BOSS

CONNECTING TO INDUSTRY

Aluminum

Whether recycled or made from dirt, this shiny metal has emerged as a star of modern industry

SUMMER 2010
ASIA/PACIFIC – WINTER 2010

BILL POULIN,
Machinist, 18 years

"WHEN IT COMES TO DELIVERING TOP-QUALITY PRODUCTS, CLOSE DOESN'T COUNT. HERE AT DIXON, THERE'S NO SUBSTITUTE FOR

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SUMMER 2010
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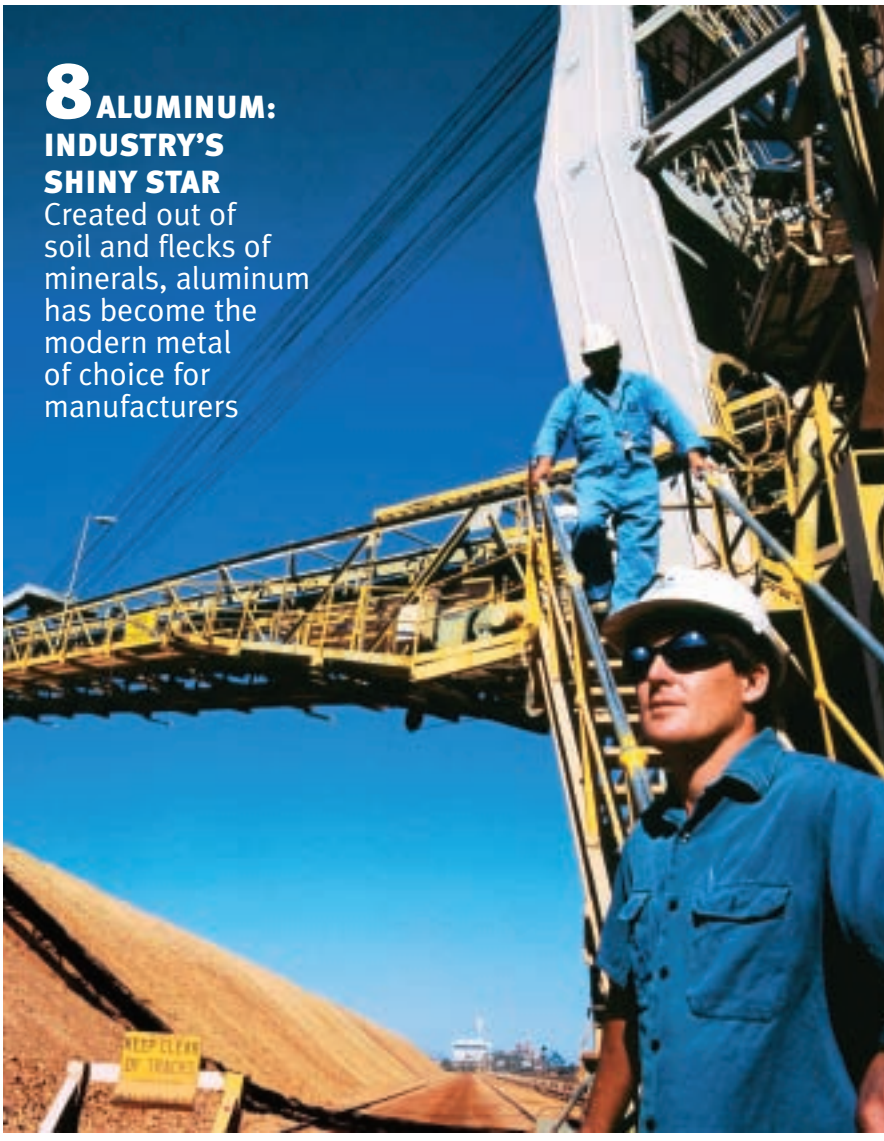
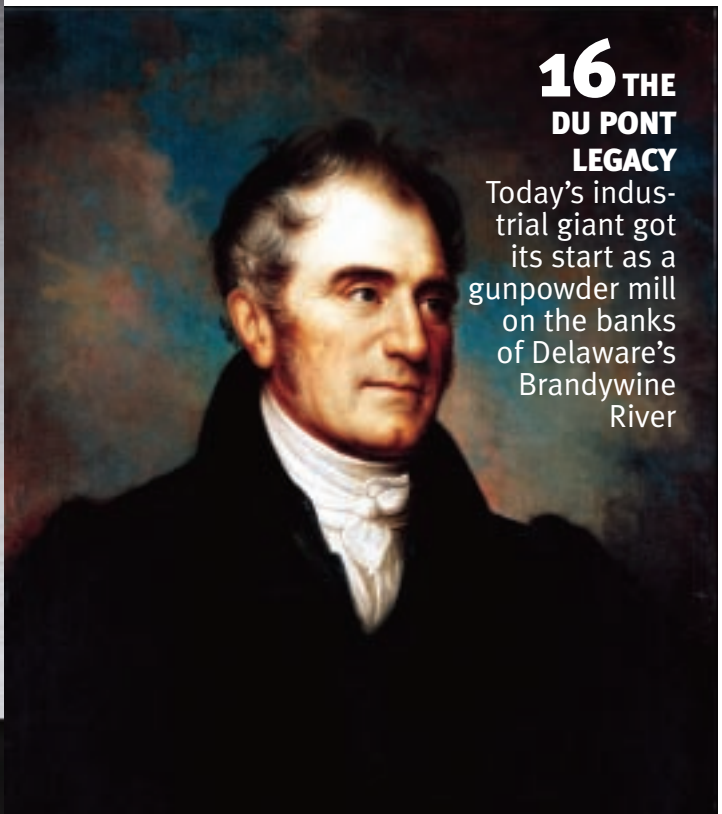
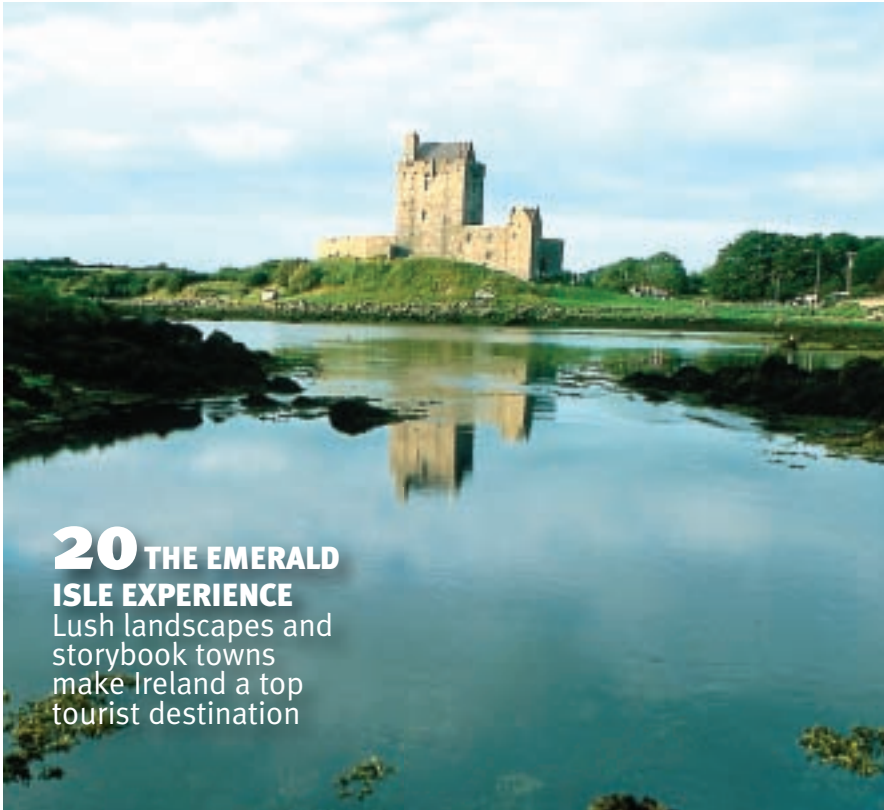
on the cover

Aluminum is the most recycled of all metals—of the 100 billion aluminum cans produced annually in the U.S., roughly two-thirds are returned for recycling.

features







Traditional Values Are Timeless

I RECENTLY FOUND a copy of an old book originally published in 1923 by Dr. Elwood E. Rice titled *Standards of Business*. The book was in a box with some other things that belonged to my grandfather H.W. Goodall, founder of Dixon. My grandfather evidently belonged to the association called the Rice Leaders of the World, which was founded in 1912 by Dr. Rice. The association is based upon the principles of honor, quality, strength and service in business. The following is an excerpt from this book.

The character of a good man inspires faith in him. His example shines like a lantern guiding the footsteps of those who would walk in the path of honor and fair dealing. Such a man, in the pattern of his life, unconsciously sets a standard by which others, also desiring to live rightly, may measure their own standing and progress.

With his wholesome aims always in view, he calmly pursues his way. He commands not only the highest respect and sympathy of those whose ideals resemble his, but also the secret unspoken regard of those whose aims and methods are, perhaps, less worthy of esteem.

The standard set by such a man is an inspiration to all who know him. As knowledge of him increases, his circle of influence widens and benefits to others multiply.

The same principle is applicable to business. A manufacturer whose character and reputation measure to the highest standard has an inspiring influence upon all who know him. It is, therefore, clearly to be seen that when more people know of such a manufacturer the business world in general is benefited.

It is true that through wider knowledge of the character and reputation of a worthy manufacturer, he benefits individually. Careful buyers naturally place their orders with a manufacturer known to be deserving of their confidence. But more than this; distributors who sell the goods of such a manufacturer strengthen their own reputation for handling dependable merchandise. The beneficial effect is extended to the consumer—he has the consciousness of using a product designed for his profit, health, happiness and comfort.

To use an apt illustration: The influence of such a manufacturer is as far-reaching as the influence of a stone cast into a lake—his personal direct profit is the splash at the touch of the water, but an ever-widening circle continues to ripple on and on, similar to the benefits flowing to distributors and consumers.

Although written in 1923, Dr. Rice's message is true today. Good character and strong values never go out of style.

Thanks for reading.

Dick Goodall

BOSS

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Shaping Our Own Destiny

BY MICHAEL JOSEPHSON

There's no doubt that our character has a profound effect on our future. What we must remember, however, is not merely how powerful character is in influencing our destiny, but how powerful we are in shaping our own character and, therefore, our own destiny. Character may determine our fate, but character is not determined by fate.

It's a common mistake to think of character as something that is fully formed and fixed very early in life. It calls to mind old maxims like, "A leopard can't change its spots," and, "You can't teach an old dog new tricks." This "etched in stone" perspective is supported by a great deal of modern psychology emphasizing self-acceptance. Like Popeye says, "I am what I am." The message is: "I'm done. Don't expect me to be more, better or different."

These views of character totally undervalue the lifelong potential for growth that comes with the power of reflection and choice. How depressing it would be to believe that we really couldn't get better, that with dedication and effort, we couldn't become more honest, respectful, responsible or caring.

There are so many things in life we can't control—whether we're beautiful or smart, whether we had good parents or bad, whether we grew up with affirmation or negation or with affluence or poverty. And though these circumstances of our lives surely influence our values and experiences, they do not control them. People of good and bad character come from all sorts of circumstances.

It's uplifting to remember that nothing but moral willpower is needed to make us better. No, it isn't easy. But if we strive to become more aware of the habits of heart and mind that drive our conduct, we can begin to place new emphasis on our higher values and become what we want our children to think we are.

Wiesel receives the U.S. Congressional Gold Medal from President Ronald Reagan, left. Wiesel's seminal work, above, has sold more than 7 million copies.

The Fight Not to Forget

Elie Wiesel has spent decades bearing witness to his 'walk among the dead'

BY MARIA BLACKBURN

Elie Wiesel lost his family, his town, his entire history in World War II. Imprisoned in a Nazi concentration camp as a teenager, Wiesel was issued the number #A7713, and he was starved, beaten and forced to watch as the people around him, including his parents and 7-year-old sister, were murdered because of their heritage.

"Forget where you came from, forget who you were," Wiesel and his fellow prisoners were told in the camps. "Only the present matters."

Some 6 million Jewish people were killed in the Holocaust. Wiesel survived. Afterward, he could have chosen to erase the experience from his memory. Instead, beginning in 1958 with his groundbreaking book, *Night*, he has written more than 40 books, taught hundreds of classes and delivered thousands of speeches to remind us of the atrocities of the Holocaust.

"I have tried to keep memory alive … I have tried to fight those who would forget," he said when he accepted the Nobel Peace Prize in 1986. "Because if we forget, we are guilty. We are accomplices."

In bearing witness, Wiesel encouraged others to do the same. And in broadening his message beyond the Holocaust and speaking out against human suffering and injustice all over the world—from Cambodia to Darfur to South Africa—Wiesel, 81, has worked tirelessly over the last half century to ensure that the Holocaust will never be repeated. For his dedication, he has been heralded as a "messenger to mankind" and awarded not just the Nobel Peace Prize, but the U.S. Congressional Gold Medal and the French Legion of Honor.

Eliezer Wiesel was born in 1928 in Sighet, Romania, the only son of a grocer. Religion and education were at the center of his family's life and Wiesel pursued studies in Judaism, modern Hebrew, and contemporary literature. In 1943, his world was turned upside down when his family and neighbors in Eastern Europe were sent to death camps in Poland. Wiesel, his parents and his three sisters were transported to Auschwitz in 1944, and he saw his mother and little sister

sent to the gas chamber (his two older sisters escaped death and were later reunited with him). Life in the camps was unbearable. "Men and women from every corner of Europe were suddenly reduced to nameless and faceless creatures desperate for the same ration of bread and soup, dreading the same end," Wiesel said in his Nobel lecture in 1986. "Walking among the dead one wondered if one was still alive."

In January 1945, soon after Wiesel and his father were marched to Buchenwald, the elder Wiesel died of dysentery and starvation. Weeks later, the camp was liberated by the American Third Army. The teenage Wiesel was sent to France to study with other Jewish orphans. There he became a journalist. While interviewing French author Francois Mauriac, the 1952 Nobel Laureate in Literature, Wiesel became inspired to write about his experiences. So in 1955, a decade after his liberation, he began writing *Night*.

"Never shall I forget that night, the first night in camp, that turned my life into one long night seven times sealed," Wiesel writes. "Never shall I forget that smoke. Never shall I forget the small faces of the children whose bodies I saw transformed into smoke under a silent sky. Never shall I forget those flames that consumed my faith forever. Never shall I forget the nocturnal silence that deprived me for all eternity of the desire to live. Never shall I forget those moments that murdered my God and my soul and turned my dreams to ashes. Never shall I forget those things, even if I were condemned to live as long as God Himself. Never."

Originally written and published in French, *Night* has been translated into 30 languages and has sold more than 7 million copies. In the decades since it was published, Wiesel married, became a father and an American citizen, and built a career as a well-respected university professor of literature and philosophy. He is currently on the faculty at Boston University. His many works range from essays and memoirs to plays and novels; the most recent, *A Mad Desire to Dance*, was published in 2009.

Not one to rest on his laurels, Wiesel used proceeds from *Night* to establish an Orthodox Jewish school in Israel in memory of his father. With his Nobel Prize winnings he founded The Elie Wiesel Foundation for Humanity, which is dedicated to combating indifference, intolerance and injustice through international dialogue and youth-focused programs.

Wiesel's life has gone on, but he doesn't ever want to leave his memories behind. "The opposite of history is not myth," he says. "It is forgetfulness."

Aluminum

BY MICHAEL ANFT

Industry's Shiny Star

PHOTOS COURTESY OF ALCOA INC.

Created out of soil and flecks of minerals a little more than two centuries ago, aluminum has become the modern metal of choice for manufacturers

Beneath a crisp blue sky in remote North Queensland, Australia, the red dirt landscape offers a startling contrast in color. This is the site of the Welpa bauxite mine, a busy operation where front-loaders constantly dig away at vast shallow pits of crumbly ore. Scoop by scoop, the front-loaders deposit their loads into waiting dump trucks. It's hard to imagine how these heaping piles of red dirt could ever amount to anything useful.

But they will.

During the ensuing days, the pea-sized ore mined here in Australia will be screened, washed, crushed, refined, smelted and fabricated—and ultimately emerge as gleaming ingots of shiny aluminum.

From a single 4-ton truckload of bauxite ore comes enough aluminum to make more than 60,000 soda cans or the space-frames for seven full-sized cars or 40,000 computer memory disks (enough to store all the books ever published).

In the 130 years since scientists discovered the chemical magic behind manufacturing this popular metal, aluminum has become a star of modern industry. Today it trails only iron and steel as the favorite metal of

Aluminum starts as a collection of clay and minerals that comprise bauxite, above left. Top: Molten metal being poured at an aluminum foundry. Temperatures reach more than 1,000 degrees Fahrenheit (538 Celsius) during the manufacturing process.

A worker outside the carbon bake scrubbers at Alcoa's Point Henry smelter in Victoria, Australia, top left. After being mined, bauxite gets offloaded into a crusher, where it is pulverized while traveling via a conveyor, above. At an Alcoa plant in San Ciprian, Spain, a worker examines a conveyor belt full of bauxite, above right. The Pinjarra refinery in Western Australia, right, is one of the world's largest.

builders and manufacturers—for everything from aircraft and appliances to paint and electrical transmission lines.

It's easy to see why aluminum has become a mainstay of consumer goods, increasingly prized by manufacturing companies around the world. Aluminum bonds well with other metals. It is lightweight, reflects heat and is resistant to rust. And it is strong but easily workable, retaining its shape and holding up to extreme cold without becoming brittle.

Perhaps most importantly, aluminum comes from readily available ores and has an unmatched level of recyclability, which helps ensure a ready, renewable supply. (About 34 percent of U.S.-manufactured aluminum comes from reclaimed materials.)

Aluminum might be considered the world's "green metal" but for one reason: It requires a huge amount of electricity and other fuels to convert it from raw bauxite ore to a powder of oxide and then, finally, to a genuine metal.

Humble Beginnings

Among major metals, aluminum comes from arguably the humblest beginnings.

The material that ends up becoming aluminum starts as a collection of clay and minerals that comprise bauxite in the topmost layers of the Earth's crust. Aluminum makes up 8 percent of the Earth's crust—more than any other metal—and is third among elements, behind only oxygen and silicon.

Aluminum compounds have been used for thousands of years. In 5000 B.C., ancient Persian potters used clay containing aluminum oxide to make stronger tableware. A few millennia later, Babylonians, Egyptians, Greeks and Romans turned various crude forms of aluminum into cosmetics, dyes and medicines.

But unlike other metals, including copper and bronze, that were mined and forged for thousands of years, aluminum doesn't occur naturally as a metal. No one could see it.

Finally, in 1808, British chemist Humphry Davy proved the metal's existence and gave aluminum its name. It would take more than 70 more years to develop a high-volume, low-cost process for making the metal. During those intervening decades, aluminum was so rare that its price rivaled that of gold or silver (See "More Precious Than Gold," p. 11).

By 1884, total annual production of aluminum in the U.S. was just 125 pounds. Enter Charles Martin Hall. He was a young student at Oberlin College when he became intrigued by a challenge issued by his chemistry professor. Professor Frank Jewett handed around small pellets of aluminum—produced at that point by a labor-intensive process that involved heating sodium with aluminum chloride. Whoever could discover a cheap way to make this metal would become rich, Jewett predicted to the class.

Hall was hooked. He converted his backyard woodshed into a laboratory and began experimenting. He first learned how to make aluminum oxide—a white powdery substance known today as alumina. Then, in 1886, the 22-year-old Hall succeeded with the second crucial step. He filled a carbon crucible with a cryolite bath, added the alumina and then passed an electric current through it. The result? A congealed mass that, when cooled, could be shattered…into small pellets of pure aluminum.

More Precious Than Gold

ALUMINUM HAS ROLLED OFF OF FACTORY LINES FOR ONLY A CENTURY or so. For decades after its metallic properties were discovered in the early 19th century, the shimmery stuff was nearly impossible to extract from bauxite ore. What's more, those who could separate it lacked a cheap process that would churn out large amounts of it, so only small bits were made. Aluminum was considered a precious metal, more valuable than gold.

The metal's rareness and showiness made it a favorite among royals. Bars of it were displayed alongside the French crown jewels during the Universal Exposition of 1855. Smelted bits of it formed a crown for the king of Denmark. And, tale has it that Napoleon III treated his favored guests to rare aluminum table utensils.

Despite some modest improvements in extraction and manufacturing in the ensuing years, aluminum was worth about as much as silver in 1884, when the United States made only 125 pounds of it (56 kilograms). More than 6 pounds of that—about 100 ounces (2.7 kg.)—were set aside for a lasting memorial. The largest piece of aluminum ever cast at the time was maneuvered into place atop the capstone of a new, 555-foot-tall obelisk made of Maryland granite, marble and sandstone: the Washington Monument. Aluminum, cast by William Frishmuth, an architect and metallurgist, topped what was then the world's loftiest structure. It was the first time the metal had been used in architecture.

It still rests atop the oversized pillar today, demonstrating the metal's resistance to oxidation—though only the birds can see it.—**M.A.**

Weeks after Hall's discovery, the electrolytic extraction process he developed was replicated independently by Paul Heroult in France. It became known as the Hall-Heroult smelting process. Within two years, Hall found financial backing, built a plant in Pittsburgh and began producing the first commercial aluminum.

In the years that followed, Hall continued to improve on the process, reducing the price of aluminum from $4.86 a pound [$113 today] to 78 cents in 1893 [$19.20 today]. The operation that would eventually become the Aluminum Company of America (Alcoa Inc.), today the world leader in the production and management of aluminum, was off and running.

Akin to Alchemy

Today, aluminum is manufactured in plants all over the world. While operations differ in size and scope, all follow the same basic process—a process that could almost pass for alchemy. In the words of Alcoa's written history of the metal, "It all begins with dirt…"

On the floor of a smelter in Wenatchee, Washington, above. Alcoa's Corporate Center on Pittsburgh's North Shore riverfront, above right, is a gleaming aluminum-and-glass structure. By recycling aluminum cans, below right, manufacturers use only 5 percent of the energy needed to make the metal from ore.

Mining: While bauxite, an ore rich in aluminum oxide, was first mined in France, today most bauxite mining occurs in Australia (the world's larger producer of the ore), Africa and the Caribbean.

At the Welpa mine near Queensland, Australia, which stretches across some 2,500 square kilometers [1,550 square miles], about 16.5 million tons of bauxite is mined each year, according to the Australian Aluminum Council. Once extracted from the shallow pits, the red bauxite ore is hauled by trucks to a dump station, then moved by conveyors or rail to a plant where the ore is screened, washed and stockpiled before being shipped to nearby refineries.

Refining: At the refinery, workers grind the bauxite ore, then mix it with lime and caustic soda. This mix is pumped into high-pressure containers and then heated—a process developed and named for scientist Karl Bayer. The caustic soda dissolves the aluminum oxide, which is then precipitated out of the solution, washed and heated to drive off any water. The result? A pure white powder resembling sugar that's known as alumina.

Alumina serves as the raw material for the Hall-Heroult smelting process. But it can also be used for a wide range of products—from toothpaste and fluorescent light bulbs to rocket fuel and ceramic windshields for military aircraft. Roughly 10 percent of alumina produced each year winds up in products other than aluminum.

Smelting: At the smelter, the alumina powder is placed in large, carbon-lined cells (known as reduction pots) and dissolved in a molten cryolite bath (comprised of sodium aluminum fluoride) that reaches temperatures of about 1,780 degrees F [970 Celsius]. Reduction pots are arranged in rows of 50 to 200 pots that connect to form an electric circuit.

The transformation occurs when a powerful electric current is passed through the bath, breaking the bonds between the aluminum and oxygen atoms in the alumina molecules. Once freed, the aluminum atoms settle to the bottom of the pot as molten metal, which is siphoned off.

What is a Metal?

WHETHER AN ELEMENT, COMPOUND or alloy, a metal is characterized by high electrical conductivity. Metals—which comprise about two-thirds of the known elements in the periodic table—readily lose electrons to form positive ions. Those ions are surrounded by delocalized electrons, which are responsible for the conductivity.

Metals can differ widely in terms of their hardness, ductility, malleability, density and melting point—making it difficult to distinguish between them and non-metals.

Aluminum, atomic No. 13 in the periodic table, does not exist naturally, but is an important constituent of many minerals.

More than 30 percent of the 25 billion pounds of annual aluminum supply in the U.S. comes from recycled sources. No other metal approaches that level of renewability.

Smelters typically house two or three potlines, and most potlines produce about 66,000 to 110,000 tons of aluminum annually. Smelters operate the pots seven days a week, 24 hours a day.

Fabricating: Once aluminum leaves the smelting pots it is moved into furnaces for mixing with other metals (such as copper, zinc, manganese or magnesium)—a choice determined by how the product will eventually be used. For structural components in aircraft and truck wheels, for instance, a common copper and magnesium aluminum alloy offers a high strength-to-weight ratio and good fatigue resistance. After being purified through a process called fluxing, the metal is poured into molds or cast directly into ingots. Further fabrication may include casting, rolling, forging, drawing or extruding.

The entire aluminum manufacturing process is run by a law of halves: It takes 4 tons of bauxite to make 2 tons of alumina, from which manufacturers can reap 1 ton of metal.

Though manufacturers have made attempts over the past century to replace the Hall-Heroult smelting process, their efforts turned out to be too costly or environmentally troublesome. So it remains the industry standard today.

Thus, high-energy consumption remains a trademark of aluminum. Up to 40 percent of the cost of manufacturing aluminum comes from the electric power used to smelt it. Even though domestic operations have become more efficient in recent years—using about half the electricity to make a pound of aluminum than it took 50 years ago—the number of primary aluminum smelters in the United States has dropped from 33 in 1970 to 15, the result of the higher cost of domestic energy. (Industry representatives are quick to point out that, despite the shuttering of smelting facilities, the nation's factories churn out only 1 percent less aluminum than they did 40 years ago.)

Predictably, many aluminum conglomerates have transplanted operations to countries with cheap sources of traditional energy, such as China, Russia and South Africa. In Iceland, Alcoa made headlines when it spent $1.1 billion to flood a 22-square-mile area there to tap that country's vast hydroelectric and geothermal sources of power.

Countries with plentiful sources of natural gas, such as the United Arab Emirates, are becoming aluminum powerhouses, too. Wherever there are developing or inexpensive sources of energy,

Craning a coil of aluminum sheet, above. Dawn unfolds at an ingot storage location in Kitts Green, United Kingdom, above right. Workers prepare an enormous aluminum ingot to be rolled into can sheet, right.

you'll find aluminum makers (See "Top Makers By Country," p. 15). Of the 39 million metric tons of the metal produced in 2008, China—home to heaps of cheap coal and few environmental regulations to limit its use—was the top producer. It accounted for one-third of the total global production, with 13.2 million tons.

A Sustainable Product

Fortunately, melting down recycled aluminum cans and other products made from the metal requires only 5 percent of the energy needed to make the metal from ore. After melting, the serviceable metal retains the same physical properties as smelter-made aluminum.

More than 30 percent of the 25 billion pounds of annual aluminum supply in the U.S. comes from recycled sources. No other metal approaches that level of renewability. Of the 100 billion aluminum cans produced each year in the U.S., roughly two-thirds are returned for recycling. The reclamation rate for aluminum from automobiles is even higher—about 90 percent.

According to Alcoa, more than 70 percent of the aluminum ever produced

is still in use—equaling 586 million metric tons of a total 806 metric tons manufactured since 1886, the time of Hall's discovery.

After aluminum is either recycled or smelted, and then milled at more than 200 facilities in the U.S., it is made into $40 billion worth of products and exports, notes the Aluminum Association, which represents primary producers of the metal. The metal's lightweight durability continues to advance its popularity, with carmakers clamoring for more of it for auto bodies, engines and housings. In 2006, aluminum became the second-most used metal in new cars and trucks worldwide, surpassing iron.

Nearly 4 billion pounds of aluminum are used each year in construction (1.8 billion kilograms), while more than 5 billion pounds per year are shipped as beverage cans, food containers and various types of foil (2.3 billion kg.).

Toward a Sustainable Future

Back at the Welpa bauxite mine in Australia, workers continue digging, loading and unloading enormous piles of crumbly red soil.

Australia is the world's largest producer and exporter of alumina, and the fifth largest producer of aluminum. For that reason, the Australia Aluminum Council is committed to mitigating the industry's negative impact on the environment.

Before mining begins at the Welpa mine, workers first take up the existing vegetation. Once all the bauxite ore has been removed from that section, the land is re-planted with indigenous bushes and grass.

Thus, the pebbly red ground that once, improbably, gave rise to tons of gleaming silver metal will revert back to its natural state—a blanket of green grass and shrubbery.

Sue De Pasquale contributed to the reporting and writing of this article.

FACTS AND FIGURES

By the Numbers:

Top Makers of Primary Aluminum by Country, 2008
(Figures in thousands of metric tons)

1. CHINA.....13,177
2. RUSSIA.....4,187
3. CANADA.....3,120
4. UNITED STATES..... 2,658
5. AUSTRALIA.....1,983
6. BRAZIL.....1,661
7. NORWAY.....1,359
8. INDIA.....1,308
9. UNITED ARAB EMIRATES.....910
10. BAHRAIN.....865

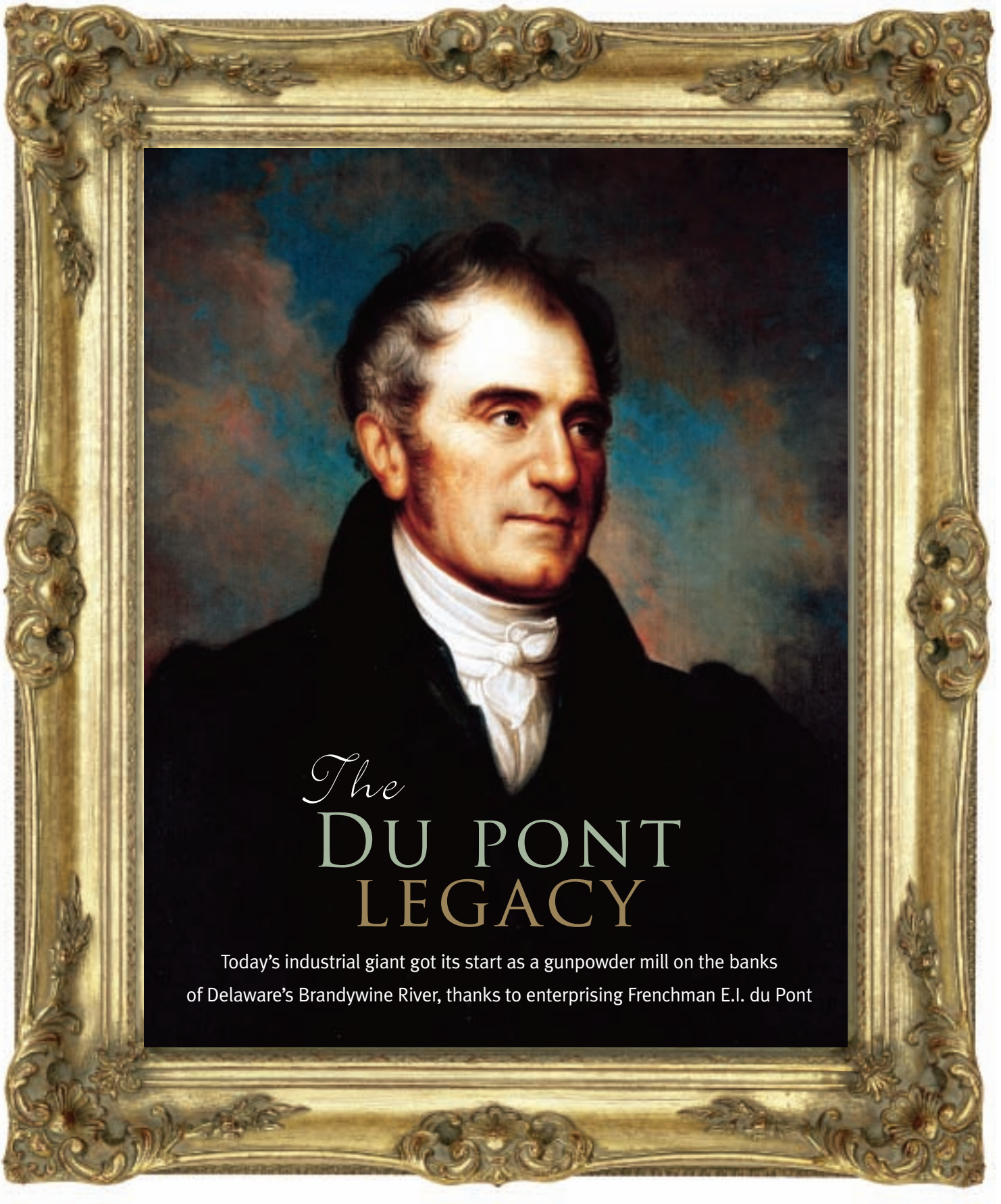
TOTAL WORLDWIDE PRIMARY ALUMINUM PRODUCTION:
39.3 MILLION METRIC TONS

Source: *The Aluminum Association*

Top Bauxite Producers by Country, 2008
(Figures in thousands of metric tons)

1. AUSTRALIA.....63,000
2. CHINA.....32,000
3. BRAZIL.....25,000
4. INDIA..... 20,000
5. AUSTRALIA.....18,000
6. GUINEA.....15,000
7. JAMAICA.....6,400
8. RUSSIA.....5,900
9. VENEZUELA.....4,800
10. SURINAME.....4,500

Source: *The U.S. Geological Survey*



The DU PONT LEGACY

Today's industrial giant got its start as a gunpowder mill on the banks of Delaware's Brandywine River, thanks to enterprising Frenchman E.I. du Pont

BY SUE DE PASQUALE

THE AIR WAS CRISP ONE AUTUMN DAY IN 1800, WHEN ELEUTHÈRE IRÉNÉE "E.I." DU PONT AND HIS HUNTING COMPANION, THE FORMER FRENCH PATRIOT MAJ. LOUIS DE TOUSARD, TOOK A BREAK FROM HUNTING. THEY'D RUN OUT OF AMMUNITION. SO THE DUO MADE A QUICK TRIP TO THE COUNTRY STORE NEAR TOUSARD'S FARM IN WILMINGTON, DEL., TO BUY MORE GUNPOWDER.

Du Pont was dismayed by the high price and low quality of the gunpowder he found. Tousard was nonplused. Everyone knew that quality gunpowder had to be imported from England, he told his young companion, who had just arrived in the United States from his native France.

E.I. du Pont sensed an opportunity. He asked to tour an American powder plant and Tousard soon obliged, with a visit to the Lane-Decatur factory in Frankford, Pa. The 29-year-old du Pont had trained at the side of renowned chemist Antoine Lavoisier at Essonnes, France's national powder works. It didn't take him long to find problems with every aspect of the American manufacturing process—from refining saltpeter, to its mixing with charcoal, to the pressing and glazing of the various ingredients.

For the enterprising E.I. du Pont, the future was clear. America was an

up-and-coming nation where gunpowder was essential—for everything from keeping wild animals at bay to blasting out roads, to supplying the fledgling military with munitions. Irénée (whose name means "peace") approached his father, Pierre Samuel, and elder brother, Victor, with a recommendation: The du Pont family should stake its fortunes on becoming the finest producer of gunpowder in their newly adopted nation.

Today, more than 200 years after E.I. du Pont de Nemours and Co. established its first gunpowder mill on the banks of Delaware's Brandywine River, the DuPont name is synonymous with one of the most successful industrial enterprises in the world. The company that E. I. du Pont started with a single gunpowder mill went on to grow exponentially and to diversify—to plastics, dyes and synthetic materials (leading the 20th-century polymer revolution with such products as nylon, neoprene, Teflon, Mylar and Lycra). Today DuPont operates in more than 70 countries, employing more than 5,000 scientists and engineers and generating $31.8 billion in annual revenues.

Portrait of E.I. du Pont, far left. Above, the historical Du Pont seal; during the company's first century, the U.S. military was a leading customer.

Prized for its high quality, Du Pont gunpowder quickly proved popular among hunters, left. Above, an early photograph of the Du Pont corporate headquarters in Wilmington, Del. E.I. du Pont's passion for raising sheep, below right, also proved profitable, through a woolen mill constructed on his brother's side of the Brandywine.

AS A CHILD GROWING UP IN PRE-revolutionary France, Eleuthère Irénée seemed unlikely to achieve great things—at least to his father, an outspoken and influential intellectual and government economist. Young Irénée, marred by a red birthmark on his left cheek, was quiet and introspective, the exact opposite of his larger-than-life father and charming brother Victor, who would serve in the diplomatic corps in New York.

The compliant Irénée did defy his father at age 20, however, when he fell in love with Sophie Madeleine Dalmas, the 16-year-old daughter of a Paris shopkeeper. The elder du Pont was horrified: he had risen from toiling as the son of a watchmaker to being an adviser to the king of France; his son could not marry so far beneath his station! But his youngest son persisted, even fighting two duels for Sophie's hand, and eventually Pierre Samuel relented. Irénée and Sophie were married on Oct. 26, 1791. Their marriage would prove to be a loving and productive union, yielding seven children.

The post-revolutionary years were politically volatile and dangerous for Pierre Samuel (he was imprisoned at one point and narrowly avoided the guillotine); so, on Oct. 2, 1799, the elder du Pont, Irénée, Victor and their young families set sail for a new life in the United States aboard the ill-equipped *American Eagle*. The journey, which stretched on for nearly three months, was harrowing; the ravenous travelers reportedly dined on rats on more than one occasion. But once they reached land on Jan. 1, 1800, the dawn of a new century, the family's fortunes quickly improved.

After scouting a variety of locations for his Eleutherian Mills, Irénée wisely opted to set up shop on Delaware's Brandywine River. The river's rapidly moving waters (averaging a flow of 4,500 gallons per second) would offer an ideal source of power, the area's plentiful willow trees could be harvested for charcoal, key to black powder, and the site was sparsely populated (five miles north of Wilmington, De.), highly desirable for a business where explosions posed a daily threat.

From the outset, Irénée proved an innovator. Rather than constructing the then-customary single building for his powder works, he puzzled the locals by erecting a series of trapezoidal buildings along the riverbank. Each had heavy stone walls, a thin wooden roof (constructed without nails, lest they create a spark), and a lower front side that fronted the river. Separating the buildings prevented the potential for a chain reaction in the event of an explosion, he reasoned—and the force of a blast would be channeled out over the water.

For the latest equipment and trade secrets, and to raise capital, Irénée returned to France in 1801, where Napoleon (eager to decrease U.S. dependence on England's exports as the new French leader) was only too happy to supply whatever the du Pont family needed, at cost. The first barrel of "Brandywine Powder" was sold in spring 1804. Thanks in part to a laudatory letter from Thomas Jefferson, requesting the gunpowder for the War Department, sales of du Pont gunpowder (renamed Du Pont in 1808) quickly took off. In less than a decade, with the advent of the War of 1812, annual sales jumped to $148,597 (more than $2 million in today's market).

Despite E.I. du Pont's taciturn nature

and constant concern about safety (he posted a sign on New Year's Day 1811 reading, "All kind of play or disorderly fun is prohibited!"), he came to be widely respected by his workers for being fair and generous. He was among the first leaders of industry in the U.S. who saw the value in building and training a work force. In 1811, Irénée instituted a system of overtime and night pay, previously unheard of, and two years later he set up a savings plan for his employees; for every $100 they saved, the company would pay 6 percent interest, notes author Adrian Kinnane in a bicentennial history of the company. To help employees go on to establish homesteads, he purchased a large tract of land in Western Pennsylvania, offering credit to former employees who wanted to transition to farming.

E.I. du Pont also believed strongly in education. He incorporated the Brandywine Manufacturers' Sunday School at the Eleutherian Mills, where employees could learn the 3Rs on their day off each week. In the days before public education, the school also offered classes to workers' children, and Irénée's daughter Victorine was an especially popular and steadfast teacher there; between 1817 and her death in 1861, she touched the lives of nearly 2,000 children and teens at the white clapboard school.

Company employees, whose homes were at the mills, appreciated the fact that the du Pont family was willing to share in the danger of the industry. E.I. du Pont's sprawling family home was perched atop a hill on one side of the Brandywine River, and Victor du Pont's house sat across the water. Tragedy struck on March 19, 1818, with one of the worst accidents in the company's history. A series of explosions (reportedly felt all the way to Lancaster, Pa., 47 miles away) leveled the mill works, killing 40 workers, and severely damaging the E.I. du Pont family home.

Irénée and his family were away in Philadelphia at the time. He hurried home to survey the damage and comfort the grieving families of his workers. Rebuilding quickly commenced (the process ultimately took a year) and Irénée set up a monthly pension system for the families who had lost breadwinners in the accident. All but two of the workmen who survived the blasts agreed to come back to work, reports historian Joseph Frazier Wall. As the years passed, fathers handed down their steady and well-paying jobs to their sons, assuring a continuity and loyalty to the Du Pont company that paved the way for financial success.

Irénée's strategy of constantly reinvesting profits into the company to fuel growth didn't meet with approval from investors—or even his father—early on, but it ultimately proved savvy. In 1822, ever the innovator, Irénée replaced the company's up-and-down stamping method with less dangerous and more efficient rolling mills—large, 4-ton iron wheels that mixed the powders—the first rolling mills in the nation.

When he wasn't in business meetings, touring the company's new mills that sprang up around the region or relaxing with Sophie and his children, Irénée was a gentleman scientist who enjoyed toiling in his garden (in fact, he'd listed "botanist" as his profession on his passport). While a young man in France, he frequently visited le Jardin des Plantes, and he brought a variety of seeds and plants across the Atlantic for his gardens at Eleutherian Mills. He also sent samples from his gardens back to colleagues in France.

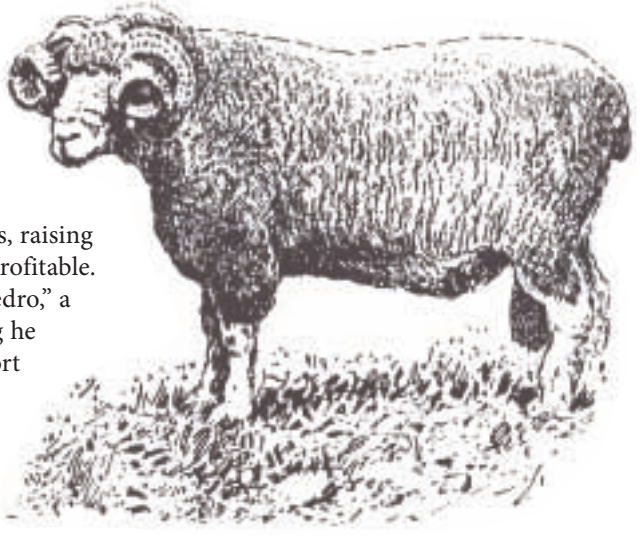
Another of Irénée's passions, raising sheep for wool, proved quite profitable. In 1805 he purchased "Don Pedro," a prize ram, for $60. Before long he had enough livestock to support a thriving woolen mill, which was constructed on Victor du Pont's side of the Brandywine. When Don Pedro died in 1811, the du Ponts reportedly received cards of condolence from across the country—most notably from Thomas Jefferson.

Throughout his life, Irénée du Pont suffered bouts of depression, "habitual dullness and melancholy," as he wrote at one point to his brother-in-law. His melancholy became all-consuming when the unexpected death of his brother Victor, in January 1827, was followed 21 months later by the demise of his beloved Sophie in November 1828. For months after her passing, he could be found seated on a rock, staring forlornly out at the flowing waters of the Brandywine, reports author Wall.

Eventually, the love of his children and grandchildren, and the demands of business, helped him rally, and he returned to his involvement with the family company. But the strain of constant worry and sadness took its toll. On Oct. 30, 1834, while in Philadelphia on business, E.I. du Pont suffered a heart attack on a street corner. He died shortly after, at the age of 63.

The forward-thinking native of France—scientist, innovator, philanthropist, family man—who had set the standard for American industry and launched a multibillion-dollar family business, was buried along the flowing waters of his beloved Brandywine, in the Du Pont family plot.

As the years passed, fathers handed down their steady and well-paying jobs to their sons, assuring a loyalty to the Du Pont company that paved the way for financial success.



THE Emerald Isle EXPERIENCE

Ireland's lush landscapes, rocky shores and storybook towns make it a top travel destination for tourists from around the world

The Old Head of Kinsale, on the southwest coast of Ireland, is home to a world-class golf course with panoramic views.

BY GREG RIENZI

I BRAVED DUBLIN ON ST. PATRICK'S DAY on my most recent visit to Ireland. Some Dubliners will tell you that New York City stages the holiday on an even grander scale, but there's no denying the Irish can throw one banshee of a party.

The city swells as tens of thousands come to watch a frenetic parade, revel in the twisty streets and throw down a pint—or two—of Guinness. My favorite pint was had in a pillar-box-red pub in the Temple Bar area. The place jostled with electricity as patrons packed shoulder to shoulder, desperately trying to keep beverages upright. The music blared and when U2's "Where the Streets Have No Name" came on, the crowd sang in unison.

Later that same trip, while roaming the island in a tiny rental car, we delightfully waited on a small flock of sheep to cross the road—the legendary Irish rush hour. Not a human in sight, just the white woolly animals amid a vista of low stone walls and sloped green fields.

Surprises are nice, but Ireland can be at its most charming when in stereotype.

For those of Irish descent or anyone who appreciates a picturesque landscape, the Emerald Isle remains a top travel destination, with its bounty of lush green valleys, rocky shores and storybook towns tucked into rolling hills.

"Just like the song says, visitors come to see the '40 shades of green.' It really is beautiful," says Carmel Murray, who has run a bed-and-breakfast in the west coast town of Clifden for two decades. "They also love the hospitality that they find," says Murray, and the "unpretentious but comforting" local cuisine, with its

Clockwise: The Carrick-a-Rede Rope Bridge, in Northern Ireland, links the mainland to the tiny Carrick Island. Built in 1520, Dunguaire Castle sits on the southeastern shore of Galway Bay. The Guinness Storehouse, located in the heart of the St. James Gate Brewery, is Ireland's No. 1 international visitor attraction. Pubs abound across the Emerald Isle. A detail from Dublin Castle.

staples of wild salmon, sausages, hearty potato-based soups and stews and brown bread.

The capital city of Dublin makes an ideal launching point for any sojourn to Ireland. Located on the east coast of the island, Dublin is bisected by the River Liffey that flows out into Dublin Bay. In 841, Vikings sailed up the Liffey and established a fortified stockade on high ground where the Poddle and Liffey rivers meet, a pond they called Dubh Linn (black pool), hence the name. On this site now sits Dublin Castle, one of the country's most famous landmarks and the former seat of British rule in Ireland.

The city attracts nearly 5 million visitors a year to its many historical and cultural gems. Dublin blends the modern and medieval in a compact 115 square kilometers, although most visitors stick to the City Centre.

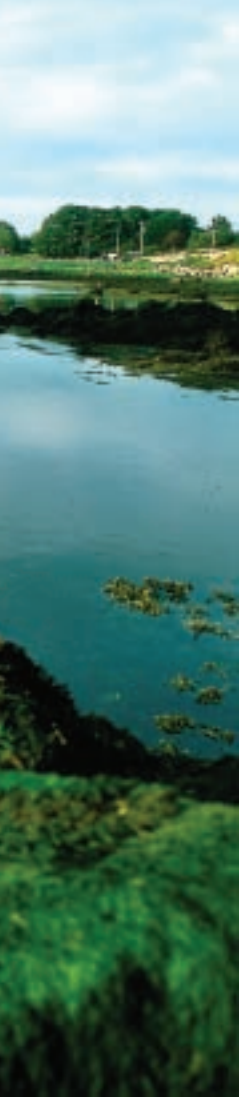
Head to the coastal regions for high-cliff shores, windswept beaches, quant villages, majestic medieval castles and seaside towns.

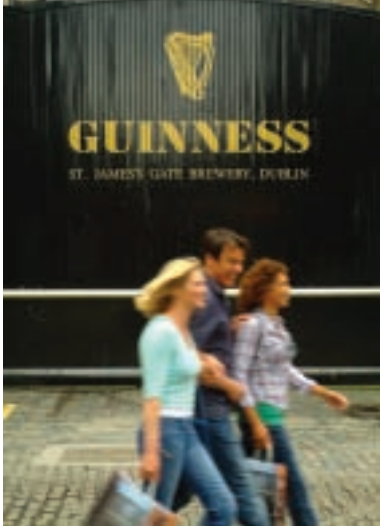
You'll want to wander into the Temple Bar area, located on the south bank of the Liffey and just over the Ha'penny Bridge (until a decade ago, the only pedestrian bridge over the river). The relatively small but lively bohemian district boasts a congested hodgepodge of restaurants and pubs painted in a kaleidoscope of primary colors. This pub-mad town, if you believe the claims, features the smallest, loudest, best-Guinness-pint-serving and oldest pubs in the country. (The oldest would be the Brazen Head, dated back to 1198.)

From Temple Bar, head south to Grafton Street for some first-rate boutique shopping. Farther on up the road lies St. Stephen's Green, a public park with ponds, statues, walkways and an ornate indoor shopping plaza.

One of Europe's fasting growing cities, Dublin now features a revitalized waterfront area known as the Docklands. The development, said to be the most ambitious urban renewal project in the country's history, has transformed unused docks into a vibrant area of waterside apartments, offices, retail space, a park and tourist attractions.

The area has a slew of new restaurants and clubs, and in the past two years celebrated the opening of the Grand Canal Theatre (Dublin's version of the Sydney





Opera House), and the O2, a Victorian warehouse turned state-of-the-art concert venue that attracts big music acts such as Rod Stewart and Pearl Jam. A convention center is in the works, as is a U2 Experience Museum and the U2 Tower, to be Ireland's tallest building and the band's future recording studio.

When you've had your fill of all Dublin has to offer, rent a car and head to the coastal regions for high-cliff shores, windswept beaches, quaint villages, majestic medieval castles and seaside towns.

The Causeway Coast and Glens in Northern Ireland ranks high on the list of possible stops. The Causeway Coastal route, roughly from Belfast Lough (bay) to Lough Foyle, includes such national treasures as the Giant's Causeway, 40,000 interlocking basalt columns, made of volcanic rock, that stand watch over the North Channel; the Carrick-a-Rede Rope Bridge, a 24-meter-high walkway near Ballintoy that offers stun-

IRELAND BASICS

When to go: March is a high tourist month, largely due to St. Patrick's Day, and best to avoid unless you want to take part in the holiday. The weather is ideal in August, but popular destinations within the country can get crowded then. Aim for April and September for quieter months and still pleasant weather.
What to wear: Pack some sweaters and rain gear, as you never know when it's going to get chilly or wet. Hats also come in handy.
Currency: The euro is the currency of the Republic of Ireland. Those in Northern Ireland use the sterling.
People: You will find many warm, smiling and talkative types among the 5.7 million residents of Ireland. Although the Irish still teach Gaelic in school, the language is seldom used in public and English is preferred. Feel free, however, to say "Slainte!" (SLAN-cheh)—Gaelic for "Cheers!"—when giving a toast.
Climate: Ireland has a mild, temperate climate with summer temperatures ranging from 60 to 70 Fahrenheit (15.5 to 21 degrees Celsius), although recent highs have been in the low 80s (27 C) down south. Temps in spring and autumn are generally in the 50s (10 C-plus) and in winter between 40 and 50 F (4.5 to 10 C). Snow is rare.
Pubs: The legal drinking age is 18. Pubs in the Republic of Ireland are open seven days a week, usually from 10:30 a.m. Closing times vary from 10:30 p.m. to 12:30 a.m. Smoking is not allowed in any public areas, including pubs and restaurants.
Driving: On the left side of the road. A valid driver's license from the home country is required. Many roads are narrow, so don't be surprised when a delivery truck pushes you to road's edge in order to pass.
Where to stay: Ireland has some very fine hotels, but if you plan to tour the island, opt for bread-and-breakfasts. The B&B owners provide a wealth of information on where to go, and you can wake up each morning with a traditional Irish breakfast of eggs, bread and two or three types of sausage. The hefty plate will provide energy until dinner. The country's official tourism page, www.discoverireland.com, offers a search engine of more than 3,000 B&Bs.

DUBLIN TIPS & VITALS

What to do: Billed as Ireland's No. 1 tourist attraction, the Guinness Storehouse is located adjacent to the brewery that started it all. Visitors can learn about the history of the brand and the man, Arthur Guinness (1725-1803). You'll also get a complimentary pint of Guinness in the Gravity Bar, which offers a fantastic, 360-degree view of the city. Another must-see is Trinity College, for its Old Library and the

Sheep graze above Keem Beach on Achill Island, top. An ages-old custom of marking them with color makes them easy for herders to spot. The famed Ha'penny Bridge, above right, which allows pedestrians to cross over the River Liffey in Dublin, was built in 1816.

ning views of the sea and the Scottish coast; and Dunluce Castle, a 13th-century cliff-top castle, now in ruins, surrounded on either side by spine-tingling steep drops.

For outdoorsy types, the north holds plenty in store—including hiking paths, streams ideal for fly-fishing and nine challenging golf courses with magnificent sea views. The Royal Portrush Golf Club is hailed as one of the world's greatest links. Portrush is also a stone's throw from the town of Bushmills, home to the famous Irish whiskey distillery (which offers guided tours).

Next, head south to Galway City, a big town with a small feel perched on the shore overlooking Galway Bay. Galway maintains a strong artistic heritage and is a haven for music clubs, artisan stores and a never-ending lineup of festivals.

Slightly farther down the coast is The Burren, an area of limestone-layered fields, crumbling stone castles and churches, underground rivers, magnificent wildflowers and ancient monoliths.

Of course, no visit to Ireland would be complete without a cliff overlook, and none are more expansive than the Cliffs of Moher in County Clare. The Cliffs reach 214 meters (702 feet) at their high point and spread over 8 kilometers (nearly five miles). From the cliffs one can see the Atlantic Ocean, Aran Islands, Galway Bay and the mountains of Connemara.

End your stay with a scenic drive through County Cork, which includes some of Ireland's most attractive and vivid landscapes. Must-see destinations include the medieval town of Kinsale, the quintessential fishing village Union Hall (a seal and whale watching boat tour there is a must) and Blarney, the home to the castle and Blarney Stone. Cork City and the area offer some of Ireland's best seafood restaurants.

Whichever path you take through the island, go slow and don't pass up the opportunity to stop and refuel with some brown bread and potato soup at a local pub or restaurant. You'll undoubtedly encounter a chatty barman or patron, whom you might have trouble fully understanding—but that's half the charm.

Book of Kells Exhibition. Located in the heart of Dublin City, Trinity hearkens back to the 18th century, when its magnificent library building was constructed. Inside is housed the Book of Kells, a ninth-century gospel manuscript famous for its colorful and detailed medieval Celtic art. Dublin has a wealth of museums and one of the best is the National Museum of Ireland, home to the greatest collections of Irish material heritage, culture and natural history in the world. To see Dublin, take a Liffey River cruise, a popular 45-minute sail up the river with commentary that offers some insight into Dublin folklore and history. For a less formal tour, don a Vikings hat and hop on the Viking Splash Tours, an amphibious World War II vehicle that shows off the sights by land and water. Currently, one of the most popular activities is the Dublin Literary Pub Crawl, a four-stop tour of traditional pubs with professional actors performing works of Dublin's most famous writers including Joyce, Beckett, Oscar Wilde and Brendan Behan.

Getting there: Fly into Dublin Airport, which serves all the major airlines and offers many direct flights from major cities around the world. The City Centre area is roughly six miles from the airport. Use AirCoach, Dublin Bus or taxi.

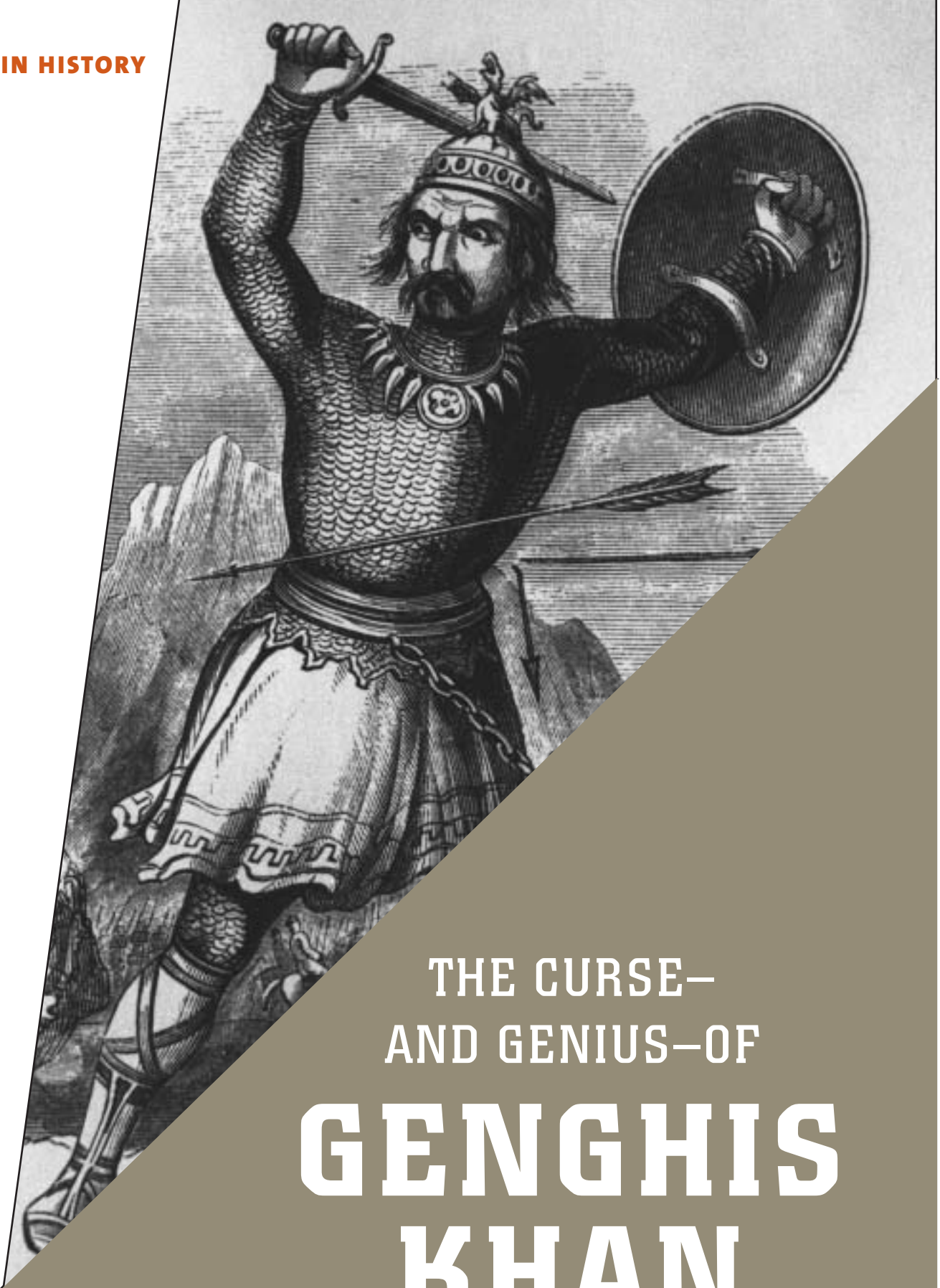
Getting around: Dublin is compact and easy to navigate, so no need to rent a car. You can walk to most points, or buy a 24-hour hop-on, hop-off pass to ride the open-top double-decker tour buses. To zip from one point of the city to another take the DART (Dublin Area Rapid Transport) or Luas tram (light rail system) red or green lines.

The Dublin Pass: For extended stays in Dublin, consider purchasing a Dublin Pass, a card that offers free entry to more than 30 of the city's top visitor attractions—including the Dublin Castle, Guinness Storehouse and Dublin Zoo—plus transport from the airport to the city and other special offers and discounts. A three-day pass costs 65 euros.

Where to shop: Grafton Street, located near Trinity College, has a long row of big stores, little boutiques and cafes. The street—named after Henry FitzRoy, the illegitimate son of Charles II of England—runs from St. Stephen's Green in the south to College Green in the north. Buskers—including musicians, poets and mime artists—commonly perform to the crowds.

Where to get a pint: Dublin markets itself as home to 1,000 pubs, so there's no shortage of places to tipple. Some standouts: The Stag's Head, a favorite of James Joyce's on Dame Street near Trinity College replete with elaborate mahogany woodwork, a red Connemara marble-topped bar and a big stag's head. The Long Hall, an elegant old bar on South Great George's Street, is extensively decorated in mirrors, and has a massive carved wooden arch. You also can't go wrong at Kehoe's pub, a quirky pub on South Anne Street that offers the traditional snug and walled-in pub atmosphere. Yes, the Guinness really does taste better in Ireland, but if porter is not your style try a Smithwick's (pronounced Smit-icks).

MILESTONES IN HISTORY



THE CURSE– AND GENIUS–OF GENGHIS KHAN

BY EUGENE FINERMAN

How an unlikely Mongol nomad summoned the brutal force to conquer half the known world

Among the great conquerors in history, Genghis Khan stands apart, in both the extent of his victories and his own remarkable story. It took Rome three centuries to forge an empire stretching from Britain to Iraq. Genghis Khan conquered a realm twice that size, from China to Iraq. Alexander the Great, his only rival in military achievements, was born with advantages that the Mongol did not have. Alexander was the prince of a powerful kingdom and inherited the finest army of his day. Genghis Khan was the child of an insignificant nomadic tribe that subsisted in the vast steppes (harsh, arid prairies) of North Asia. But he would make his tribe the core of a force that would conquer half of the known world.

Although we know him as Genghis Khan, that was actually his title—the acknowledgment among his subjects that he was their "Universal Ruler." His name was Temujin (Tem-oo-gin), and he was born around 1162 in a Mongol encampment. At the time, the Mongols were a loose collection of kindred tribes, herders struggling in the harsh environment of the northern steppes. When they were not fighting among themselves, they faced rivals—Tatars, Naimans, Merkits and others—for water and grazing lands. This hard and violent world made the tribesmen into formidable warriors: fine horsemen and skilled archers. For centuries, these fierce nomads had raided south to the rich lands of China; to stop such incursions, the Chinese built the Great Wall.

Temujin's father, a chieftain among the Mongols, was killed in the ongoing feud with the Tatars. No more than 13 at the time, Temujin was considered too young to succeed his father, and the camp dispersed as the members allied themselves to other chieftains. If he could not inherit his father's position, Temujin would win it in his own right. He certainly had all the attributes of a leader: the courage of a warrior, a confidence that inspired men to his banner and a cunning that earned him victory after victory.

Temujin started out with only a small following of kinsmen and friends, but he turned that band of fierce but disorganized warriors into a cohesive, coordinated force. Applying military discipline to his soldiers, he transformed the nature of steppe warlord. On his own, the mounted archer was a formidable foe; as part of a synchronized attack, the Mongols of Temujin were unequaled and unbeatable. The other Mongol chieftains either became allies…or corpses.

But it was not enough for Temujin to reclaim his father's position or even assert his rule over all the Mongol tribes. He intended to be the master of all the peoples of the steppes, forging them into one nation. To the vanquished tribes, he offered what seemed magnanimous terms: pledge their personal allegiance to him and enjoy all the protection and wealth of the growing Mongol Empire.

Of course, there was a brutal alternative. One Tatar tribe refused his offer, so Temujin had every male in the tribe executed by the sword. He was not one to leave defiant enemies behind, and that demonstration of his ruthlessness made the other tribes much more amenable. Temujin knew the value of terror. (One Mongol custom was to collect severed heads and build them into a pyramid.)

By 1206, he had established himself as the Genghis Khan of the steppes. He controlled a realm that bordered Persia in the west and China in the south. Both neighbors were rich and tempting.

With the combined might of the

The Mongol Horde was in fact the best-organized army since the Romans.

tribes, the Khan first moved on China in 1211. The Mongol Horde was in fact the best-organized army since the Romans, with an effective chain of command linking the smallest unit of 10 men to the division of 10,000. While China's Great Wall could deter raiding parties, it couldn't hold back such an army, and political divisions in China had weakened the country.

There now were two Chinese emperors: the Jin dynasty ruling in the north, and the Sung dynasty in the south. The Jin Empire had the misfortune to be closer to the Mongols. Its armies were no match for the Khan's. The Mongol forces consisted solely of cavalry but their tactics were devastating. When confronted by a Chinese army, the Mongols' mounted archers would attack, unleashing wave after wave of armor-piercing arrows. The Chinese cavalry might counter the attack but would be riddled with arrows for the effort. The infantry would be helpless under the archers' onslaught. Demoralized and suffering heavy casualties, the infantry would inevitably become disorganized. Then the Mongol lancers would attack, mowing through the Chinese ranks. At that point, the battle was over and the slaughter had begun.

But the Chinese initially did have one successful defense against the Mongols: walled cities. The Mongols had no equipment and little patience for sieges. But Genghis Khan was always resourceful, tapping a number of Chinese units that had been bribed or intimidated into defecting to the Mongols. Their engineers found steady work building the siege equipment the Mongols needed. Then, there was the tactic of terror. In the customs of war at the time, any city that refused to surrender could expect no mercy if it fell—its people subject to pillage, rape and enslavement. For Genghis Khan, that threat was insufficient. When any city defied him it would be burned to the ground and its entire population exterminated.

That was the fate of the imperial capital of Zhongdu in 1215. (The Chinese eventually built a new city nearby and called it Beijing.) Such atrocities did persuade other cities to capitulate. Yet, the conquest of northern China was so vast an enterprise that it would not be completed in the Khan's lifetime. Indeed, he was diverted by a war with Persia.

If you have never heard of the Khwarezmian Empire, that was Genghis Khan's intention and the measure of his success. In the early 13th century, Khwarezmia was the greatest nation in the Islamic world, a Persian empire that encompassed modern Iran, Afghanistan and Turkmenistan. Although the Mongol Empire extended to the northern border of his empire, the shah dismissed any threat posed by Genghis Khan. After all, the Mongols were thousands of miles away fighting in China (where the conquest of 120 million people would seem to be a full-

The Shrine of Hazrat Ali Mazar-I-Sharif was destroyed by Genghis Khan and rebuilt by Timurid Sultan Husain Baiqara in 1481, far left. Walls of an ancient city of Khiva, Uzbekistan. The Great Wall between Jinshanling and Simatai, above. From his original realm, Genghis Khan conquered a region from China to Iraq—half the known world at the time, shaded, right.

time job), and the shah had an army twice as large as the Khan's. In 1219, a Mongol caravan was seized by a Persian governor. When a Mongol embassy complained to the shah, he had the Mongols' translator beheaded.

That effectively ended the conversation and started a war.

The Mongol conquest of Persia is still studied in military science as a masterpiece of mobile warfare. Although at the other end of Asia, the Mongol Horde could move at a routine pace of 80 miles a day—a pace that modern armies would find a challenge. With 200,000 horsemen under his command, Genghis Khan synchronized a series of attacks that confused, bled and eventually overwhelmed the larger armies of the shah.

The shah had stationed nearly half of his forces on the Northern border, along the Syr Darya River. In February 1220, a Mongol force of 20,000 men crossed the eastern end of the river, outflanking the Persian defenses there. As the shah's main army marched to meet that threat, a larger Mongol force forded the western end of the river. Caught between the river and the Mongols, the first Persian line of defense collapsed...and the Mongols were not taking prisoners.

The two Mongol forces united and moved toward the great city of Bukhara. The shah could anticipate the invaders' objective, and he met them with an army of 200,000 men. But the Mongols had maneuvered him into a trap. A third Mongol force, personally led by Genghis Khan, had moved through a desert and evaded Persian attention, taking the circuitous route to Bokhara. The shah thought that he was facing the entire horde—only to discover 50,000 Mongol horsemen behind him. Most of the shah's army died on that battlefield, as did his empire. Khwarezmia was left defenseless against the Mongols, and the entire campaign had taken less than six months. The Mongol Empire now extended to Mesopotamia.

Genghis Khan died in 1227 while campaigning in China, but his sons and grandsons would continue his legacy of conquests: Russia, Mesopotamia and Southern China. Marco Polo would travel throughout Asia, from Syria to China, and always find himself under Mongol rule. But in time, the empire would fragment, divided among vying and weak descendants whose realms grew increasingly smaller. The Mongol dynasties of the Middle East and China lasted less than a century; over Russia, for two centuries.

The nation of Mongolia reveres Temujin as its founder, but in most of Asia his memory is a curse. The genius of Genghis Khan is indisputable, but his achievements are measured in shattered nations and millions of deaths.

Courting Disaster

Putting profits above worker safety can be costly

BY PHIL KIMBLE

Construction work, as an occupation, routinely falls into the Top 10 list of most dangerous jobs. One would think that construction companies, knowing the inherent perils of the job, would be stout advocates of workplace safety. First, it's the morally right thing to do. Second, it's the financially right thing to do. With workmen's compensation insurance premiums already sky high, it makes fiscal sense to try to ensure that everyone goes home intact at the end of the day. The truth is, most employers, construction companies included, value the safety and well-being of their employees.

But then, you find one that refused to prioritize worker safety—a company that values the dollar above all else.

The new hire, because of his experience, was assigned to the grout crew of a construction company that was building a new housing development. When they arrived at the site, the crew began setting up the equipment. The new guy was staring at the pump and hoses with a quizzical expression on his face when one of his co-workers yelled, "Hey! Get those hoses connected now! The first load will be here any minute." The new hire turned and said, "I've been working with concrete for over 10 years and I've never seen camlocks used on anything but water lines." Another worker chimed in, "That's all we've ever used. Be on your toes. These things break a lot and it's real easy to get hurt."

"Yeah, the Boss don't care as long as the work gets done," added another worker. Uneasy about what he had gotten himself into, the new guy started connecting hoses.

Just as the first load of cement arrived, so did the owner of the construction company. The new hire saw him pull up in his pickup and went over and asked, "Hey Boss, what's up with the camlocks on the concrete hose?" The boss turned to him and snarled, "My father did it this way when he started this company 20 years ago. I took over this business five years ago when he passed. If it was good enough for Pop, it's good enough for me. You'd better get over there and do some work if you want to get a paycheck. I've got a hundred guys lined up to take your job if you don't want it. Those fittings are cheap and easy to replace just like you. Now, get back to work."

Humiliated, he trudged back to rejoin the crew.

The crew was into their second load, pouring what would be the foundation slab for a new home. The new guy's job was to help move the bulky 3-inch hoses around when needed. One worker was at the end of the hose directing the flow. The two other crew members were tamping and smoothing the poured "'crete." All of a sudden, the worker holding the end of the hose yelled, "Plug!" The new guy looked on in amazement as the worker holding the end of the hose dropped it and began sprinting away. The other two guys were running in the opposite direction like scared rabbits. In a flash, the camlock nearest him exploded. The hose whipped violently, striking him in the thigh. It snapped his femur like a twig.

In trying to save money, the construction company owner ignored the steps he should have taken to ensure his workers' safety: Fittings designed for the applications and the pressures associated with pumping concrete, as well as its abrasiveness, are the only ones to use. Always adhere to the STAMPED acronym (Size, Temperature, Application, Media, Pressure, Ends, Dixon) for proper hose and coupling selection.

All employees have a reasonable right to a safe working environment within the constraints of their particular occupation. Asking any component to handle more than five times its rated working pressure is a recipe for disaster. A dollar saved today can mean millions spent tomorrow if someone is seriously hurt or injured on the job.

THE DIXON DRILLER

JULY 2010

"Published once a moon since 1932"

To read The Dixon Driller on a monthly basis, visit our website: www.dixonvalve.com

TRIVIA Did you know that...

Ernest Vincent Wright wrote a novel, *Gadsby*, which contains over 50,000 words—none of them with the letter E! The most used letter in the English alphabet is 'E', and 'Q' is the least used!
The names of Popeye's four nephews are Pipeye, Peepeye, Pupeye, and Poopeye!
A lightning bolt generates temperatures five times hotter than those found at the sun's surface!
A "jiffy" is an actual unit of time for 1/100th of a second!
When glass breaks, the cracks move faster than 3,000 miles per hour. To photograph the event, a camera must shoot at a millionth of a second!
There are 18 different animal shapes in the Animal Crackers cookie zoo!
It takes glass one million years to decompose, which means it never wears out and can be recycled an infinite amount of times!
The average life span of a major league baseball is 5-7 pitches!
The two-foot long bird called a Kea that lives in New Zealand likes to eat the strips of rubber around car windows!
No piece of square dry paper can be folded in half more than 7 times!
If you counted 24 hours a day, it would take 31,688 years to reach one trillion!
The longest recorded flight of a chicken is 13 seconds!
Tourists visiting Iceland should know that tipping at a restaurant is considered an insult!

ON THE LIGHTER SIDE

For years, three men were stranded on a desert island.

One day, a magic lamp washed on to the beach. They rubbed the lamp, and a genie appeared that granted each man a wish.

"I wish I was off this island and back with my familly," said the first man, and he disappeared.

"I also wish I was off this island and back home," said the second man. He too disappeared.

The third man, looked around and feeling lonely, looked up to the genie,

"I really kind of like this island. I have everything I want, but it is getting a little lonely, so I wish my two friends were back to keep me company."

In some foreign country a priest, a lawyer and an engineer are about to be guillotined. The priest puts his head on the block, they pull the rope and nothing happens—he declares that he's been saved by divine intervention—so he's let go.

The lawyer is put on the block, and again the rope doesn't release the blade. He claims he can't be executed twice for the same crime and he is set free too.

They grab the engineer and shove his head into the guillotine, he looks up at the release mechanism and says, "Wait a minute, I see your problem...."

Once there was a retired pirate who decides to live with his brother. The pirate walks up to his brother's house and knocks on the door. His brother answers the door and says, "Oh my gosh , what happened to your hand?"

The pirate said, "I lost it in a sword fight , but now I have a hook."

Then the brother said, "What about your leg?"

The pirate said, "A cannonball hit it, but now I have a peg leg ."

Then the brother said, "Well , what about your eye?"

The pirate said, "I got some dust in it ."

The brother said, "How could you lose your eye by just getting some dust in it?"

Then the pirate said, "It was my first day with my hook!

(http://www.danggoodjokes.com)

PRODUCT SPOTLIGHT

EZ-mate couplings can be found on p. 123 of DPL410; or search Dixon's online catalog at www.dixonvalve.com for additional information.

EZ-mate couplings are an exhaust type coupler designed to exhaust air pressure prior to the disconnection process. To connect, push the nipple into the coupler. No air is allowed to flow through the coupling at this point. The valve sleeve is then rotated clockwise to open flow and automatically engage the sleeve-lock mechanism. To disconnect, rotate the valve sleeve counter clockwise. The flow of air through the coupling will be shut off and all downstream air is vented to the atmosphere.

EZ-mate couplings combine push-to-connect, exhaust-style action with a self-locking valve sleeve to guard against accidental disconnection. Simply follow the direction of the on-off arrow stamped on the yellow chromate valve sleeve. The valve sleeve acts as an integral shut-off valve allowing connection and disconnection at zero pressure. When the sleeve is moved to shut off air flow, it automatically vents air downstream allowing for disconnection at zero pressure and eliminating the risk of hose whip.

The O-ring interface seal ensures a "bubble tight" seal and long service life. EZ-mate Series couplers use industrial interchange nipples. For industrial interchange minimal force is needed to connect and disconnect due to the internal valve. For more information about the EZ-mate coupling Series or any of our products please call 1-877-963-4966 or email us at sales@dixonvalve.com.

Dates in History

1887
On July 9, the All England Croquet and Lawn Tennis Club began its first lawn tennis tournament at Wimbledon, then an outer-suburb of London. Twenty-one amateurs showed up to compete in the Gentlemen's Singles tournament, the only event at the first Wimbledon. The winner took home a 25-guinea trophy.

1931
On July 26, a swarm of grasshoppers descended on crops throughout the American heartland, devastating millions of acres. Iowa, Nebraska and South Dakota, already in the midst of a bad drought, suffered tremendously from this disaster.

1940
On July 18, Franklin Delano Roosevelt who first took office in 1933 as America's 32nd president, was nominated for an unprecedented third term. Roosevelt would eventually be elected to a record four terms in office, the only U.S. president to serve more than two terms.

1958
On July 29, the U.S. Congress passed legislation establishing the National Aeronautics and Space Administration (NASA), a civilian agency responsible for coordinating America's activities in space.

1984
On July 1, the Motion Picture Association of America (MPAA), which oversees the voluntary rating system for movies, introduced a new rating, PG-13.

1992
On July 2, the 1 millionth Corvette, a white LT1 roadster with a red interior and a black roof—the same colors as the original 1953 model—rolled off the assembly line in Bowling Green, Kentucky.

(http://www.history.com)

Family Affair

Exercising regularly with your kids has benefits beyond fitness

BY MARIA BLACKBURN

Parents are accustomed to their children nagging them for a new toy, or type of breakfast cereal, or a later bedtime. But an exercise program? Now that's unheard of.

At least that's what Ashley Deadwyler thought, until about a year ago when her two sons Avery, 10, and Julian, 8, began nagging her to take them running. The Houston teacher had just completed her first 10K and her sons were so inspired by the excitement and crowd at the finish line that they pleaded with her to train them for a race.

So after consulting with her father, who had helped her with her own training, Deadwyler, 36, filled some water bottles and took her boys to a nearby residential development that had flat roads and no traffic. They started out slow and ran together, sharing stories and offering words of encouragement along the way. Every night after dinner, the Deadwylers went out and ran for an hour. Today, as a result of their training, the boys are running six miles a night alongside their mom.

The rewards haven't just been in terms of mileage, says Deadwyler, whose family's story is featured in *Be Well*, a collection of stories and advice from a dozen U.S. mothers who have reduced childhood obesity risk in their families through diet and exercise.

"Not only are the boys more active, but they are sleeping better at night and their grades and behavior at school have improved," she says. "Nobody watches TV anymore." And when the boys miss a night of running due to soccer practice, they can't wait to get out the next night and spend time together as a family. Deadwyler is convinced that other families could benefit from exercising together. "Once any mom started doing this with her child she would see such a difference in her family and feel better, too."

Childhood obesity rates are rising, daily physical education at school is falling victim to budget cuts and many children and adults struggle with getting their recommended daily exercise.

(That's 60 minutes daily for children and teens, 30 minutes five times per week for adults.) Most U.S. students exercise twice a week or more, but they still rank near the bottom among all countries for frequency of exercise, according to a recent federal government report, "U.S. Teens in Our World."

"When we were growing up we had phys ed every day in school and parents didn't need to worry so much about getting in the recommended daily allotment of exercise," says Jan Schroeder, an associate professor of kinesiology at California State University, Long Beach, who is affiliated with the American College of Sports Medicine. "Now, we as families have to make sure that our children are being provided with enough opportunities to move."

Getting out and exercising as a family doesn't require any special equipment or a huge time commitment, says Shawn Dolan, a sports dietitian and triathlete in California. And the benefits of establishing a dedication to fitness early on can last a lifetime.

"Getting the whole family involved in being active together shows everyone that activities can revolve around movement rather than going out to eat or going shopping," Dolan says.

Here are some tips from experts on how to get moving together as a family: Let the kids decide on the activity. "When children choose, they have a vested interest," Schroeder says. "They don't want to think of this as a chore. This is playtime. This is an adventure." Ask your children what they would like to do, or give them some choices (like walking to the playground or playing tag in the yard) and let them decide.

Break a goal into manageable mini-goals and ask the kids to keep track, suggests Kay Morris, founder and director of Marathon Kids, a free school and community-based fitness program for elementary students and their families that currently has 180,000 participants who walk and run 26.2 miles (the length of a marathon) over six months. Students keep track of their miles and their fruit and vegetable intake by coloring in a chart as they go. "Little kids are really visual and they love seeing their endurance increase visually," Morris explains.

Make getting to a destination part of the activity. "It might be as simple as walking your kids to school or riding your bikes to the store," Dolan says.

If you have a teenager, have them invite a buddy along on your exercise outings. "A friend provides a much-needed social connection since it's uncool to be with parents at that age," Schroeder says.

Take your talk for a walk. Exercising together allows kids to relax and talk about their day. "I used to get one-word answers from my kids when I asked them about school," Deadwyler says. "Now that we walk and run together, it's great because they share the whole story of their day with me."

Chew on This

With ancient origins, chewing gum became a triumph of 20th-century mass marketing

BY SUE DE PASQUALE

On a sweltering afternoon, in the late 1920s, deep in the Yucatan rain forest, a nimble chiclero shimmies up the trunk of a 90-foot-tall sapodilla tree, hacking zigzags into the tree's gray bark with a machete. He releases an oozy, rubber-like substance known as chicle, which drips into waiting buckets below.

Over the next weeks, it will find its way to an eager American audience who will chew, chomp and pop the sought-after stuff…in the form of chewing and bubble gum.

Among American manufacturers of the popular product at the turn of the century, competition was stiff. "Anyone can make gum," noted the colorful William Wrigley Jr. "Selling it is the problem." Wrigley tackled the challenge by launching one of the first mass marketing campaigns of the 20th century: On placards in streetcars, huge electric signs in Times Square, billboards lining railroad tracks and through free samples sent to millions, Wrigley proclaimed the merits of his Wrigley's spearmint and Juicy Fruit chewing gum.

The result of such efforts? Gum became an ingredient key to American taste and culture. During World War II, American companies shipped 150 billion sticks of gum to GIs serving overseas, where it was a staple of the troops' military ration. At home, kids eagerly bought up and hoarded the pink stuff, cleverly packaged with baseball trading cards. After the war, consumption leapt by 500 percent, notes Michael Redclift, author of *Chewing Gum: The Fortunes of Taste.*

The sweet, minty confection bore little semblance to the first known chewing gum, tree resin chewed by the ancient Aztecs. Gum derived from spruce tree resin gained popularity in the United States in the early 1800s—a habit borrowed from the American Indians. Entrepreneur John Baker Curtis commercialized the product—cutting it into strips covered in cornstarch to prevent sticking—and opened the world's first chewing gum factory in Portland, Maine, in 1852.

Enter the Yankee investor Thomas Adams, whose path crossed with exiled Mexican General Antonio Lopez de Santa Anna (who won the Battle of the Alamo) in 1869. In New York, the general approached Adams with a lump of chicle. Its rubber-like qualities could make them a fortune, he predicted. Adams had no luck transforming the resin into vulcanized rubber—but he did start production on a chicle-based chewing gum.

In 1871, the first boxes of "Adams New York No. 1—Snapping and Stretching" chewing gum began flying off shelves. Adams and Son took their gum on the road and later added flavors—including licorice to produce "Black Jack gum," still around today. The market for the chewy stuff was born, and soon, other manufacturing companies entered the fray. Wrigley emerged as the biggest winner: At the time of his death in 1932, he was one of the 10 richest men in the U.S., with factories in 37 countries.

By the 1950s, manufacturers shifted to synthetic forms of gum, partly sparked by Frank H. Fleer, who wanted a gum that could be blown into bubbles. He spent two decades experimenting with synthetic bases, eventually marketing the first bubble gum, "Blibber-Blubber," in 1906. But when it exploded on the face, it had to be removed with turpentine. Fleer accountant Walter Diemer solved that issue in 1928 with a pink mixture—dubbed Double Bubble—that easily peeled away.

Today most chewing gum is manufactured from vinyl resins or microcrystalline waxes. But chicle and chewing gum have come full circle. In an era when organic products and preserving the rain forest are in vogue, chicle-based gums are making a comeback as a boutique industry for those favoring all-natural products.

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