as its central figure. Tradition holds that if visitors throw a coin backward into the fountain they are ensured a return to Rome.

If you seek refuge from the busy streets, turn into the Villa Borghese, the largest public park in Rome. Located just north of the Spanish Steps, the 148-acre park contains wide shady paths, a man-made lake, fountains, statues and several museums.

In between checking out all the city's many architectural wonders, take in some of the many outdoor events including concerts, theater performances and outdoor films held all over town. Italians love their movies and a great place to go during the summer is the Cineporto, an open-air cinema near the Stadio Olimpico that shows both new films and Italian classics.

Where to eat and drink: When in Rome, do as the Romans do and consume much coffee, wine, pasta and gelato, just not at the same time. For coffee, go to Caffe' Sant Eustachio, a timeless and quaint café located near the Piazza Navona

where they roast their own beans and drip a lovely crema on top of the cup, if you like. Debatably, Il Gelato di San Crispino has the best gelato in town. The flavors range from the simple (lemon and hazelnut) to the more sophisticated, such as crema del Malpighi, a vinegar-based ice cream that has an aftertaste of cherry and juniper.

Almost everything in Rome goes with wine, and one of the best places to try some is the Cul de Sac, a restaurant that offers a dizzying selection of wines from around the world.

For pasta, Rome has countless world-class restaurants. To find a good deal and delicious fresh cuisine, go to Trattoria Da Oio, a few blocks from the Testaccio market, or Rivadestra Home Restaurant in the Trastevere area. The latter features Italian Mediterranean cuisine lovingly paired with some of the country's best wines.

Where to stay: The hotels in Rome can get very expensive—think New York City or London prices—but there are still affordable options. The Hotel Rosetta, in the Monti neighborhood, is a good bet and it's conveniently located near the Colosseum, the Roman Forum and other main attractions. If you crave style and luxury, stay at the Albergo Cesari, located right near the Pantheon and in the heart of Old Rome. There are many shops, restaurants and landmarks nearby and the service consistently gets top marks.

A 75-foot obelisk marks Rome's largest square, the Piazza del Popolo (left).

In the center of Rome lies the Piazza di Spagna. It's located at the foot of the Spanish Steps, three flights that lead to the church Trinita dei Monti. The steps are decorated each April and May with a dazzling array of potted azaleas and the square itself, which is somewhat butterfly shaped, is a magnet for tourists.

The largest of the squares is the Piazza del Popolo (of the people), which is in truth an oval, not a square. A 75-foot obelisk, put there to commemorate the conquest of Egypt, stands in the center of the traffic-free piazza, which is surrounded by magnificent neoclassical architecture, cafes and restaurants. This piazza is also the site of the city's northern gate, the Porta del Popolo.

To get from one piazza to another, the recommended modes of transportation are foot, bus or motor scooter, the quintessential way to see Rome. The city does have a metro, but its stops are few, and taxis there are pricey.

In fact, Rome can get very expensive, perhaps no more so than in the Via Veneto district. In addition to many upscale hotels and shops, the area is home to Harry's Bar, an elegant restaurant and piano bar immortalized in Fellini's *La Dolce Vita* and a haven for celebrities.

In need of a sports fix? Football (soccer) is Rome's main attraction. Both SS Lazio and AS Roma, two top division teams, play their home matches at the Stadio Olimpico, located to the north of the city's center. The football season lasts from September to May and most matches take place on Sunday afternoons.

The heart of Rome might just be Trastevere, an area on the left bank of the Tiber River. This bohemian neighborhood is marked with winding streets, terra-cotta buildings, one-of-a-kind boutiques, and coffee bars

Tips from a local

Brian Wingfield first visited Rome when he studied abroad as a graduate student. His studies took him to Bologna, but he often found time for day trips into Rome.

He loved the area so much that he stayed for a time after graduation. As a contributing writer for *The New York Times*, Wingfield also stayed in Rome for six months in 2005-2006.

He says he loves to walk the city's streets and along the Tiber River, especially during an early fall afternoon, but one of his favorite stops takes him well above street level, to the observation deck on the Capitoline Hill.

"I love to go there late or early evening, just to hang out and take in the city. The view is incredible." Wingfield says. "Sometimes you can have the whole place to yourself."

Another favorite destination of his is the Vatican.

"There are things there you just can't see anywhere else in the world," he sys. "Plus, the pomp and ceremony is like nothing else, it's just so grandiose."

He recommends that visitors seek out the Campo de Fiori quarter and stroll through its famous open-air market to people watch and to buy fresh flowers and tasty fare.

While there is plenty to see and do in Rome, Wingfield says you should save some time for a day trip to Tivoli, a historic hill town in the Lazio region. Tivoli's two most famous tourist attractions are the magnificent gardens and fountains of the Villa d'Este and the extensive ruins of Hadrian's Villa, known as the Villa Adriana.

What is particularly wonderful about Rome, Wingfield says, is its timelessness. He marvels at how history oozes out of every corner of the city and says you can't help but be transported back in time when you visit such spots as the Pantheon or the Colosseum, both great reminders of the Roman Empire.

"Locals will even tell you that Rome never changes. If you visited there 50 years ago, it would not be tremendously different than it is today," he says. "For the Italians, preservation is really important."

and restaurants aplenty.

If you want to go off the beaten path and taste traditional Roman fare, head to Testaccio, a traditional working-class area named after the mountain of discarded amphoras (jars) called Monte Testaccio. The area has a lively market area where you can sample such traditional pleasures as pizza, bacalao (dried and salted cod) and sweetbreads. This up-and-coming part of town also recently sprouted many nightclubs.

Renzo Bragantini, a professor of literature at the University of Roma La Sapienza, says that the city, which has been his home for more than 30 years, still inspires and awes him.

"It's just so beautiful: the colors, the monumental palaces. It's a wonderful place, especially if you like Renaissance and Baroque architecture," Bragantini says. "I think it's one of the most attractive and unique places in the whole world."

The Tiber River, left, flows through Rome and is the third largest river in Italy.

A Shocking Danger

Static electricity in chemical hoses can be more than just a surprise

By Phil Kimble

Storm clouds. Shuffling feet on a carpet. A chemical hose in use. What do these three things have in common? They all have the capability of producing static electricity.

Most of us are familiar with the shock associated with static electricity. Children have amused themselves for centuries by shuffling their feet across a carpet and touching a doorknob or playmate for a quick zap. As entertaining as these events may be, static electricity commands respect. In an industrial hose, static electricity can cause volatile products to explode or even burn through the side of a hose.

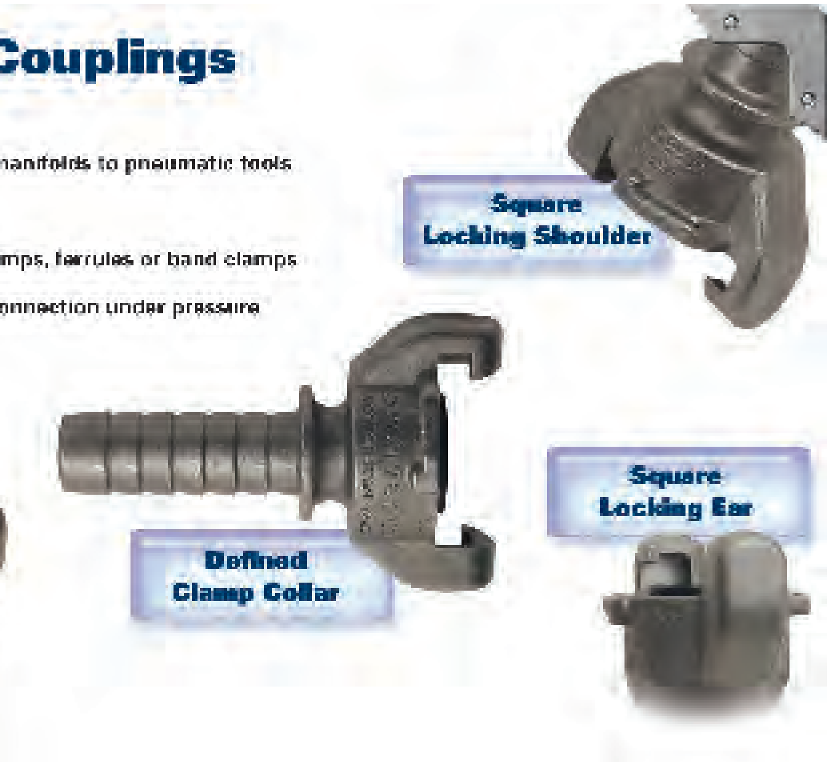
Static electricity is a serious concern when it comes to hose assemblies used in chemical transfer. The products they transmit fall into two categories: accumulator or non-accumulator. The movement of accumulator liquids (hydrocarbon-based liquids such as gasoline) transfers electrons from the insulator (rubber hose) to the accumulator liquid. Continued movement of these products through an assembly not capable of transferring this charge makes it susceptible to explosion or heat damage. Workers handling these assemblies can be exposed to extreme electrical shock similar to picking up a live 115-volt line. In addition, ungrounded assemblies conveying accumulator liquids can act as storage batteries. Depending on the product, it can take several minutes for the charge to dissipate after movement has ceased. So, even after the pump has been turned off, workers are still vulnerable to a significant electrical shock if they touch the metal couplings.

Other industrial hose applications carry a risk of electrical shock or damage to the hose through the buildup of static electricity. Many workers have been surprised at the powerful shock they received from touching the metal fittings on a steam hose that was not properly grounded. All assemblers and users must follow the hose manufacturer's guidelines for proper static grounding. Typical static grounding procedures use the built-in static wire (when present) or helical wires. Assemblies that require grounding must be tested for electrical continuity. This is done by taking a multimeter reading and comparing it to those supplied by the hose manufacturer. Not only should these assemblies be hydrostatically tested on a regular basis for serviceability, but they should be periodically checked for electrical continuity because in rare occurrences, the static wire or helical wire may fracture during use.

The spark from touching a metal object is nature's way of balancing out positive and negative charges. To balance the positive and negative charges in an industrial hose, the hose must be grounded properly. "Keep it safe" by testing these assemblies before installation and periodically thereafter. Let's keep the fireworks for a Fourth of July celebration.

Air King Universal Couplings

- Also known as Crow's Foot and CP's
- Primary use is connecting compressors or air manifolds to pneumatic tools
- Available in iron, brass and stainless steel
- Attaches to hose with Air King interlocking clamps, ferrules or band clamps
- Heads lock together to prevent accidental disconnection under pressure
- Look for these features:
  - defined clamp collar
  - holes for safety pins
  - square locking shoulder
  - square locking ear



Play in the Snow

Being outside during the cold weather can be fun and keep you fit.

By Lisa De Nike

When you were a child, winter's first few snowflakes probably sent you racing outdoors, where you spent hours waging snowball fights with friends and building elaborate forts from drifts of freezing white stuff.

But as you got older, the onset of cold weather undoubtedly found you scrambling the other way: inside, away from the first frigid blasts of wind and into the warm depths of your favorite easy chair. And that's too bad, because outdoor activities are a great way to stay fit during the colder months.

According to the U.S. Centers for Disease Control, a half-hour of regular physical activity a day reduces your risk of dying of heart disease, helps control your weight and diminishes your chances of developing colon cancer, diabetes, stroke and high blood pressure.

But the benefits aren't just physical: exercise improves your mood, too. A recent study by doctors at England's Nottingham Trent University found that bodies in motion produce a chemical called serotonin that may explain why exercise helps people suffering from depression.

So it's no wonder that Jay Dyer, director of sports performance at the nationally respected Union Memorial Sports Medicine Center in Baltimore, Md., recommends getting outside and active during the winter.

"Most people have a fitness goal—losing weight, gaining muscle and so on—and the winter is the best time of year to make progress," Dyer advises. "You have six months before that first trip to the pool, beach or cutting the grass with your shirt off. If you've spent the summer inside a gym on a treadmill, winter can mark a change in your routine. Your lungs will appreciate some fresh air."

So get out into the world of winter with one of the cold weather sports listed below, or find one of your own. Not only will you feel healthier and stronger, but you may even rediscover the childhood thrill you felt as you raced down a hill on your very own sled.

Ice skating and ice hockey

Looking for a fun and inexpensive way to strengthen your muscles and burn some calories? Break out that old pair of figure or hockey skates and head for a nearby pond, lake (frozen, of course) or indoor rink. According to fitness experts, recreational ice skating burns between 250 and 810 calories per hour, and ice hockey consumes between 450 and 1,800 calories an hour. Because skating is such a great all-in-one workout (you would have to use a number of exercise machines at the gym to get the same whole-body workout session,) don't forget to warm up with some stretches and by jogging in place for a few moments beforehand.

Skiing and snowboarding

It's not hard to understand why skiing—both the downhill and cross country varieties—is one of the world's most popular wintertime activities. Though many people don't realize this, downhill (also called Nordic or Alpine) skiing is a demanding sport that helps develop your balance, endurance and muscle tone. In addition, experts tell us that the adrenaline surge that comes as you race down a mountainside activates certain receptors in your nervous system, causing your heart to beat faster and increasing the amount of air coming into your lungs. This causes endorphins—chemicals that make you feel happy—to rush to your brain.

Cross country skiing offers similar benefits, and an enhanced cardiovascular workout, burning between 600 and 900 calories an hour. It's also quite easy to master: most people can learn the "kick and glide" technique (which pulls the skier along the top of the snow) in just a few minutes.

If you're a veteran skier and want to try something new, but related, consider snowboarding. Between 1998 and 2004, participation in snowboarding in the United States increased more than 300 percent, to 5.5 million enthusiasts, according to SnowSports Industries America, the industry's largest trade group. Why the increase? It's good, clean fun.

The Chores Can Be Beneficial

Skiing, sledding, snow biking and hiking are fun ways to keep fit during the winter months. But you can also get a surprisingly good workout just by doing the following "everyday" chores:

- **Chopping wood:** A 150-pound man can burn up to 212 calories in 30 minutes swinging an ax to split wood for the family fireplace.
- **Raking and bagging leaves:** Your yard will look better, and your body will thank you for burning off 136 calories in a mere half-hour.
- **Shoveling snow:** Somebody's gotta do it, so why not use this chore to sweat off some of last night's dinner? A 210-pound man burns 300 calories shoveling snow for 30 minutes.
- **Plowing**: Believe it or not, you can even burn calories when you use a plow and tractor to move snow. The average 210-pound man burns 122 calories in a half-hour.
- **Run errands on foot:** Need to buy a gallon of milk or mail a letter? Forgo the car and walk.
- **Wash your car:** Grab a bucket and sponge and rid your car of winter's grime and salt while expending 300 calories in a mere half-hour.

Plus, boarding not only tones your entire body, it also provides a terrific cardiovascular workout, strengthening your heart and muscles.

Sledding

Dig that toboggan out of the garage and find the nearest slope. Though you won't exercise much more than your lungs (hollering as you plunge downhill), you'll definitely get a workout walking back up to the top after each run. Maybe that's why athletic trainers such as Dyer are increasingly recommending sled-pulling as a workout method.

Winter hiking and snow shoeing

Strap on some hiking boots with nice, thick treads and head for the woods. A brisk walk is a great way to relieve stress and get an up-close-and-personal look at nature in a nearby park or woods. Breathe deeply and swing your arms as you go for best conditioning effect. Don't forget to take your dog.

You might also want to try snow shoeing. Not only does this sport burn a great many calories in a short amount of time, but it also is among the safest of all outdoor winter sports, and easy to learn. You will, however, need a pair of snowshoes. (Contrary to what you have seen in old movies, you cannot just strap a pair of tennis racquets to your feet and go!) Proper snowshoes are about 24 inches long and are fashioned of lightweight aluminum. They attach easily to most footwear, including hiking boots. Most snowshoe enthusiasts also consider a pair of "walking poles" essential to the sport.

Happy trails.

The 1 millionth Frigidaire refrigerator is proudly displayed as it comes off the assembly line in Dayton, Ohio, in 1929.

Keeping Cool

The refrigerator evolved from an expensive and dangerous appliance to a household necessity

By Eugene Finerman

Early in the 20th century, when most physicists were engrossed by the discovery of the atomic structure or theory of relativity, Frenchman Marcel Audiffren was concerned with temperature variations in wine cellars. So he designed an appliance that chilled wine at a consistent temperature.

Audiffren's work was based on the principle that heat is drawn toward cold. Ice attracts and dissipates the heat in a surrounding space. Of course, the ice melts and overall temperature gradually increases. To combat this law of nature, Audiffren used an engine and a compressor to create a steady flow of coolant through pipes in an insulated cabinet. The cabinet's temperature could be controlled by regulating the coolant's flow.

General Electric was interested in Audiffren's machine and redesigned it to preserve perishable food. In 1911 GE introduced the Audiffren Refrigerating Machine. It was an extravagance—costing $1,000 when the average American's salary was $750 a year. Aside from its intimidating cost, the machine was a behemoth. It consisted of three separate components: the "cold box," a steam engine and compressor. The engine and compressor were installed in the basement under the kitchen. The machine also used a toxic gas, sulfur dioxide, as the coolant; leaks were a serious hazard.

In 1911, the icebox was the standard for keeping food cool and half of America's households had one. The traditional icebox was the size of a small cabinet with a single block of ice at the top or bottom. As the ice slowly melted, the icebox's interior temperature varied and increased the risk of spoilage. But in those days, no one expected food to have an indefinite shelf life—people just didn't want it to spoil overnight. The icebox inexpensively served that purpose.

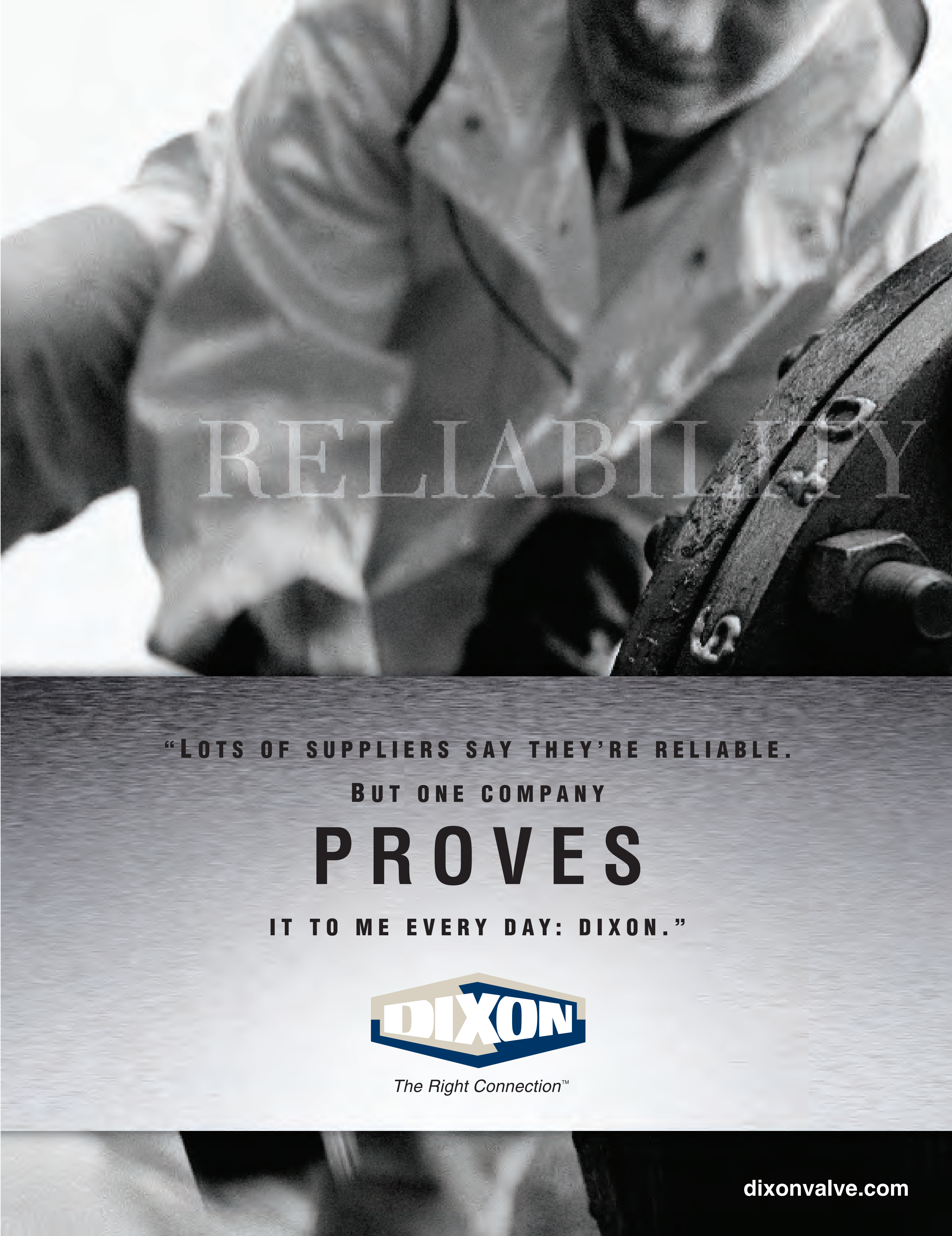
But not for long. In 1916, Alfred Mellowes built the first self-contained refrigerator. Its electric engine, compressor and cold box were built into a single unit. General Motors was so impressed that it bought Mellowes' invention in 1918, and began a refrigerator division called Frigidaire.

By the mid-1920s, mass production and a competitive market had lowered the price of refrigerators, but a formidable problem remained. Refrigerators ran on electricity and less than one-third of American households had that utility.

And refrigerators were still dangerous: Leaking toxic coolants caused several deaths. But in 1930, when DuPont introduced Freon, a non-toxic coolant, the refrigerator became safe. By the end of the decade, 2 million American households had one. That, however, was less than 10 percent of the population. A decade-long Depression had discouraged sales. Then, World War II literally stopped the manufacture of refrigerators. But when the war ended, everything changed.

Every veteran was entitled by the G.I. Bill to decent, affordable housing. In 10 years, 15 million new homes had been built and each had a refrigerator. By 1955, 80 percent of U.S. households had one and the rest of the world noticed. But other countries were not so quick to adopt the American phenomenon. In fact, in 1963, only 30 percent of Italian households had refrigerators.

In the past half-century, however, the refrigerator has become a standard item in homes throughout the world. A refrigerator can now be found in virtually every kitchen in the United States, Europe and Japan, and even, according to a 2004 *AgExporter* article, in 90 percent of urban Chinese households. After an unwieldy and dangerous beginning, the refrigerator has solidified its place as a necessity in our lives.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