BOSS

CONNECTING TO INDUSTRY

A-maizing CORN

Our wide-ranging appetite for the yellow-kerneled crop is voracious—and shows no signs of slowing down.

FALL/WINTER 2014
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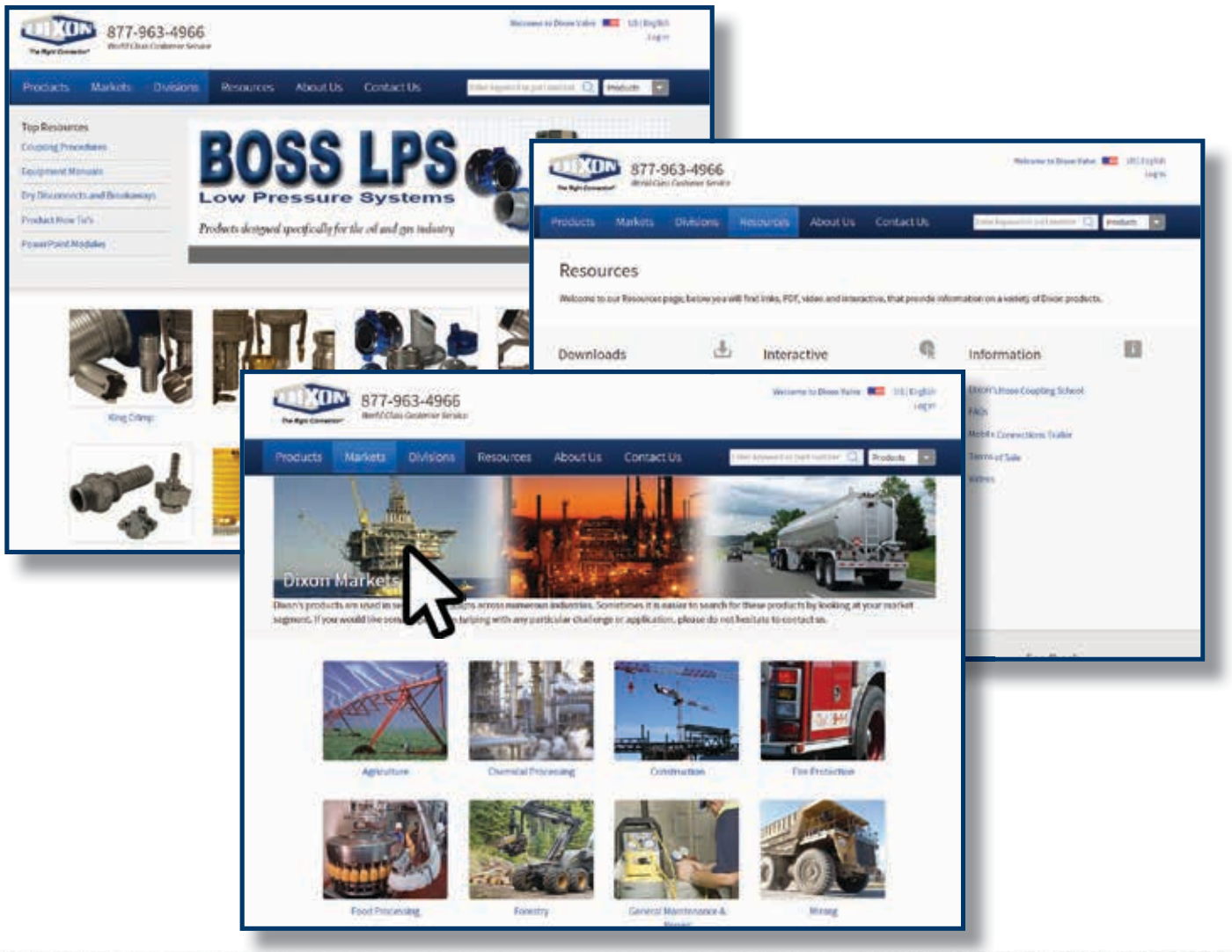

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FALL/WINTER 2014
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FEATURES

DEPARTMENTS

THE GEE WHIZ FACTOR

I am reminded we are living in an era of incredible advances in science and technology with this issue's stories on thought-controlled prosthetics (Health, p. 36) and 3-D printing (Inventions, p. 38). Before very long, an amputee or paralyzed person will merely need to *think* about lifting an artificial arm to grasp a book, and it will happen. And consumers will be able to purchase a wide variety of products—all made via 3-D printing technology.

Over the years, in each issue of *BOSS*, we've highlighted forward-thinking people and inventions that have dramatically improved life for millions, with profiles of people like Henry Ford, Alfred Nobel and Charles Goodyear, and articles about the origins of the printing press, the telephone and the battery.

These stories are important examples, because in the world of manufacturing we have a special opportunity—actually more like a *responsibility*—to drive tomorrow's important advances by investing in research and development today. That begins by encouraging all employees, at every level, to question existing methods and processes and to "think outside the box" to come up with creative solutions to today's challenges. (To read past invention articles that have appeared in *BOSS* since the magazine's start, visit: https://dixonvalve.com/boss-magazine-invention-articles.)

Thanks for reading,

Dick Goodall

BOSS
FALL/WINTER 2014
ASIA/PACIFIC – SUMMER 2014

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Don't Kill the Messenger

>As I speak to business groups around the country, I frequently hear senior executives utter modern clichés about wanting employees to "think outside the box," to take risks, to be creative. And while I'm sure companies truly appreciate breakthrough ideas that increase profits, productivity or quality, the problem is that the culture in most organizations is quite inhospitable to those who challenge old ways of doing things, including practices that make no sense or are simply inefficient.

An often overlooked obligation of ethical management is to establish an atmosphere where employees are truly expected and willing to accept responsibility for improving the quality of programs, products and procedures—even if it means challenging well-established policies or management decisions. Though most managers think they're open to ideas, Josephson Institute studies show that one-third of employees say there's a "kill the messenger" tradition where they work, which discourages suggestions and promotes concealment of negative information. Whenever a manager asks, "Why didn't someone tell me?" it's time to find ways to more effectively send the message that mission-oriented employees who produce and demand quality are to be prized, not penalized.

I think every manager has the ultimate responsibility to assure that practices and procedures are efficient, effective and consistent with organizational values and goals. This requires a full, hands-on, detailed knowledge of what subordinates actually do and an understanding of how things really work.

Saint on Earth

Mother Teresa fed the poor and treated the uncared for with deep compassion

KEYSTONE Pictures USA/ZUMAPRESS/Newscom

Mother Teresa, Jan. 1, 1970, in Paris

> For nearly 70 years, she clothed and fed the poor, cared for the babies no one wanted, nursed the sick and gave the dying a place where they could die with dignity. She ministered to people with leprosy and AIDS, the hungry, the orphans, the destitute, the elderly. And in addition to giving them the food, medicine, shelter and services they needed, Mother Teresa gave the needy something equally important: the love and compassion they so desperately yearned for.

"We think sometimes that poverty is only being hungry, naked and homeless," said Mother Teresa, who won the Nobel Peace Prize in 1979 for her work. "The poverty of being unwanted, unloved and uncared for is the greatest poverty."

Through her actions, this tiny Catholic nun in the simple white and blue sari showed others how they could make a difference in the world by giving of themselves. "Her greatness [lay] in her ability to give without counting the cost, to give until it hurts," Pope John Paul II said of Mother Teresa. "Her life was a radical living and a bold proclamation of the Gospel."

Mother Teresa was born Agnes Bojaxhiu in 1910 in Skopje, now the capital of Macedonia. Her parents, Nikola and Drana, shared the little they had with others by opening their home to all, especially the poor. "My child, never eat a single mouthful unless you are sharing it with others," Nikola told young Agnes. It was a lesson she never forgot.

In 1928, at the age of 18, Agnes left home to join the Sisters of Loreto. She taught at the Loreto School in Calcutta for almost 20 years, becoming headmistress. In September 1946, Mother Teresa received what she referred to as her call within a call. "The message was quite clear," she said. "I was to help the poor while living among them. It was an order."

In 1950 she established the Order of the Missionaries of Charity and became the order's superior general. Her goal, she said, was to provide "free service to the poor and the unwanted, irrespective of caste, creed, nationality or race." When she realized that people with leprosy needed medical care, she set up mobile clinics and instructed her charges to treat them without gloves so the sick could feel their touch. When she witnessed a woman dying in the

WORDS TO LIVE BY

- People are often unreasonable, irrational and self-centered. Forgive them anyway.
- If you are kind, people may accuse you of selfish, ulterior motives. Be kind anyway.
- If you are successful, you will win some unfaithful friends and some genuine enemies. Succeed anyway.
- If you are honest and sincere, people may deceive you. Be honest and sincere anyway.
- What you spend years creating, others could destroy overnight. Create anyway.
- If you find serenity and happiness, some may be jealous. Be happy anyway.
- The good you do today will often be forgotten. Do good anyway.
- Give the best you have, and it will never be enough. Give your best anyway.
- In the final analysis, it is between you and God. It was never between you and them anyway.

These words were found written on the wall in Mother Teresa's Home for Children in Calcutta. They are believed to be adapted from "The Paradoxical Commandments" by Kent M. Keith.

street outside a hospital and could not convince the hospital to take the woman in, she established a home for the dying and called it Nirmal Hriday, "the place for the pure of heart."

As Mother Teresa continued to identify unmet needs throughout Calcutta and the world, and word spread of her order's work, the services provided by the Missionaries of Charity grew to include 80 centers in India and more than 100 centers in 90-plus countries worldwide.

Despite her good deeds, Mother Teresa was not without her share of critics. She did not support abortion, contraception or divorce, and was unafraid to express her views on these matters.

She replied, "Forgive them for they know not what they do."

Even as she aged, her work continued. She fed the hungry in Ethiopia, opened one of the first AIDS clinics in New York City and cared for people with radiation poisoning in Chernobyl. Mother Teresa used the $192,000 she received with the Nobel to feed the hungry, and persuaded the Nobel organizers to cancel the banquet after the event and use those funds for the same cause.

> "Her greatness [lay] in her ability to give without counting the cost, to give until it hurts."
>
> —POPE JOHN PAUL II

When Mother Teresa died in 1997 at the age of 87, the Missionaries of Charity had more than 500 missions, 4,000-plus sisters and hundreds of volunteers throughout the world. Since its founding, the order has nursed, fed and cared for millions of people.

During her lifetime, Mother Teresa became known as the "saint of the gutters." Two years after her death, Pope John Paul II waived the five-year waiting period and began the process that opened her canonization cause. Mother Teresa has not yet officially been named a saint. To many, however, this classification means little since she already lived the life of a saint on earth.

"God doesn't ask us to do great things," Mother Teresa said once. "He asks us to do small things with great love." ✒

Our wide-ranging *appetite for the yellow-kerneled crop* is voracious—*and shows no signs* of slowing down

BY MICHAEL BLUMFIELD

A-maizing COR

Drive through rural Iowa in early August and you'll be surrounded by corn. Acre upon acre will be awash in the tall plants—a sea of green as far as you can see.

But it's not just Iowa in August: Corn is commonplace everywhere, every day, even if it's not always so visible.

The starched shirt you put on this morning owes its crispness to corn. Besides your corn flakes, corn elements are in your breakfast yogurt and cranberry juice, as well as your vitamins and medicines. Last night's dinner could well have been cooked with corn oil. If you had meat, it came from an animal most certainly fed with cornmeal. When you brushed your teeth afterward, guess what was in the toothpaste?

Even the paper with these words printed on it probably has traces of corn in it.

Corn is a hugely important substance in our daily lives. Its production, harvesting and processing are big business in the United States, which produces 40 percent of the world's supply (See "By the Numbers," p. 16).

Take just one example of the magnitude of the corn industry. On many Iowa farms, the sea of corn will be swallowed by an 18-ton harvester with a GPS system to help the driver track the vehicle's field position. The harvester will suck up some 4,500 bushels (about 23,000 pounds) of corn

Sunrise over summer corn in Iowa

A combine harvests a crop of corn on an Ontario grain farm in fall.

in an hour, 12 rows at a pass. The retail price for this mechanical monster? Between $350,000 to $500,000.

But the harvest is just the beginning of a long journey for the corn, which will be subject to a series of processes designed to extract the value from each element of every kernel.

Corn's *Global* Conquest

As food sources go, corn is a relative newcomer. Archaeologists believe rice and wheat were harvested as far back as 30,000 years ago. Corn didn't take its place among edible plants until about 9,000 years ago, when inhabitants of southern Mexico began to cultivate it.

Despite the big head start that wheat and rice enjoyed, corn now leads the pack of the Big Three Grains. One of the advantages corn has over other grains is that each plant contains a higher percentage of usable material (see "The Corn Refinement Process: Extracting Value From Those Kernels," p. 12). That's in part what has led to its widespread adoption.

Some 784 million tons of corn were harvested globally in 2012 (the most recent records available), compared to 633 million tons of rice and 605 million tons of wheat. (Those three represent 85 percent of all grain harvesting, based on weight.)

Corn is a domesticated crop; it depends on humans to reproduce. Exactly how and when that started is not clear. But corn's origins are in the Americas—it didn't make its way to Europe until Christopher Columbus brought it back to Spain in the late 15th century.

While information is spotty, it's clear that corn was key—probably the most important cultivated crop—for thousands of years in the Americas before Columbus' arrival. The corn-growing areas stretched from what is

Uses of corn

There are an estimated 500 different uses for corn. Besides food products, corn is used in:

- plastics
- packing materials
- insulating materials
- adhesives
- chemicals
- explosives
- paint
- paste
- abrasives
- dyes
- insecticides
- pharmaceuticals
- organic acids
- solvents
- rayon
- antifreeze
- soaps
- alcohol

Young corn plant

now North Dakota to current-day Argentina and Chile.

The discoverers of the New World initially relegated corn to a garden curiosity. But as its food value was recognized, it spread throughout France, Italy, southeastern Europe and northern Africa. By the late 16th century, corn had dispersed into Asia, entering western China and becoming important in the Philippines and the East Indies. Today, the Americas still dominate as corn sources, claiming four of the top five production spots. Slipping in as number two in total corn production is a country you'd normally associate with rice: China.

Early *Seeds of Industrial* Use

In the United States, corn began to play a starring role in the laundering process in the mid-19th century. Though wheat was originally the primary source of starch, in the 1840s a chemist working in New York found a way to use corn instead. His employer switched the company's starch-making plant from using wheat to using corn. The employer's name: William Colgate, whose company later would make toothpaste.

While starch eventually would find its way into that toothpaste to give it texture and moisture, its main function was to make clothes stiffer for mid-19th-century Americans. But

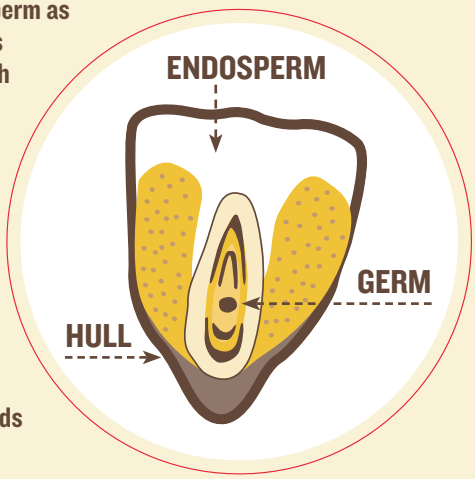
(continued on pg. 14)

Anatomy OF A KERNEL

A corn kernel is a simple biological structure, containing just what the plant needs to reproduce. The germ represents the baby plant that would one day become an 8-foot-tall plant if we hadn't decided to cut its journey short by harvesting it and the rest of the kernel.

The germ is sustained by the endosperm as it matures following pollination. This surrounding material contains starch and glucose. The whole thing is packaged up in a tough shell called the hull—the part that gets stuck in your teeth when you're eating corn on the cob.

Initially, only the endosperm was processed—mainly to use as starch in the laundry industry. But advances in science throughout the years now mean the entire kernel ends up in one finished good or another.



Endosperm

- **GLUTEN** Cattle Feed
- **CORN MEAL** Cereals
- **RAW STARCH**
  - **ETHANOL**
  - **EDIBLE STARCH** Cornstarch, Jellies, Candies
  - **DEXTRIN** Mucilage Glue, Textile Sizing, Food Sauces, Fireworks
  - **INDUSTRIAL STARCH** Laundry Starch, Textile Sizing, Manufacture Filler in Paper, Cosmetics, Explosives
  - **CORN SYRUP** Mixed Table, Syrups, Confectionery, Ice Cream, Shoe Polishes
    - **CORN SUGAR** Infant Feeding, Diabetic Diet, Caramel Coloring, Vinegar, Lactic Acid, Tanning Mixtures, Brewing, Artificial Silk

Germ

- **OIL CAKE (OR MEAL)** Cattle Feed
- **CRUDE CORN OIL**
  - **SOAP**
  - **GLYCERIN**
  - **SOLUBLE CORN OIL** Textile Sizing, Cloth Coloring
  - **REFINED CORN OIL** Salad Oils, Cooking Oils, Medical Oils
  - **PLASTIC RESIN** Rubber, Substitutes, Erasers, Elastic, Heels

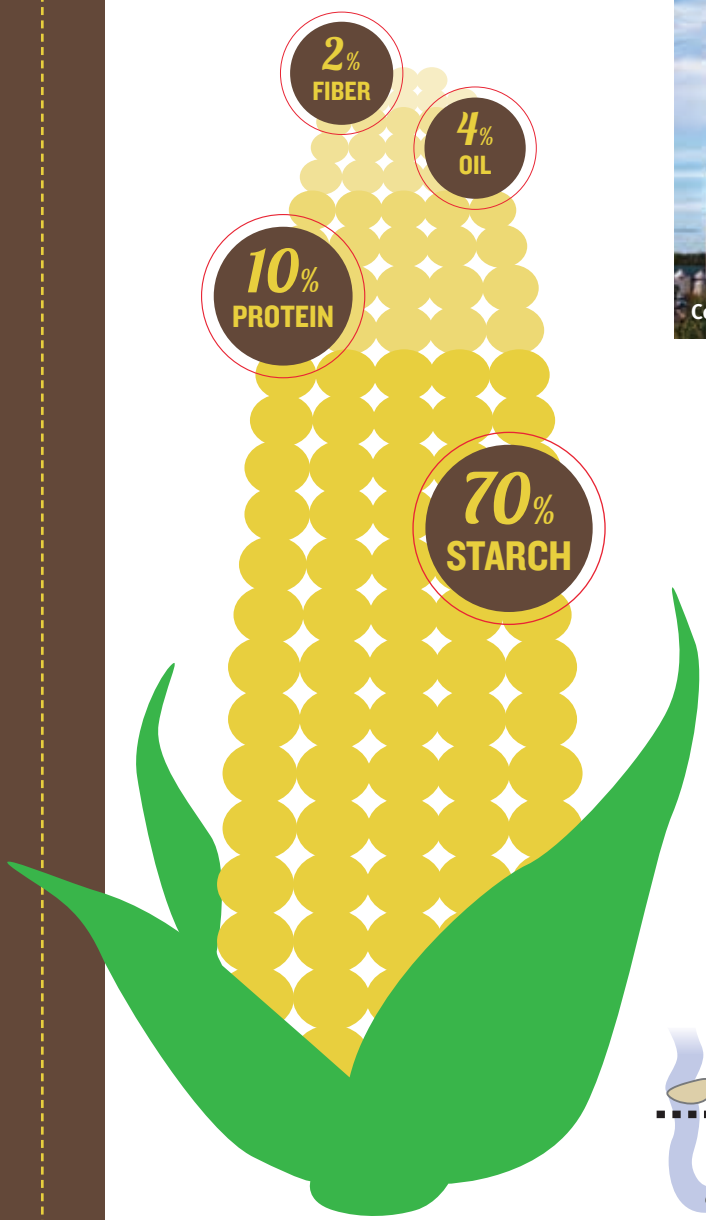
Hull

- **BRAN** Cattle Feed

The Corn Refinement Process:

Extracting Value From Those Kernels

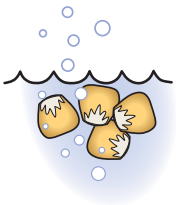
Corn comes in various forms, but the type that's processed into other products is known as field corn, or dent corn. Of each kernel, about 70 percent is starch, 10 percent protein, 4 percent oil and 2 percent fiber. The refining process separates these components and processes them into specific products.



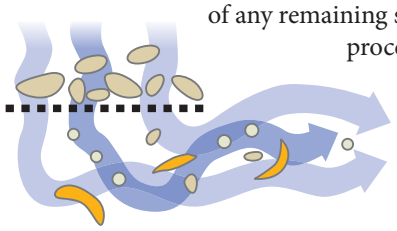

Corn dryer silos standing in a field of corn

©iStockphoto.com\stu99

Once corn arrives at a refining facility, it's inspected, cleaned to remove pieces of cob, dust, chaff and foreign materials, and then stored in silos.



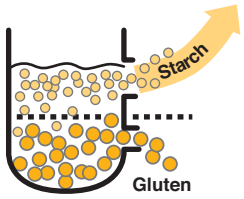
- **Steeping:** Next the corn is dumped into a stainless steel steep tank—about 3,000 bushels at a time—to soak in 120 degrees Fahrenheit water for 30 to 40 hours. A tiny amount of sulfur dioxide is mixed into the water to curb bacterial growth and to help loosen the gluten bonds in the corn, releasing the starch.
- **Rough grinding and separation:** After the steeping, the corn is coarsely ground to break the germ away from the other components. The steepwater itself is condensed so the nutrients it contains can be captured and used in animal feed. The ground corn, floating in a slurry, goes to a germ separator. Spun free of the rest of the corn, the germ is pumped into screens and washed repeatedly to get rid of any remaining starch. Mechanical and solvent processes extract the oil from the germ. That oil is refined and made into finished corn oil. What's left of the germ becomes another component of animal feed.



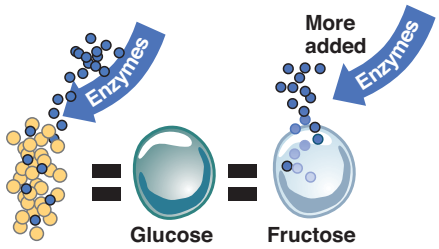
From left: Corn harvested and stored in silo. Ground corn being loaded into a grain truck after it has been used for ethanol production at Big River Resources ethanol production plant near Burlington, Iowa. This byproduct is known as distillers grain and will be used for commercial feed for cattle.

- **Fine grinding and screening:** The corn and water slurry that remains after saying goodbye to the germ goes to a new processing stage: the impact mill. After this milling stage, the suspension of starch, gluten and fiber flows over fixed concave screens, which catch the fiber but let the starch and gluten pass through. The fiber gets further processing, stripped of any residual starch or protein, and then is sent to another stage to be used in—you guessed it—animal feed.

- **Starch separation:** Because gluten has a lower density than starch, it can be spun out and used for this multipurpose product. The starch gets a thorough washing—up to 14 times—where it's rediluted and washed in hydroclones to eliminate whatever protein has stubbornly tried to remain. That leaves starch that's 99.5 percent pure. Some of that starch is dried and marketed as unmodified cornstarch, and some is made into specialty starches, but most is converted into corn syrups and glucose.



- **Syrup conversion:** The starch, suspended in water, is liquefied with acids or enzymes, converting it into a low-glucose solution. This is where refiners can stop or continue treatment with acid or enzymes depending on what final product they're seeking. For example, if they want a low- to medium-sweetness syrup, they may halt the conversion of starch to sugar early in the process. If they're seeking high fructose corn syrup, the process will continue. With runs through more filters and centrifuges, as well as ion-exchange columns, what was starch becomes a syrup.



- **Fermentation:** Once starch has been converted to glucose, it's frequently piped into fermentation facilities. There it's made into alcohol by traditional yeast fermentation, or into amino acids and other bioproducts through either yeast or bacterial fermentation. After fermentation, the resulting broth is distilled to recover alcohol, while some of it is concentrated to make other bioproducts.

In contrast to the corn processing of 150 years ago, when most of the kernel's components were trashed, in today's processing even the carbon dioxide released during fermentation is recaptured and sold. Not even gas escapes the fastidious corn processors.

Process Graphics by Lee Hulteng/© 2010 MCT/Corn Refiners Association, NIH/Newscom

Ian Wagreich UPI Photo Service/Newscom

Urbana, Maryland, cattle feeding on corn feed

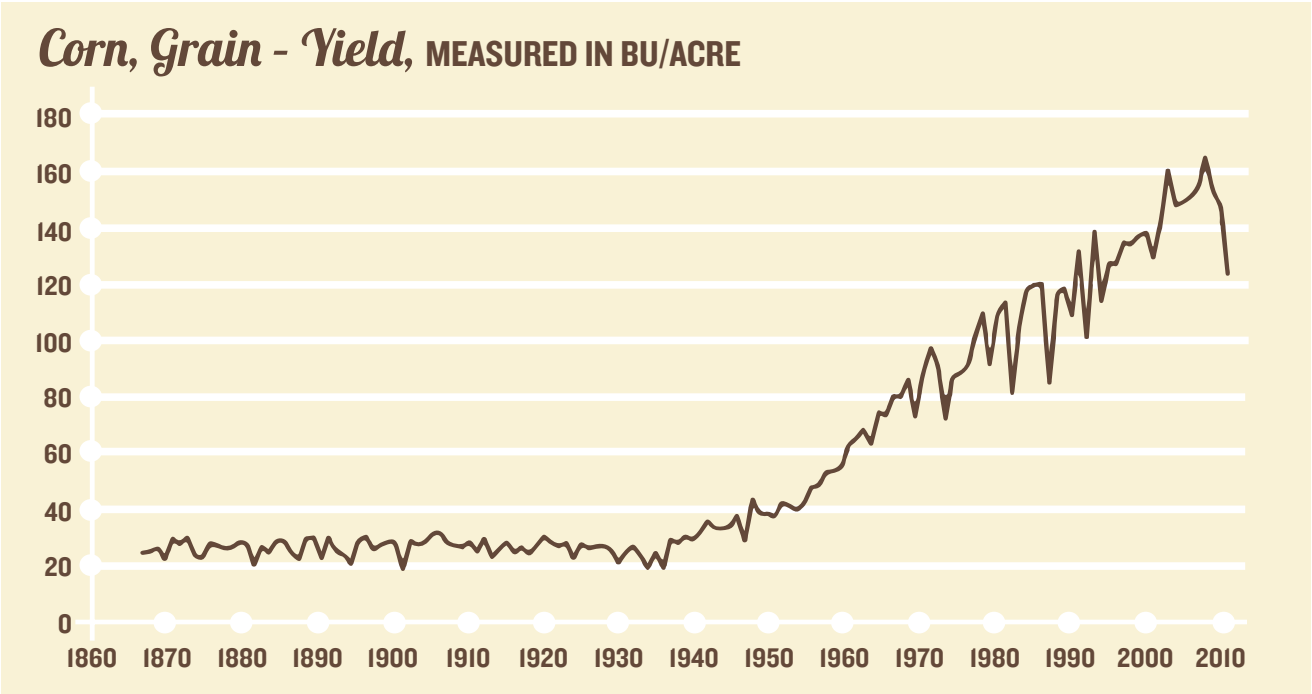
scientists soon found more ways to extract value from those kernels.

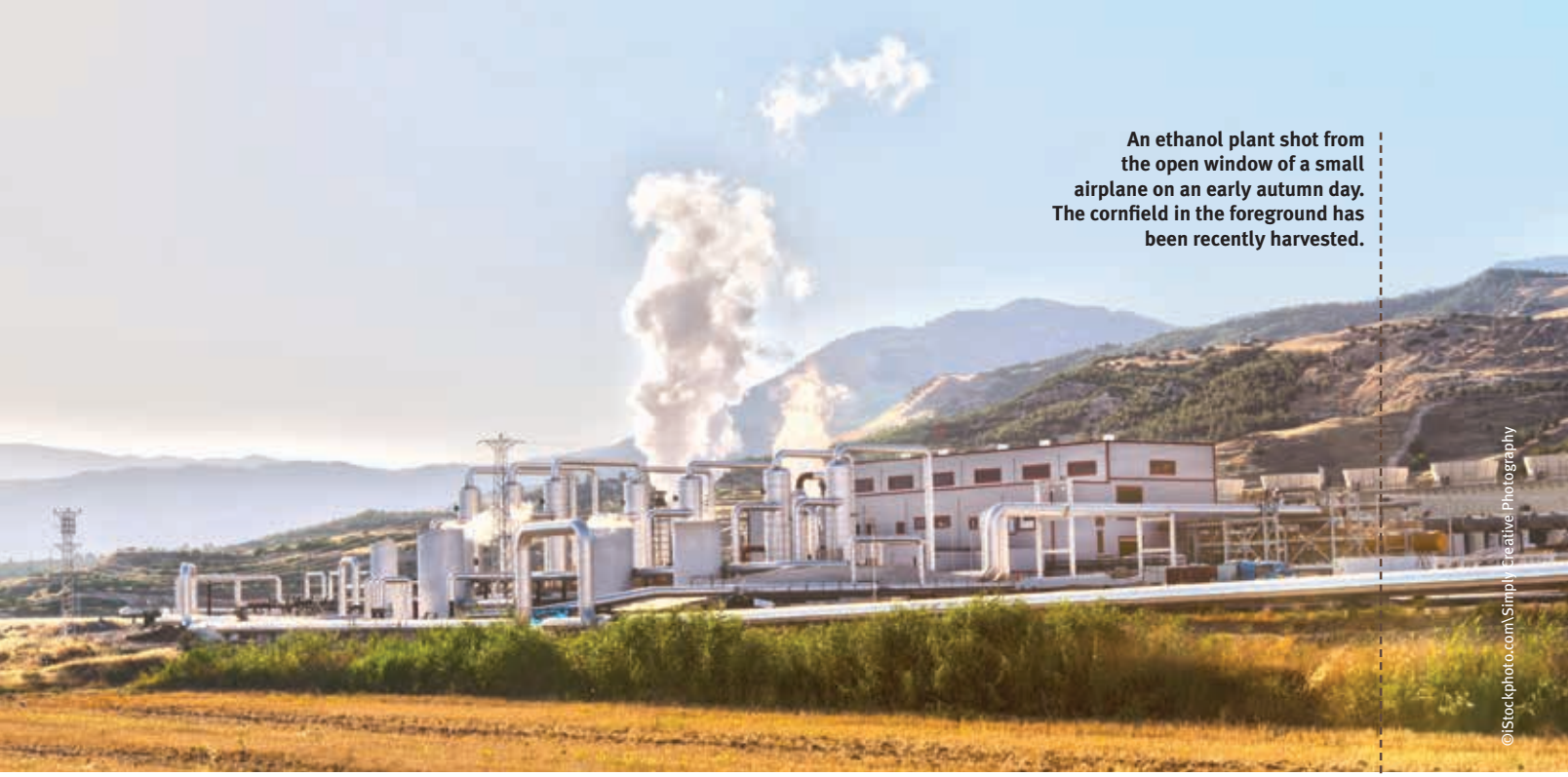
In 1866, they began extracting dextrose, the first corn-derived sweetener. Fifteen years later they found out how to manufacture refined corn sugar, or anhydrous sugar. Even so, those efforts focused only on making use of part of the corn kernel. Its fiber, germ and protein had been tossed away (see "Anatomy of a Kernel," p. 11). By 1882, corn refiners began using those proteinase portions—misleadingly called corn gluten feed—as food for cattle. A few years later, the corn manufacturing industry found it could extract oil from the germ.

Corn refining begins by first soaking corn in water, and even that substance ended up becoming valuable to refiners. By the turn of the century, operators learned how to condense the leftover water and extract its nutrients for feed products.

The refinement of starches and sweeteners continued to evolve. By the 1950s the purification and crystallization of dextrose made corn a viable competitor to sugar in some markets. Then in 1967 came the big advancement for corn refiners: high fructose corn syrup. Initially, the fructose level wasn't so high—only

Ethanol now creates the largest demand for corn in the United States.





An ethanol plant shot from the open window of a small airplane on an early autumn day. The cornfield in the foreground has been recently harvested.

about 15 percent. But a year later it reached 42 percent, and by the mid-1980s, high fructose corn syrup became the predominant sweetener for the U.S. soda industry.

An *Energy* Alternative

In addition to corn's appearances in your home and in the supermarket, it's likely to (warning: pun ahead) crop up whenever you fill up. Ethanol now creates the largest demand for corn in the United States. But ethanol is a far older product than you might suspect.

Like other grains, corn can be fermented to create alcohol. The product of that fermentation, ethanol whiskey, is better known as "moonshine." Early automakers saw the energy potential in ethanol, and the Ford Model T was designed to run on it. During World War II, the U.S. Army thought corn could be a supplemental fuel source for military machines and built the first ethanol plant in Nebraska. Once the war ended, gasoline was cheap and plentiful, so demand for corn-based fuels dried up.

With the oil embargoes of the 1970s, gas prices shot up, as did concerns that the United States was too dependent on other countries for its energy supplies. The abundance of corn and its readiness for transformation into alcohol made it the mainstay of the ethanol industry.

Varying prices for corn made it hard to count on ethanol as a resource. So state and federal laws were passed to provide subsidies and add stability. While federal policy has called for an increased amount of biofuels in the future, corn is no longer viewed as the only source of ethanol. Other cellulosic feedstock sources are expected to meet more than half the total demand.

Is Ethanol a Viable Fuel Source?

While the federal government has been promoting ethanol production for decades, there is some debate as to its viability as a fuel source. Proponents note that it can be produced in large quantities and that it requires fewer technological breakthroughs and less infrastructure than is needed to support electric vehicles and fuel cell vehicles. Moreover, a byproduct of ethanol production—"brewers' grain"—can be used for cattle feed.

But critics raise three major objections:

1. **It's unethical to produce fuel from a food source such as corn, particularly when it drives up food prices.**
2. **It takes a lot of energy to produce ethanol, which contains less energy than gasoline.**
3. **Some studies show that ethanol production hurts the environment by increasing CO_2 emissions, which have been linked to global warming.**

By the Numbers

Top 10 CORN PRODUCERS IN 2012

COUNTRY	PRODUCTION (TONS)
UNITED STATES	273,832,130
CHINA	208,258,000
BRAZIL	71,296,478
ARGENTINA	25,700,000*
MEXICO	22,069,254
INDIA	21,060,000*
UKRAINE	20,961,300
INDONESIA	19,377,030
FRANCE	15,614,100
SOUTH AFRICA	12,500,000*

** estimated*

Future *Growth and Use* of Corn

It's hard to imagine that as common as corn is in products all around us, there's a push to expand its use. But advances in biotechnology and process engineering are constant and rapid. So it's only a matter of time—and not much time at that—before more corn-based products come to market.

The corn-manufacturing industry notes that over the past two decades, we've witnessed the development of new starch products, low-calorie sweeteners, vitamin and amino-acid food additives, and biodegradable polymers for use in plastics, fabrics and fibers.

With so much demand for corn, you'd expect that record numbers of acres will soon be covered in a sea of the tall green plants in summer, right? Probably not.

Compare the total acres planted and yield per acre between 1932 and 2012.

Loading corn grain in the tractor trailer

In 1932, about 113 million acres of corn were planted in the United States. In 2012, the number was down to about 97 million. But total production more than tripled. That's because the average per-acre yield went from 26.5 bushels in 1932 to about 123.4 bushels in 2012.

And now you know why it makes economic sense to spend up to half a million dollars on a harvester.

akg-images/Newscom

"I LIKE IKE" Button (Top Right): Independent Picture Service/UIG via Getty Images

IN THE YEARS AFTER WORLD WAR II, DWIGHT D. EISENHOWER WAS THE MOST FAMOUS MAN IN THE WORLD AND MOST TRUSTED MAN IN AMERICA

BY DAVID HOLZEL

The weather forecast over the English Channel for June 5, 1944, was for storms. The greatest amphibious assault in history was poised to get underway—but would the Allies' attempt to dislodge the Nazis from France founder due to bad weather?

The final decision to launch Operation Overlord was with the supreme Allied commander, Gen. Dwight D. Eisenhower. Steady, indefatigable and a master of detail and morale building, the 53-year-old Kansan had led the painstaking planning for what has since become known as the D-Day invasion.

Overlord relied on Allied air superiority to help break the German line. So when it came to its execution, Eisenhower argued for total commitment. "Every obstacle must be overcome, every inconvenience suffered and every risk run to ensure that our blow [is] decisive," he wrote to the Combined Chiefs of Staff, supreme military staff for the Western Allies. "We cannot afford to fail."

They had only a small window of opportunity to act. The launch had to be made at dawn, on low tide, with at least a half moon the night before. In the spring of 1944, those conditions were met only in early May and the first and third weeks of June. May was now past, and the first week of June was almost over. The Allies were running out of time.


U.S. Army via CNP/Newscom

General Dwight D. Eisenhower giving orders to American paratroopers in England on D-Day, June 6, 1944.

Eisenhower decided to take the chance. After meeting with the top Allied commanders in their London headquarters, Eisenhower gave the order to launch the attack at 9:45 p.m.

In clearing weather, more than 156,000 troops landed on June 6. It was, one historian said, as if a medium-sized city had been moved 100 miles away in one night, against violent opposition. The D-Day invasion was like a vast machine of moving parts and systems, a bureaucracy of departments, each responsible for its own job. The only man responsible for seeing the whole picture, for knowing if the machine was working correctly, was Eisenhower.

"Plans are worthless," he told an audience when he was president, "but planning is everything."

In the first week, the Allies consolidated a bridgehead. And although Allied victory was a long way from being assured, D-Day was the beginning of the end of Nazi Germany. Out of that defeat, Eisenhower, with his lopsided grin, straight talk and modest demeanor, became the most famous—and possibly most popular—man in the world.

U.S. Army via CNP/Newscom

US Official Photograph Mirrorpix/Newscom

Left: Cadet Dwight D. Eisenhower kicking a football at West Point in 1912. Above: American troops drive an amphibious vehicle aboard an invasion landing craft in preparation for the Normandy invasion.

As commander of the Allied Forces in Europe in World War II and two-term president, Dwight D. Eisenhower had helped lead America's transformation into a superpower on a permanent war footing. America had entered a new age on Eisenhower's watch—the nation was prosperous beyond belief but sat on the edge of nuclear conflict.

LITTLE IKE

He was born in 1890 in Denison, Texas, but spent his formative years, until he shipped out to West Point, living in Abilene, Kansas. One of six brothers, he was early on given the nickname "Little Ike"—"Big Ike" was big brother Edgar. The boys rolled and tumbled, fought and played sports. Parents David and Ida Stover Eisenhower taught their children to be honest and self-reliant.

As a boy, Eisenhower studied military history on his own. Athletic as a youth, he discovered leadership talents while organizing baseball and football games during high school. At West Point, a knee injury ended his career as a football player, but he quickly became a coach. Coaching brought out the best of him: his organizational ability, his enthusiasm that roused his players to victory. During World War II, his approach as a commander would remind some of a good football coach.

Eisenhower graduated from West Point in 1915 but was not sent to Europe to fight in World War I. Instead, he put his coaching skills to work training troops.

After the Armistice, Eisenhower remained in the peacetime army. As the years went by, the ambitious Eisenhower had little to show for his dedication to the armed forces. He served ably as an assistant to Gen. Douglas MacArthur in the Philippines and was a protégé of Chief of Staff Gen. George Marshall. But when the Japanese attacked Pearl Harbor on December 7, 1941, Eisenhower was 51 years old and had never seen battle.

Once war was declared, however, Eisenhower's rise was swift. Marshall and President Franklin D. Roosevelt saw how essential Eisenhower's diplomatic skills would be in holding together the fractious allies.

In 1942, Marshall sent Eisenhower to London as chief of the European theater of operations. There, his straight talk and good humor engaged the British people and the American press, who turned Ike, as the public now called him, into a celebrity. He became the

PULLING RANK: EISENHOWER'S MILITARY ASCENDANCY

NI Syndication/Newscom

July 1, 1916: First Lieutenant, U.S. Army

May 15, 1917: Captain, U.S. Army

June 17, 1918: Major, National Army

October 14, 1918: Lieutenant Colonel, National Army

June 30, 1920: Captain, Regular Army (reverted to peacetime rank)

July 2, 1920: Major, Regular Army

July 1, 1936: Lieutenant Colonel, Regular Army

March 11, 1941: Colonel, Regular Army

September 29, 1941: Brigadier General, Army of the U.S.

March 27, 1942: Major General, Army of the U.S.

July 7, 1942: Lieutenant General, Army of the U.S.

February 11, 1943: General, Army of the U.S.

December 20, 1944: General of the Army, Army of the U.S.

April 11, 1946: General of the Army rank made permanent in the Regular Army

ORDER OF THE DAY: JUNE 6,1944

"Soldiers, Sailors and Airmen of the Allied Expeditionary Force!"

"You are about to embark upon the Great Crusade, toward which we have striven these many months. The eyes of the world are upon you. The hopes and prayers of liberty-loving people everywhere march with you. In company with our brave Allies and brothers-in-arms on other Fronts, you will bring about the destruction of the German war machine, the elimination of Nazi tyranny over the oppressed peoples of Europe, and security for ourselves in a free world.

"Your task will not be an easy one. Your enemy is well trained, well equipped and battle hardened. He will fight savagely.

"But this is the year 1944! Much has happened since the Nazi triumphs of 1940–41. The United Nations have inflicted upon the Germans great defeats, in open battle, man-to-man. Our air offensive has seriously reduced their strength in the air and their capacity to wage war on the ground. Our Home Fronts have given us an overwhelming superiority in weapons and munitions of war, and placed at our disposal great reserves of trained fighting men. The tide has turned! The free men of the world are marching together to Victory!

"I have full confidence in your courage and devotion to duty and skill in battle. We will accept nothing less than full Victory!

"Good luck! And let us beseech the blessing of Almighty God upon this great and noble undertaking."

—Dwight D. Eisenhower

unpretentious incarnation of American can-do spirit.

It was Eisenhower's first command and when the Allies decided their offense would be to expel the Germans from North Africa, he proved to be a cautious leader. His caution led to delays and missed opportunities, even though his superiors urged him to be bolder.

By then, many perceived a looming Soviet threat to Europe and argued that the defeated German military should be co-opted as a new ally. But Eisenhower, who had spent the war holding the alliance together, had faith in U.S.-Soviet relations and would not double-cross the Russians.

SO GREAT WAS EISENHOWER'S POPULARITY THAT REPUBLICANS AND DEMOCRATS ALIKE SOUGHT HIM AS THEIR CANDIDATE FOR PRESIDENT.

Eisenhower learned from his freshman error. And the next year he was made a four-star general, as the Allies turned toward reconquering Europe. The battle for Sicily began on July 10, 1943, with the largest amphibious assault ever attempted, and saw a race across the island between rival generals, American George S. Patton and British Bernard Montgomery. While these battles are often seen as strategic failures, they did give the Allies, including Eisenhower, valuable experience for the next phase of the war—the 1944 D-Day landing in northern Europe.

When victory came, almost a year later, Eisenhower's reputation as a hero was sealed. With Hitler dead, the Germans surrendered on May 7, 1945. After the ceremony, the victorious officers were too exhausted to celebrate.

THE INDISPENSABLE MAN

Eisenhower, then, was present at the birth of the Cold War, as Germany was divided by the Allies and Berlin found itself surrounded by Soviet occupation. After being elected 34th president in 1952, he spent eight years trying to keep hostilities from breaking into nuclear war.

Like his presidential predecessors Washington and Grant, Eisenhower was a war hero who seemed the indispensable man to lead the country. So great was his popularity that Republicans and Democrats alike sought him as their candidate. "His political views, unexceptional and shared by millions of American voters, were quintessentially Republican, Midwestern, middle-of-the-road, patriotic," writes Tom Wicker in his biography *Dwight D. Eisenhower*.

So it was as a Republican that Eisenhower made his candidacy, first for the Republican nomination against party leader Sen. Robert Taft of Ohio and later against Democrat Adlai Stevenson in the general election. When the ballots were counted, the most trusted man in the country and most famous American in the world had been elected president.

His first test was ending the unpopular Korean War. The war had begun in 1950 when North Korea invaded the South. The United Nations adopted an American resolution committing to the defense of South Korea. The war was a stalemate when Eisenhower became president in 1953. He took advantage of a diplomatic

President Dwight D. Eisenhower and his wife, Mamie Eisenhower, hold up a copy of the New York *Daily News* headlining Eisenhower's presidential victory, November 5, 1952.

EISENHOWER'S RIBBONS OF ROAD

The Interstate Highway System, that web of limited-access high-speed roads, has a first name: Eisenhower. It was President Eisenhower who signed the Federal-Aid Highway Act of 1956, and he considered it one of his greatest accomplishments in office.

Eisenhower had been thinking about the national importance of good roads since his early soldiering days. In 1919, as a young lieutenant colonel, he joined a convoy that was road testing Army vehicles by riding them from Washington, D.C., to San Francisco to see what it would take to move the army across country. They made their transcontinental journey at an average speed of 6 miles per hour. During 62 days there were numerous crashes and breakdowns. Vehicles got stuck in mud and sand and crashed through wooden bridges.

"The old convoy had started me thinking about good, two-lane highways," he wrote years later, "but Germany had made me see the wisdom of broader ribbons across the land."

In Germany, as Supreme Allied Commander during World War II, Eisenhower saw the advanced design of the autobahns, which allowed the Nazi army to move quickly through Germany.

As president, Eisenhower championed the idea of an interstate highway system. In his State of the Union Address in 1954, Eisenhower told the nation that it was important to "protect the vital interest of every citizen in a safe and adequate highway system." Congress acted quickly and passed the Federal-Aid Highway Act of 1954, which allotted $175 million for the interstate system.

During the next two years, Congress debated and voted on various highway bills. In his 1956 State of the Union, Eisenhower again called for a "modern, interstate highway system."

In June, Eisenhower was being treated for ileitis at Walter Reed Army Hospital when aides brought in a stack of bills for his signature. One of them was the Federal-Aid Highway Act of 1956. It called for a 41,000-mile network of interstate highways and allocated $26 billion to pay for them. The system was extended to about 48,000 miles, and the cost has been estimated at $425 billion in 2006 dollars.

The interstate highway system was one of the elements that unify the United States, Eisenhower believed. "Without them," he said in 1955, "we would be a mere alliance of many separate parts."

opening from the Communist Chinese, North Korea's patrons, and over the objections of the dictator of South Korea pushed forward an armistice. It has held until today.

Eisenhower's economics were straightforward. He balanced the U.S. budget for two years out of his eight and proposed cuts to the defense budget. He believed in a strong defense but thought that the strength of the country didn't come merely from its weaponry.

"Throughout his presidency, Eisenhower continually connected the country's security to its economic strength, underscoring that our fiscal health and our military might are equal pillars of our national defense," his granddaughter Susan Eisenhower wrote in 2011. "This meant that a responsible government would have to make hard choices. The question Eisenhower continued to pose about defense spending was clear and practical: How much is enough?"

Through the tense 1950s, Eisenhower kept the country out of nuclear and conventional war. He didn't allow the U.S. to be drawn into the Suez Crisis of 1956, and he forced Britain, France and Israel to back down from their takeover of the Suez Canal. He did land Marines in Lebanon briefly to reassure Western allies in the region.

While Eisenhower's caution kept the country out of war, his reticence on the domestic front prompted criticism. He tolerated the demagoguery of Wisconsin Sen. Joseph McCarthy and his crusade to expose Communists in the government and the entertainment industry.

And when in 1954, the Supreme Court issued its unanimous *Brown v. Board of Education* decision, which struck down the segregation of black and white children in separate schools, Eisenhower was lukewarm. Privately he disagreed with the court. Publicly he would go only so far as to say that he would "obey" the law of the land.

While he had his detractors, Eisenhower would go down in history as being an enormously popular president, with his public approval rating during his time in office averaging 65 percent.

As he prepared to leave office in 1961, 10 years before his death, Eisenhower offered some truths that may have been forgotten in the years since: that an active citizenry is necessary to preserve its freedom and prosperity, and that every bill rung up needs to be paid.

"Every gun that is made, every warship launched, every rocket fired, signifies in the final sense, a theft," he said. "The cost of one modern, heavy bomber is this: a modern, brick school in more than 30 cities."

THE DIXON DRILLER

"Published once a moon since 1932"

WINTER 2014

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PRODUCT SPOTLIGHT

Cam & Groove Fittings with King Crimp Ferrules or Sleeves

Application: transportation of liquids and dry bulk in various applications

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Product Safety

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Did you know that...

TRIVIA

The winter solstice marks the first day of winter and occurs when the sun appears at the lowest point in the sky, creating the shortest day and longest night of the year.

No two snowflakes are alike, but all snowflakes have six sides.

The record for the most snow angels at one time was set in Ontario, Canada, in 2004 when a couple of schools joined to create 15,851 snow angels.

Artificial Christmas trees have outsold real ones since 1991.

Antarctica set the record for the world's coldest temperature at -129°F.

Average snowflakes fall at 3.1 mph.

The tallest snowman was 113 feet, 7 inches tall. It was named Angus and made in Bethel, Maine, in 1999.

Electric Christmas lights were first used in 1854.

The record for the largest snowfall in a single day was set in the United States on December 4, 1913, when Georgetown, Colorado, received a staggering 63 inches of snow—more than five feet.

The popular Christmas song "Jingle Bells" was actually written for Thanksgiving. The song was composed in 1857 by James Pierpont, and was originally called "One Horse Open Sleigh."

funology.com, 22facts.com

ON THE LIGHTER SIDE

The Lone Ranger and Tonto camp in the desert, set up their tent, and fell asleep. Some hours later, the Lone Ranger wakes his faithful friend. "Tonto, look up at the sky and tell me what you see."

Tonto replies, "Me see millions of stars."

"What does that tell you?" asks the Lone Ranger.

Tonto ponders for a minute. "Astronomically speaking, it tells me that there are millions of galaxies and potentially billions of planets. Astrologically, it tells me that Saturn is in Leo. Timewise, it appears to be approximately a quarter past three. Theologically, it's evident the Lord is all-powerful and we are small and insignificant. Meteorologically, it seems we will have a beautiful day tomorrow. What it tell you, Kemo Sabe?"

The Lone Ranger is silent for a moment, then speaks. "Tonto, someone has stolen our tent."

A man rushes into the drugstore and asks the pharmacist for something guaranteed to stop hiccups. The pharmacist slowly pours a glass of water and when it is full he picks it up, screams at the top of his lungs, and throws the water in the man's face.

"Why did you do that?" the man yells angrily.

"Well, you don't have hiccups now, do you?" replies the pharmacist.

"NO!" shouts the man. "But my wife in the car still does!"

A lady lost her handbag in the bustle of Christmas shopping. It was found by an honest little boy and returned to her. Looking in her purse, she commented, "That's funny. When I lost my bag there was a $100 bill in it. Now there are 100 $1 bills." The boy quickly replied, "That's right lady. The last time I found a lady's purse, she didn't have change for a reward."

bestcleanjokes.com

Dates in History

1783: On December 23, following the signing of the Treaty of Paris, General George Washington resigned as commander in chief of the Continental Army and retired to his home at Mount Vernon, Virginia.

1903: On December 17, near Kitty Hawk, North Carolina, Orville and Wilbur Wright made the first successful flight in history of a self-propelled, heavier-than-air aircraft. Orville piloted the gasoline-powered, propeller- driven biplane, which stayed aloft for 12 seconds and covered 120 feet on its inaugural flight.

1914: Just after midnight on December 25, the majority of German and British troops engaged in World War I ceased firing their guns and artillery and commenced to sing Christmas carols.

1936: On December 11, after ruling for less than one year, Edward VIII became the first English monarch to voluntarily abdicate the throne. He chose to abdicate after the British government, public, and the Church of England condemned his decision to marry the American divorcée Wallis Warfield Simpson.

1990: Shortly after 11am on December 1, 132 feet below the English Channel, workers drilled an opening the size of a car through a wall of rock. This hole connected the two ends of an underwater tunnel linking Great Britain with the European mainland.

history.com

PARADISE
on the Adriatic

Steeped in centuries-old history, Croatia has become one of the most popular—and affordable—travel destinations in the Mediterranean region

BY BEN MUSACHIO

"THOSE who seek paradise on Earth must come to Dubrovnik!" So wrote Irish playwright George Bernard Shaw, clearly bowled over by the beauty of the historic city that sits at the southernmost part of Croatia, one of the fastest growing travel destinations in the Mediterranean region.

A boomerang-shaped country slightly smaller than West Virginia, Croatia is a vacationer's dream, rich with sun-drenched beaches, riveting history, beautiful national parks, and culinary delights—all available at a cost less than Western European neighbors Italy and France.

As the newest member of the European Union (it became the 28th member state in summer 2013), Croatia has retained its use of the *kuna*, offering a much better value for the American dollar than the euro.

Whether you're a foodie intent on hunting truffles and sampling fine regional wines, an amateur historian eager to explore Roman-era ruins, or simply an overworked career person looking to unwind over aromatic coffee in medieval-era town squares, you can indulge your passion in Croatia without breaking your wallet.

Dubrovnik: Walled Wonder

Start your trip by heading south to Dubrovnik, the "pearl of the Adriatic," filled with old monasteries and beautiful palaces. (Fly in to Dubrovnik Airport, which is only about 9.5 miles—15.5 km—from the center of the city.)

Perched atop rocky cliffs, Dubrovnik juts out into the Adriatic and basks in a warm Mediterranean climate with groves of lemon and tangerine trees, palms and agaves.

The city's historic Old Town is surrounded by fortifying white walls, their snakelike progression interrupted here and there by a turret or tower. From atop the iconic walls (which stretch for more than a mile), visitors can enjoy glorious views, and "walking the walls" has become a

Above, detail from a Franciscan monastery, Badija (Photo by Sergio Gobbo/Source: Croatian National Tourist Board)

Perched atop rocky cliffs, Dubrovnik's Old Town is surrounded by fortifying white walls.

From left: Onofrio's Fountain, built in 1438; front facade of the Rector's Palace in Dubrovnik; sword dancing in Moreška, Korčula; the view from Mljet, Soline

favorite activity for tourists. (Pack water and avoid this popular activity during the midday in July and August, when crowds and hot sun can interfere with your enjoyment.)

Back down at street level, take a stroll along the gleaming avenue Stradun, which bisects the city, an area chock full of attractions. Onofrio's Fountain, with its famous spitting faces, dates back to 1438, for instance. A popular gathering spot for the city's young people, it was built to celebrate the completion of a new waterworks, which supplied the city with water from the Dubrovnik River, some 12 kilometers away. Also constructed around the same period was the Rector's Palace, today home to treasures like paintings of old masters, period furniture and the original keys to the city gates.

In the eastern part of the city, don't miss the Dominican Monastery, a major treasury of cultural and art heritage, including Titian's polyptych and a reliquary that features withered martyrs' bones and fingers.

You can spend hours—days even—roaming through dozens of historic attractions like these, and none costs more than 15kn/$3 to enter.

Once you've developed an appetite, duck into one of Old Town's winding side streets to find a spot to eat. Authentic taverns serve an array of Croatian favorites, like *pršut* (the Croatian take on Italian prosciutto), *pašticada* (a hearty stewed beef dish typically served with gnocchi) and *crni rižot* (Croatia's version of squid ink risotto).

Ordering a delicious entrée needn't be a guessing game since menus in Dubrovnik conveniently include both English and Italian translations.

Next, it's time to shop. Contemporary clothing shops with popular Western brands are just a stone's throw away from the city's oldest market, situated in the square

***Crni rižot*, Croatia's version of squid risotto**

Source: Croatian National Tourist Board
Map of Croatia (Left): ©iStockphoto.com\FrankRamspott


Photo by Davor Rostuhar/Source: Croatian National Tourist Board


Photo by Aleksandar Gospić/ Source: Croatian National Tourist Board

of Gundulićeva Poljana, home to the statue of Dubrovnik poet Ivan Gundulić. Around this square, shoppers can find a broad variety of wares—from the summer's trendiest sunglasses to bottles of travarica, a flavored brandy indigenous to Croatia.

Hvar: Island Getaway

When Croatia achieved its independence from Yugoslavia in the early 1990s (see "An Eventful History," below), it took with it more than 1,100 islands. These are the idyllic atolls of Marco Polo and Jason and the Argonauts, so be sure your visit includes at least one island sojourn—whether it's Korčula, renowned for sword dancing, or Mljet, a forested national park.

Many consider Hvar to be the quintessential Croatian isle—a paradise of rolling hills scented by vineyards, olive groves, lavender, and rosemary. The heart of the island is the city of Hvar, which provided an important port for the Venetian Empire during the 13th to 18th centuries. Once you've parked outside the city (pedestrian-friendly Hvar Town allows no cars), make your way to the town square, among the largest and most beautiful in Croatia, where you'll find one of the oldest surviving theaters in Europe, built in 1612.

During the summer months the city comes alive with the Hvar Summer Festival, featuring an array of artists—local as well as national and

An Eventful History

Croatia has a rich, varied history shaped by a seemingly never-ending cast of former European powers. When you visit this nation of a little more than 4 million, you immediately notice the architectural and cultural influences from these foreign peoples.

The Romans expanded out toward the modern day territory of Croatia in the first century A.D. In cities like Split, you can walk among the antique Roman ruins that serve as a reminder of four centuries of Roman rule.

Later, the short-lived Kingdom of Croatia (952-1102 A.D.) was eventually coerced into a union with Hungary for the next four centuries. The Hapsburgs, the Ottomans and the Venetians each took their turn ruling over the Croats for varying lengths of time from the 1500s to the beginning of the 19th century.

After World War II, socialist Yugoslavia—composed of six republics—nationalized industries and appropriated privately owned estates. While the Croats were economically more prosperous than their Serb or Bosniak neighbors, their standard of living was sharply below that of the Italians, or any Western European populace. The death of Yugoslavia's autocratic President Josip Tito in 1980 loosened the centralized hold that Yugoslavia held on its various republics and provinces. The weakened central authority, as well as Serbian belligerence toward the Croats, incited the Croats to declare national independence in 1991.


©iStockphoto.com\Matej Kastelic

The Roman Amphitheater of Pula, Croatia

A war between Croatia and a Serb-dominated Yugoslavia ensued from 1991 to 1995. When the bloody Bosnian War subsided in 1995, Croatia began to enjoy its independence and set up free markets. Today a member of the European Union, Croatia derives much of its economic prosperity from its flourishing tourism industry.

Given Croatia's contentious history, its citizens today enjoy a strong sense of national pride. Avoid the common American mistake of referring to them as Yugoslavians, and be aware that the locals speak Croatian (which uses the Roman alphabet), not Serbo-Croatian (Serbian uses the Cyrillic alphabet).

WHEN TO VISIT

Summer (specifically July and August) is the most popular time to visit Croatia's coast and islands. If you want to avoid the crowds, consider making your trip in May, June, September or October, when temperatures remain mild, the sea is warm and hotel prices are lower. But be warned: You may find some establishments (especially those on the islands) closed and some ferry routes may be canceled or on reduced schedules.

WHERE TO STAY

Hotel rates vary considerably depending on your location and the time of year. One night in a double room at the Sheraton in central Zagreb costs $150 and up—and includes breakfast, a policy shared by nearly all hotels in Croatia.

You'll find your best bargains in private accommodations—unused rooms and apartments that owners use to generate extra income, with some as cheap as $10 a night. Book these through local tourist agencies and be sure to inspect your room before paying, since quality can vary wildly.

GETTING AROUND

FLY in to Zagreb (ZAG) or Dubrovnik (DUB), Croatia's biggest gateways. Lufthansa is the largest international carrier that serves them.

TRAINS AND BUS: While trains connect all major cities north of Split, there is no service in the south, from Split to Dubrovnik. So make the four-hour trek by bus, courtesy of Libertas Dubrovnik, which has as many as 13 buses traveling between these two cities every day.

CAR: For more flexibility, rent a car—but drive with care. Croatians are aggressive drivers, and hairpin turns demand your attention. Never talk on your cellphone while driving (it's illegal and strictly enforced).

BY WATER: If you're intent on island hopping, consider taking a public ferry (Jadrolinija is the largest ferry company with the most connections). For the greatest flexibility, consider renting a speedboat, yacht or catamaran from a local charter company.

Hvar Island

international—in performances of classical music. As you dodge the soccer-playing kids in the square, be sure not to miss the seafront Franciscan monastery. It features a century-old cypress garden and an impressive collection of Greek and Roman coins.

If you're feeling energetic, make the steep climb to the Hvar Fortress, which rests atop a densely wooded hill, providing a stunning view of the fishing harbor below. Or take a two-hour hike along Hvar's southern cliffs to the winery of Zlatan Otok. After a late lunch and a swim, you can catch a boat ride return to Hvar Town.

To remember your visit to this idyllic island, bring home a piece of lace unique to Hvar—hand-crafted by nuns from the threads of agava leaves.

Split: Roman Heritage

Leaving Hvar by catamaran or ferry, head to the bustling city of Split. Walking along the streets of the city that is home to 400,000 Croatians, you may not notice at first that you are strolling in a UNESCO-protected Roman palace from the third/fourth century.

Diocletian, emperor of Rome from 284 to 305 A.D., returned to his native Croatia after retiring and took up residence in the extravagant palace that now dominates modern day Split. The palace—with its well-preserved temples, original stone pavement and an extensive underground complex—is located directly in the city's center; more than 3,000 people live inside its ancient walls. Shops, apartments and cafes line the open-air warren of winding streets paved with beige-colored limestone.

Left: The fort overlooking Hvar Town on Hvar Island; right: The vestibule of the imperial residence of the Diocletian Palace in Split.

Aerial view of Ban Jelacic Square in Zagreb

With its weathered porticos and Corinthian columns, Split offers an ideal setting for hanging out. So head to the city's heart and soul—the Riva harbor promenade—lined with palm trees and yachts. Espresso lovers will adore the cafe at the Hotel Adriana; its outdoor seating is ideal for people watching.

After strolling the length of the promenade, a trip to the beach is a must. Just east of the city center is Žnjan Beach, a relatively quiet stretch of sea and sand that particularly appeals to families because of its wide array of kid-friendly activities—including trampolines, moon bounces, an aquazone and an electric scooter circuit.

Beyond the Coast

While the lure of coastal Croatia is nearly impossible to resist, there is also much to see and do in the north and northeastern part of the country. Zagreb, Croatia's capital and largest city, combines the best of Eastern and Western Europe, while the Dinaric Alps, which run north/south through the country, offer abundant opportunities for hiking.

Such is the difficulty of visiting Croatia with its vivid history, beautiful coastal scenery, and sophisticated European milieu: There is much to experience, but seemingly too little time to take it all in.

If you're feeling energetic, make the steep climb to the Hvar Fortress, which rests atop a densely wooded hill, providing a stunning view of the fishing harbor below.

THE JOHNSTOWN FLOOD

In one devastating afternoon in 1889, a wall of water converged on a thriving Pennsylvania steel town, killing thousands in a tragedy that could well have been avoided

BY EUGENE FINERMAN

Johnstown, Pennsylvania, was accustomed to floods. Winter's thaw and spring rains would overflow the valley creeks that converged on the town. The housing was always cheaper along the creek banks. Despite the spring swamp and its two feet of water in the streets, Johnstown in the late 1800s was booming. A mill town of 30,000 people, it produced more steel than Pittsburgh. Steel was shaping a new, dynamic America in the late 19th century. Girders for skyscrapers, rails for trains … the prospects for Johnstown seemed as expansive as America itself.

Yet, Johnstown would not be remembered as the Steel Capital of the nation but as "The American Pompeii." On May 31, 1889, Johnstown was destroyed by a flood—the greatest single-day civilian loss of life in American history until September 11, 2001.

In the Conemaugh Valley of western Pennsylvania, the creeks converge into a river that flows 60 miles to Pittsburgh. In the late 1700s, the creeks offered water for crops and transportation to markets. Where the river formed, a German immigrant named Josef Schantz founded a farming settlement in 1800 known as Schantzstadt; it was prudently Anglicized to Johnstown. But the surrounding hills promised a more lucrative future than farming. There were lodes of coal and iron, and Johnstown soon became the center of steel production. Cambria Iron Works would become the chief employer of the town. Its foundries ran day and night, six days a week. So did the workers, on 12-hour shifts. By the 1880s, the company employed 7,000 people in Johnstown, one-quarter of the population. Cambria was as much a patron as an employer. It subsidized the culture and pleasures of Johnstown: a library, two theaters and a roller rink. As for the spring floods, they were endured and dismissed as a chronic inconvenience.

The Johnstown Flood was not simply the random reminder of nature's power. The devastation and death were the consequences of human failings. Fourteen miles upstream from the city, in the hills above the valley, a neglected dam held back the waters of a man-made lake. The earthen dam dated to 1853 and originally was part of the canal system that linked Philadelphia to Pittsburgh. The South Fork Dam was an impressive undertaking: Made of rock and earth, surfaced with shale masonry,

Opposite page: Johnstown before (left) and after the devastating flood on May 31, 1889.

it was 931 feet long and 72 feet high. Ironically, as soon as the dam was completed, it was pointless. The statewide canal system was being supplanted by the faster railroads. Yet, water still pooled behind the dam, gradually eroding the earthen construction and sometimes leaking through. The damage was never alarming, however, and continued to be ignored.

Finally, in 1879, the South Fork Dam found an interested owner. The dam, along with its 450-acre lake and the surrounding 160 acres of shoreline, was purchased by the South Fork Fishing and Hunting Club. A summer retreat for the elite of Pittsburgh, the club counted as members Andrew Carnegie, Andrew Mellon and Henry C. Frick. Here, in the Appalachian foothills, these millionaires could "rough" it. Their summer cottages were somewhat smaller than their customary mansions but included piers and boating houses for their yachts. For their further rustic delight, the lake was stocked with game fish. As for the South Fork Dam, it was redesigned for a landscaped appearance. The club members wanted to look at sloping hillsides rather than utilitarian walls. And the beautified dam continued to leak.

> *"At 3 p.m., the center of the dam gave way. The flood that struck Johnstown was dark and thick with debris: the remnants of smaller towns as well as bodies—livestock and human."*

Over the years, there were complaints and warnings. The club undertook perfunctory patchwork. The mayor of Johnstown promised to pass the complaints on to the state capital. But nothing justified alarm. The spring of 1889, however, had unprecedented rainfall. At the end of May, six to 10 inches of rain fell within one day. The rainfall and the torrents from the hills were flowing into the lake at an estimated rate of 3 million gallons an hour. By the morning of May 31, the water had reached the top of the dam and was pouring over it. Worse, water was seeping through the dam's walls and under its foundation.

As the impending disaster became obvious, an employee of the club went to the nearest telegraph office to send Johnstown a warning. His telegram did not raise any real concern. After all, Johnstown was used to floods and the dam was 14 miles away. As a precaution, people were advised to go to the second floor of their homes. George Swank, the editor of the *Johnstown Tribune*, reflected the town's nonchalance about the warning, noting, "It is idle to speculate."

At 3 p.m. the center of the dam gave way. Twenty million tons of water disgorged through a 100-foot gap in the wall. Within an hour the lake was dry. The deluge was 35 feet high, racing down the valley at 40 miles an hour and scouring all in its path. The flood that struck Johnstown was dark and thick

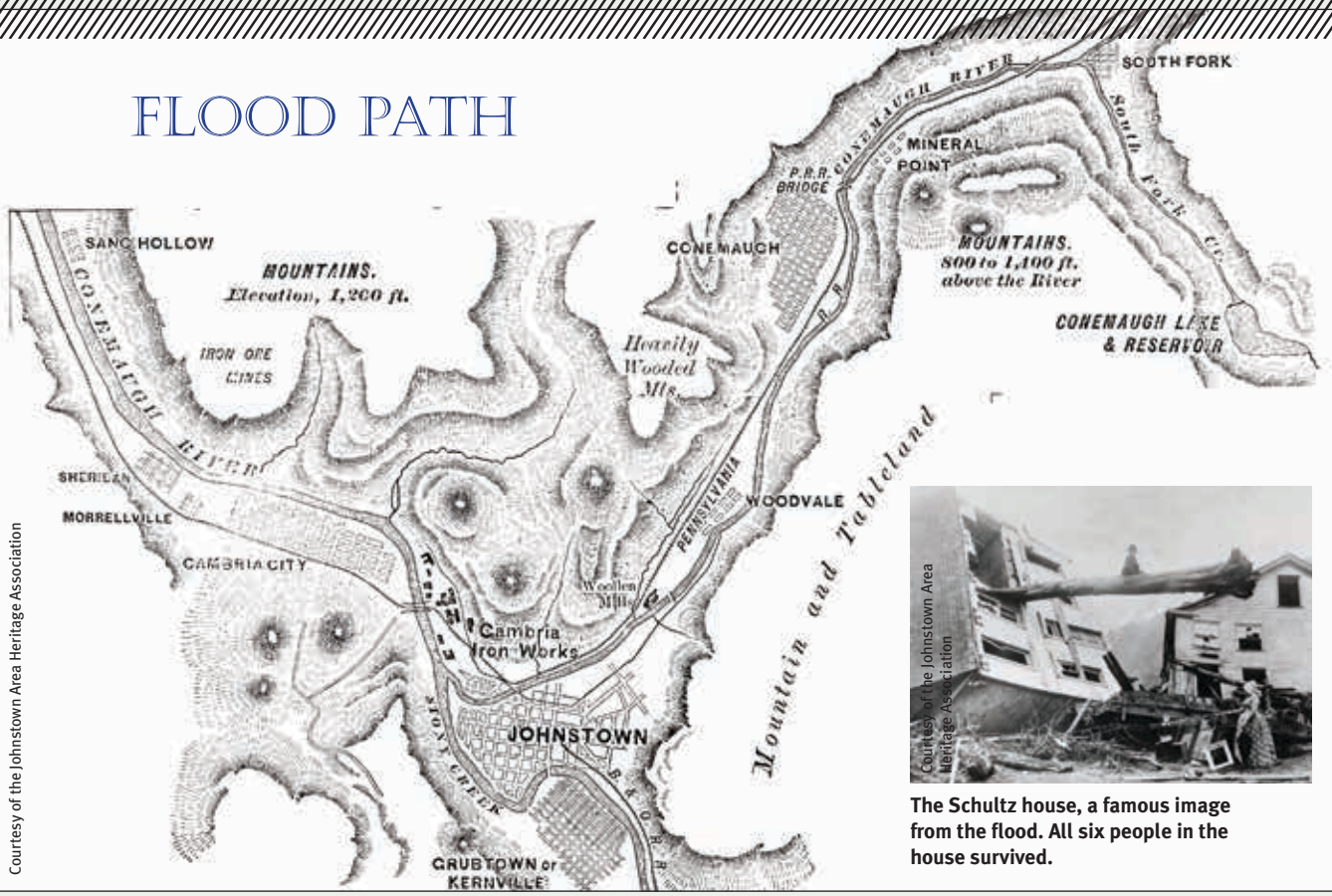
South Fork Fishing and Hunting Club, homes on the lakeshore

Courtesy of the Johnstown Area Heritage Association

Lake Conemaugh after the flood

Courtesy of the Johnstown Area Heritage Association

FLOOD PATH



Courtesy of the Johnstown Area Heritage Association

Courtesy of the Johnstown Area Heritage Association

The Schultz house, a famous image from the flood. All six people in the house survived.

> *"Of the 2,209 dead, some 700 were never identified. Families were wiped out; the dead included 396 children. Bodies were found as far away as Cincinnati."*

with debris: the remnants of smaller towns as well as bodies—livestock and human.

Johnstown was engulfed. Homes were crushed or torn off their foundations. The survivors were afloat on the wreckage. For 10 minutes the torrents submerged the city and carried much of it away. As the deluge raged west, it battered and poured through a railroad bridge, but the bridge withstood the flood and became a barrier for the debris. Wrecked homes now piled up against the bridge; the debris reached 40 feet and extended three-quarters of a mile. Within the wreckage were hundreds of trapped people. They had survived the flood, but now the debris caught fire. Their fate was worse than drowning. Many were burned beyond recognition.

Of the 2,209 dead, some 700 were never identified. Families were wiped out; the dead included 396 children. Bodies were found as far away as Cincinnati. When telegraph service was restored, a request was made for every available coffin in Pittsburgh; 50 volunteer morticians accompanied the coffins. The flood had also left 25,000 people homeless and hungry. On June 5, Clara Barton arrived in Johnstown; the founder of the American Red Cross (See *BOSS*, Fall/Winter 2012) would personally direct the distribution of supplies and the construction of shelters in the Red Cross' first major peacetime disaster relief effort. The tireless Barton was 67 years old; she would remain in Johnstown until October 24 and set a standard that the American Red Cross still strives to follow.

The governor of Pennsylvania called up the state militia—10,000 men—to assist in the cleanup of Johnstown. The Pennsylvania Railroad worked at a frantic pace for the relief of the town, rebuilding 20 miles of destroyed track in two weeks. The nation responded to the tragedy by raising $3,742,818 for

the victims ($4.4 billion today). The Cambria Iron Works vowed to rebuild its foundries; the people of Johnstown were guaranteed their livelihood. Johnstown was rebuilt. And the Johnstown Flood would take its place in American culture, the tragic inspiration for songs, art, melodramas and—eventually—movies.

The South Fork Fishing and Hunting Club denied any responsibility for Johnstown's devastation, insisting that the flood was an Act of Providence. Unfortunately, the liability laws of the time did indemnify the club. Only the original engineer of the 1853 construction was considered responsible, but he was long dead. Public outrage and political acumen would change the liability laws, so that today the club and its members would be culpable. And members of the club did personally contribute to the town's recovery. For example, Andrew Carnegie donated $10,000 for a new library. That building still stands and now houses the Johnstown Flood Museum—a place where visitors can go to learn more about the devastation that was wrought on a single dark day in American history.

WHEN IT RAINS, IT POURS

Sadly, misery revisited Johnstown in two more devastating floods during the 20th century:

Baumer Street after the 1936 flood

1936: About two dozen people died and some 77 buildings were destroyed after a flood caused by heavy runoff from melting snow and three days of rain swept through town on March 17, rising to 14 feet in some areas. The disaster became the catalyst for major federal support to restore Johnstown, and Works Progress Administration (WPA) efforts continued—in the form of new roads and bridges—even after the initial wreckage was cleared. Hoping to prevent future such devastation, President Franklin D. Roosevelt authorized the U.S. Army Corps of Engineers to channelize the rivers through town to increase their capacity.

1977: The death toll reached 85 and property damage hit the $300 million mark ($2.4 billion today) after a line of severe thunderstorms stalled over Johnstown on July 20, 1977, dumping as much as a foot of rain in some areas. Though water overflowed the channel system that had been constructed to keep Johnstown "flood-free," the disaster could have been worse: Water levels would have been 11 feet higher had the channels never been built, according to later estimates by the U.S. Army Corps of Engineers. Sadly for Johnstown, the 1977 flood was a punishing blow to the town's already fragile economy. Many downtown firms damaged in the flood never reopened and the city's population plummeted by 19 percent—from 42,221 to 34,221 between 1970 and 1980. As of 2012, the city had just 20,577 residents.

Sightseers on rooftops after the 1889 flood

Courtesy of the Johnstown Area Heritage Association

Up In (Toxic) Smoke

Cutting corners with safety can lead to disaster

> An old English saying—"penny wise and pound foolish"—continues to resonate in present day lives and professional careers. "Pennies" saved today can lead to massive "pounds" (i.e., dollars) in expenditures down the road. If we fail to see the big picture, there can be profound consequences…

A small chemical plant that specialized in the manufacture of very expensive, very toxic chemicals was going through another upper management upheaval. One new appointment in particular had left workers scratching their heads, wondering how someone with no distinguishing accomplishments at any of his previous positions had been promoted to plant manager. The workers were concerned that this mediocrity would be bad for the company—and their paychecks.

Realizing this was probably his last stop, and hearing all the remarks and innuendos when he walked through the plant, the new plant manager devised a plan to impress the owners. He decided the quickest way to increase profits was to cut costs at every opportunity. He reasoned this would get him the respect he so craved from the plant workers. He called all department heads and told them to bring him receipts for all expenditures from the past year.

The plant manager spent the next few weeks poring over each

department's expenditures and procurements no matter how big or small. He researched less expensive alternatives for products currently purchased and eliminated any expenses he felt unnecessary. With a gleam in his eye, he handed each department head a list of cost reductions and told them he expected all changes to be implemented by month's end.

The department heads felt as if they'd taken a punch to the gut, reeling with the changes they had to make. One department head felt especially dejected when he saw that the hose-testing program was totally gone. He had been instrumental in starting it and thus preventing at least a half dozen failures.

But all he and the other department heads could do was comply with their boss's wishes, keep their fingers crossed and hope for the best.

As the first anniversary of his cost savings plan approached, the plant manager was elated that the owners had requested a meeting with him later that day. Confident they would handsomely reward him for turning things around, he was gathering his report for the meeting when the evacuation alarm sounded. A hose assembly conveying the most costly, toxic product the company made had failed while loading a railcar, and in just minutes had dumped thousands of gallons on the ground. An ominous cloud of deadly fumes was forming, and the wind was taking it directly toward a small town of about 15,000 people. The worst-case scenario was about to unfold.

Knowing proper procedures and following manufacturers- and industry-established guidelines is a great way to ensure longevity of any business. The Association for Rubber Product Manufacturers has a publication, *IP-11-7 Manual for Maintenance, Inspection and Testing of Chemical Hose*, which states: "When chemical hose is used in normal bulk transfer service, it shall be visually inspected daily and hydrostatically tested every 90 days." This periodic testing allows assemblies to be removed from service before they become costly, even deadly, nightmares.

How a company goes about making a profit can make the difference between being in business for decades, even centuries—or going up in a cloud of toxic fumes.

Mind Control

Welcome to the world of thought-powered prosthetics

> More than a decade ago, a patient known only as S3 suffered a stroke that rendered her paralyzed from the brainstem down. Her arms and hands are contorted from years of disuse. Her legs and feet are strangers to her. Her agile mind and her engaging smile, however, remain as alive as ever. Both were on display recently as she took a sip of coffee from a thermos.

That she was able to drink coffee was not so remarkable. That she brought the thermos to her lips using a robotic arm under her own control, however, was nothing short of a miracle. The robotic arm was not guided by her tongue, her eyes, her nose or any other part of her physical body—but by her thoughts. Welcome to the world of neural prosthetics: thought-controlled artificial limbs.

S3 was participating in a clinical trial of the BrainGate device, and was a patient of Leigh Hochberg, MD, PhD, a critical care neurologist at Massachusetts General Hospital and associate professor of engineering at Brown University and the Providence VA Medical Center. Hochberg and Andrew Schwartz, a professor of neurobiology at the University of Pittsburgh, are among a handful of engineers, doctors and neuroscientists in the vanguard of neural prosthetics.

Schwartz recently demonstrated a human-like mechanical hand that a quadriplegic woman learned to maneuver in just two days' time. Within a few weeks, she was able to manipulate the hand with a dexterity, skill and speed almost equal to the movements of an able-bodied person.

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It has long been known that when an amputee or a paralyzed person imagines moving a limb, areas of the brain responsible for physical motion operate as if they still directed working limbs. Those impulses, however, never reach their intended targets. The nerves are disconnected or the limbs simply don't exist. Researchers in neural prosthetics are striving to record, decode and employ these electrical impulses and use them to control advanced prosthetics.

As S3's smile of delight reveals, in the act of sipping coffee lies the promise of self-sufficiency for millions. For the paralyzed, neural prosthetics might one day mean effectively leapfrogging the disconnect in their nervous systems to perform daily activities using their own, once paralyzed, limbs. Amputees can foresee new classes of lifelike prosthetic limbs controlled simply by thinking about moving a finger or a foot.

Neural prosthetics as a field is virtually brand new. It didn't exist a little more than a decade ago, but advances in technology and neuroscience have converged to the point where remarkable things are now possible.

"Three years ago, the very best prosthetic limbs were still Vietnam War–era vintage. They weren't aesthetically pleasing, and functionally they were crude," says Krishna Shenoy, a professor of electrical engineering at Stanford University and among those, like Hochberg and Schwartz, at the head of the field.

Shenoy has made strides in learning how the brain plans and executes

motion, and how to decode the brain's signals. He's helped develop new algorithms that translate those signals into movements.

> For the paralyzed, neural prosthetics might one day mean effectively leapfrogging the disconnect in their nervous systems to perform daily activities using their own limbs.

Today the connections from brain to computer to prosthetic are wired, but based upon research performed by Brown University professor of engineering Arto Nurmikko and others, eventually they will be wireless, opening the possibility that such systems will be virtually invisible. A wireless chip in the brain might send signals to a receiver on the shoulder or forearm that would control the movement of an arm and hand.

As promising as neural prosthetics are, great challenges lie ahead, Shenoy says. Chief among them is that today's prototypes remain one-directional devices. Patients can send their thoughts to the prosthetics, but the prosthetics cannot return sensory information to the patient.

"The arms can reach and the hands can grasp, but what the grasped item feels like, whether it is hot or cold and whether the grip is strong or weak, [presents] profound challenges," Shenoy says. "We still need to figure out how to get the sensory signals back into the brain."

Then, of course, there is the durability problem. Neural prosthetics will need to work reliably for years, even decades, if they are to become widespread. Today's chip performance tends to degrade over time. Meanwhile, the body's immune system does battle with the chip, which it sees as a foreign invader, though our understanding of how that affects long-term chip performance is still unclear.

Despite the hurdles ahead, researchers are resolute. After all, these challenges aren't any more formidable than those the field of neural prosthetics faced at the start. ✒

The Magic Materializer

With its additive approach, 3D printing is transforming the world of manufacturing

> The House That Chuck Built is rising in Amsterdam … very, very, very slowly. It is a 13-room canal-side dwelling that is being constructed entirely from thick plastic bricks forged on a 3D printer—a 21st-century magical materializer.

In the last few years, 3D printers have begun to revolutionize the way we manufacture objects, ranging from exoskeletons that enable paraplegics to walk to spare parts for the International Space Station.

It may not yet be "Beam me up, Scotty!" but stereolithography—as 3D printing was formally named by American engineer Charles W. "Chuck" Hull when he invented it, singlehandedly, late one night in 1983—fulfills the fantastical promise of replication-at-a-distance. It is a way to produce perfectly identical artifacts simultaneously, with error-free precision, anywhere on Earth, without the need for factories, cargo ships or trembling human hands.

In its most elementary form, a 3D printer is a home-copier-sized box that is fed what looks like thick plastic fishing line from a spool. Guiding the printer is a software program called a CAD, or computer-aided design file, which is encoded with the contours of the desired output. A printer head inside the machine melts and extrudes the plastic as a microscopically thin film that hardens immediately. Then the next layer is applied, and so on. Unlike traditional machining techniques that are "subtractive" (removing material by cutting and drilling), 3D printing is additive, allowing virtually any shape to be formed.

In the case of the 3D Printed Canal House in Holland, which is being built by DUS Architects to demonstrate the architectural potential of 3D printing, the process will continue for the next three years. The printer in use there is 20 feet tall and each "brick" it births weighs 400 pounds. But a basic 3D printer for desktop use now costs as little as $1,000 to $2,000 from manufacturers that include FlashForge, MakerBot and Cubify.

A rendering of the Canal House. Inset: the house's building blocks, forged by a 3D printer.

Plastic is only the beginning: Hundreds of compounds, chemicals and even foodstuffs already are being used as raw material in "additive manufacturing," as 3D printing sometimes is called, including ceramics, titanium and silicone. Several major corporations, including GE, Ford and Boeing, already have incorporated 3D printing into their design, prototyping and manufacturing streams.

Meanwhile, Chuck Hull, the combined Benjamin Franklin, Johannes Gutenberg and Steve Jobs of stereolithography, turned 75 last spring with no letup in his inventiveness after earning more than 60 U.S. patents. Hull is the founder and chief technology officer of 3D Systems Corp. of Rock Hill, South Carolina.

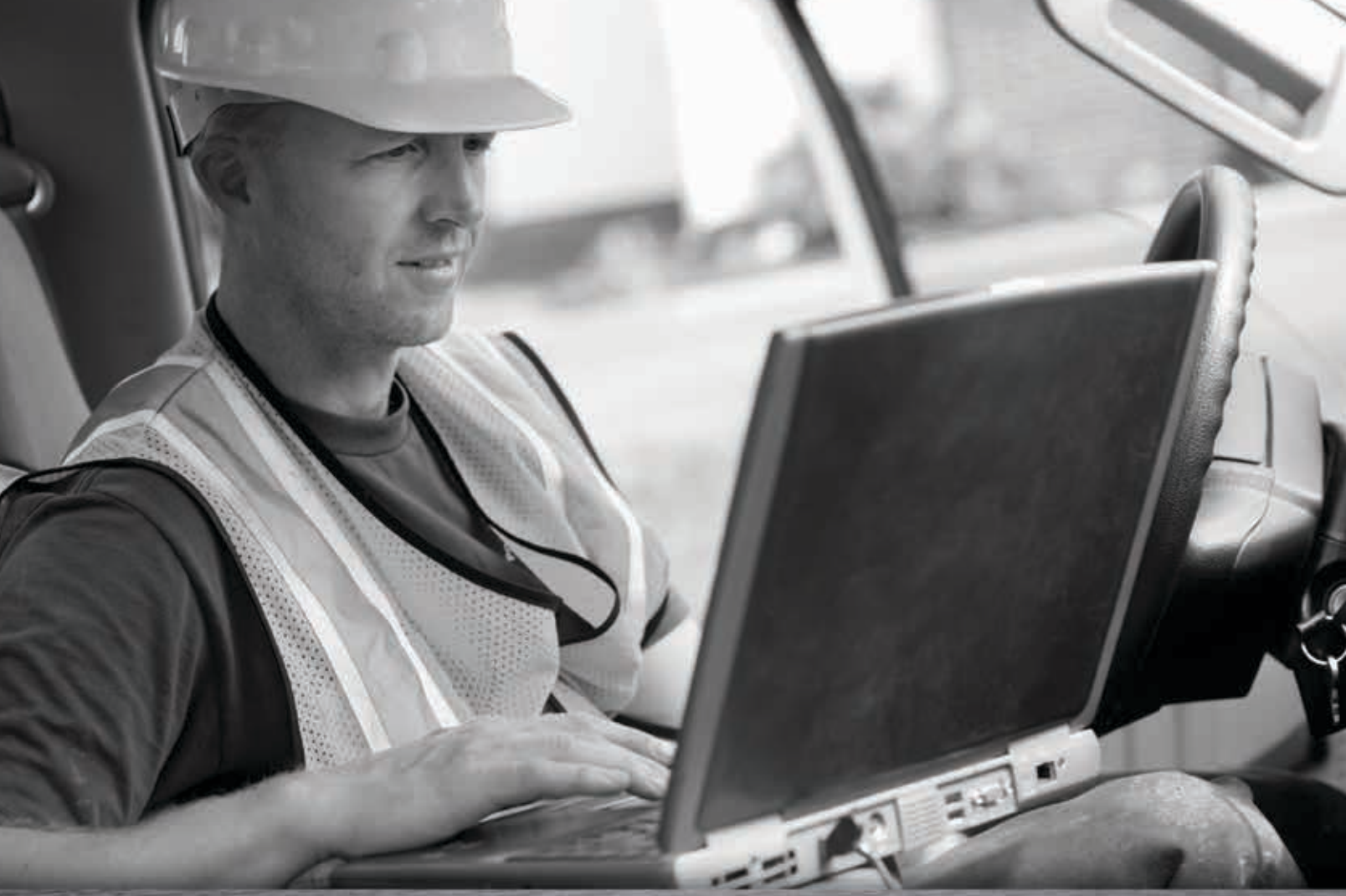
"I'm old enough that I should have retired long ago," Hull told CNN in 2013, "but it's so interesting that I don't."

Three decades ago, Hull was working for a company that used powerful ultraviolet lamps to instantly harden plastic coatings on tabletops. He noticed that, if he added layer upon layer of plastic, a three-dimensional object gradually would arise.

It was a "Eureka!" moment—and one that Hull felt moved to share with his wife, who was home sleeping soundly. "I called her up, got her out of her pajamas, told her to come down to the lab and see this," the inventor recalled, 30 years later.

"What was her reaction?" Hull was asked.

"She said, 'This had better be good.'"



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