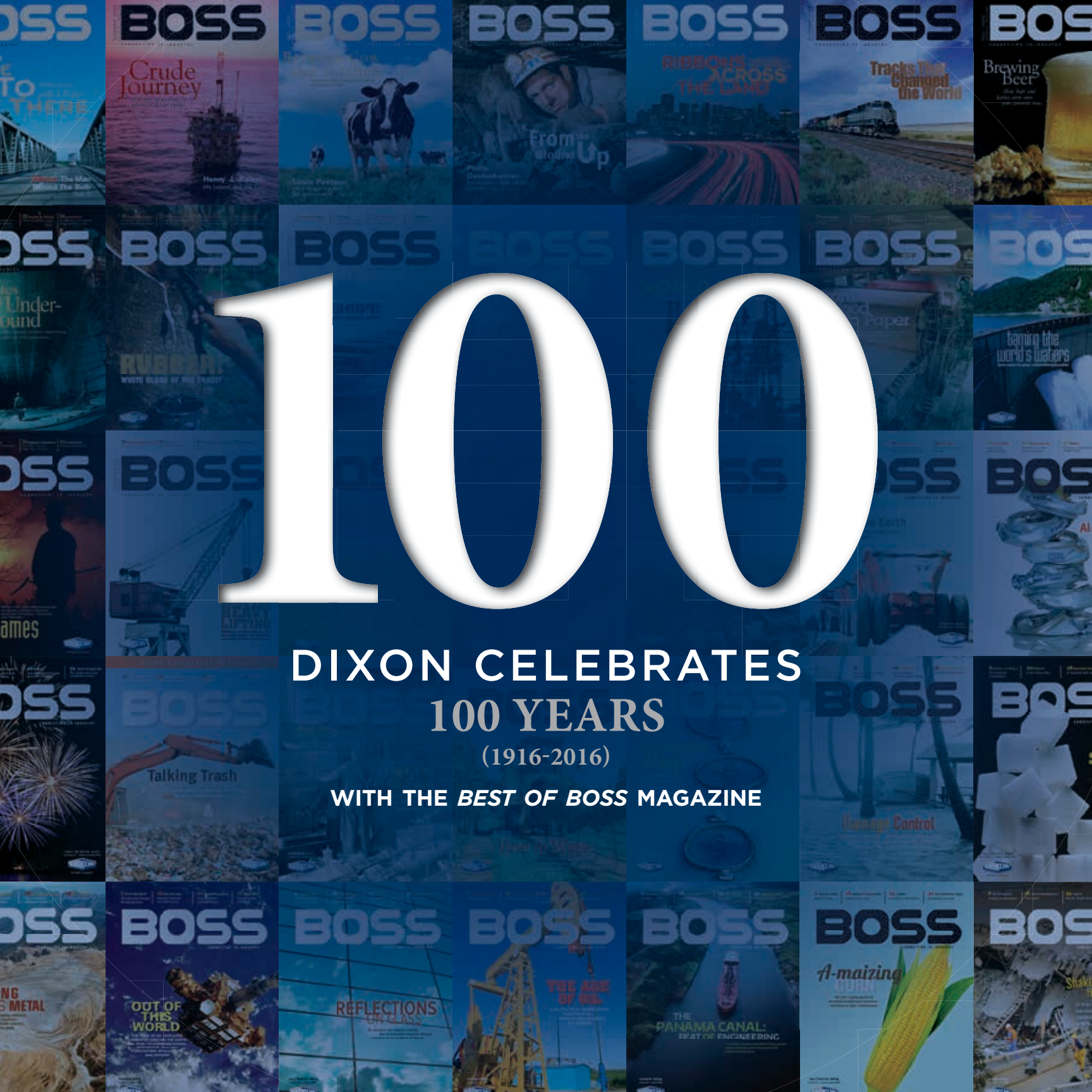
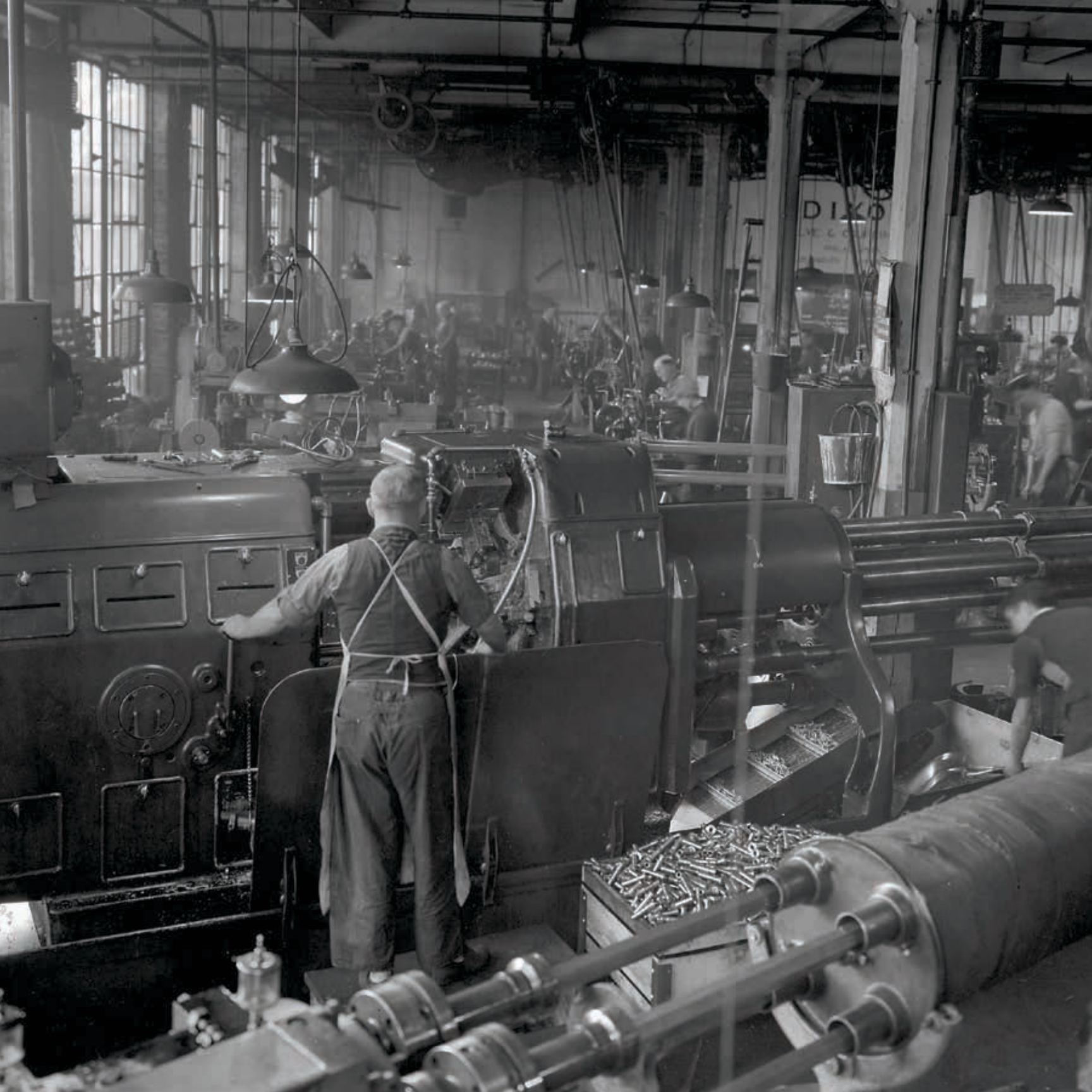


100

DIXON CELEBRATES 100 YEARS

(1916-2016)

WITH THE *BEST OF BOSS* MAGAZINE



ENDURING VALUES

A lot has changed since my grandfather, Howard W. Goodall, founded Dixon back in 1916, with only an eighth-grade education. At that time in history, a postage stamp cost just 2 cents, our nation had no commercial radio stations and women weren't allowed to vote. The average American lived to just 49, and the leading causes of death were influenza, diarrhea, pneumonia, tuberculosis, heart disease and kidney disease.

In Philadelphia, where H.W. Goodall launched Dixon Valve and Coupling Co., only 6 percent of the population owned a car, just 8 percent had a phone and only 4 percent of roads were paved.

We live in a different world today. By next year, for example, the global number of cellphone users is expected to reach a staggering 4.77 billion. And average life expectancy in the U.S. has nearly doubled and is now closer to 80 years.

While much has changed in 100 years, the foundation that is necessary for building and sustaining a successful business has not.

I am reminded here of the "Standards of Business" articulated in the 1920s by the Rice Institute—an organization my grandfather belonged to in Dixon's early years: "Honor in business insures always what is just and right. Honor can be neither bought nor sold, nor measured as a commodity. It is intangible, yet of great intrinsic value. Honor permeates every activity of concerns possessing it. It radiates the light of truth and fair dealing. It is a priceless jewel in the crown of business character."

Throughout Dixon today—from top leadership to the factory floor—we embrace and cultivate the "Six Pillars" of strong character: trustworthiness, respect, fairness, responsibility, caring and citizenship. In addition to living these values every day among co-workers and customers, dozens of Dixon employees (me included!) volunteer each week in the public schools in Chestertown, Maryland, to share the meaning of these values with local schoolchildren.

To reach a broader audience, we launched *BOSS Magazine* 10 years ago. Unlike most industry-sponsored publications that are mostly inward-looking sales tools, *BOSS* was conceived to be a general interest magazine with articles on fascinating topics in history, health, science and technology, manufacturing and more. That so many of our stories and biographies highlight men and women of strong character is no accident: Our goal with *BOSS* over the last decade has been to inspire readers by shedding light on people and events that exemplify a way of living that is, in the words of the Rice Institute, "just and right."

As we celebrate Dixon's 100th anniversary year, it seems fitting to revisit some of *BOSS*'s most impactful articles—those that reflect Dixon's core values—with a special "Best of BOSS" commemorative edition.

I hope that you will find inspiration in these pages and in the words from the Rice Institute that continue to inform our approach to business as we look to our next century:

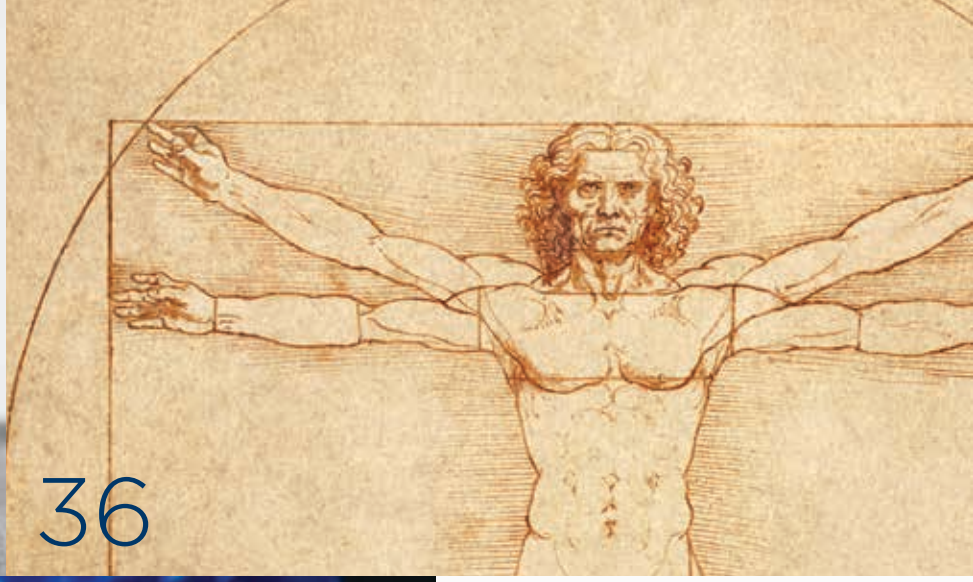
"The character of a good man inspires faith in him. His example shines like a lantern guiding the footsteps of those who would walk in the path of honor and fair dealing. Such a man, in the pattern of his life, unconsciously sets a standard by which others, also desiring to live rightly, may measure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

"A manufacturer whose character and reputation measure to the highest standard has an inspiring influence upon all who know him. … 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."

Thank you for 100 years!

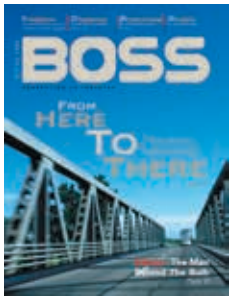
R L Goodall

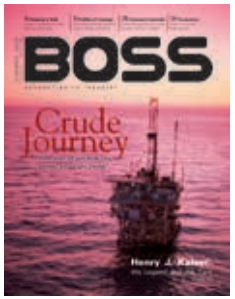
CONTENTS

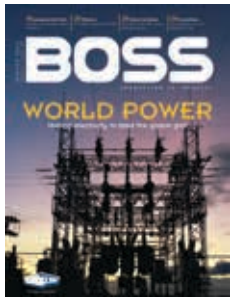


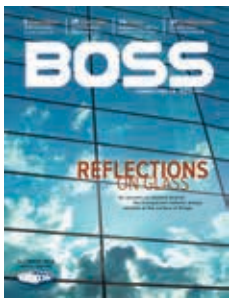
BOSS

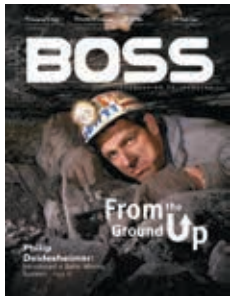
CONNECTING TO INDUSTRY

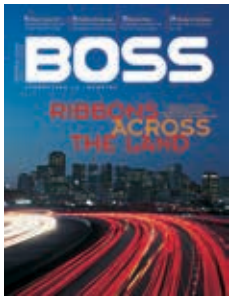


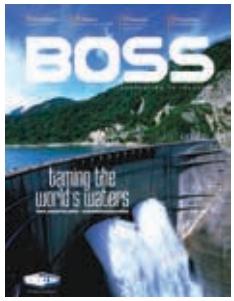


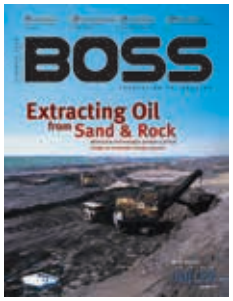












DIXON

The Right Connection®

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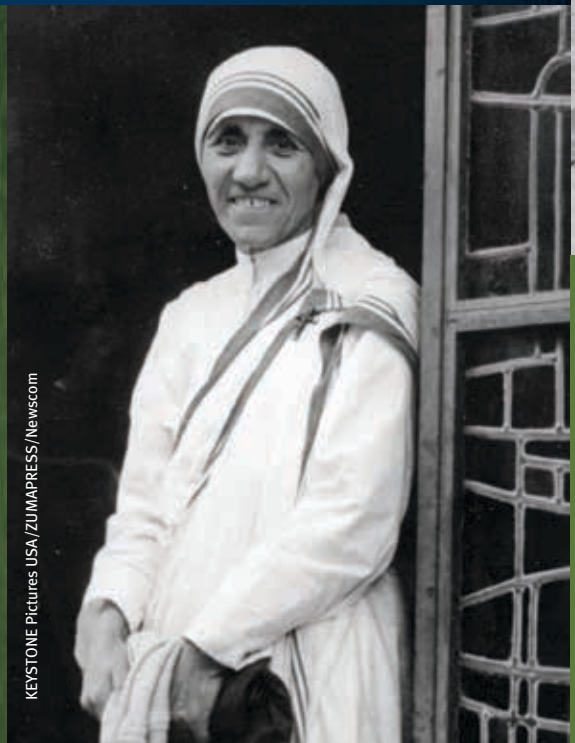
Courtesy of The Library of Congress



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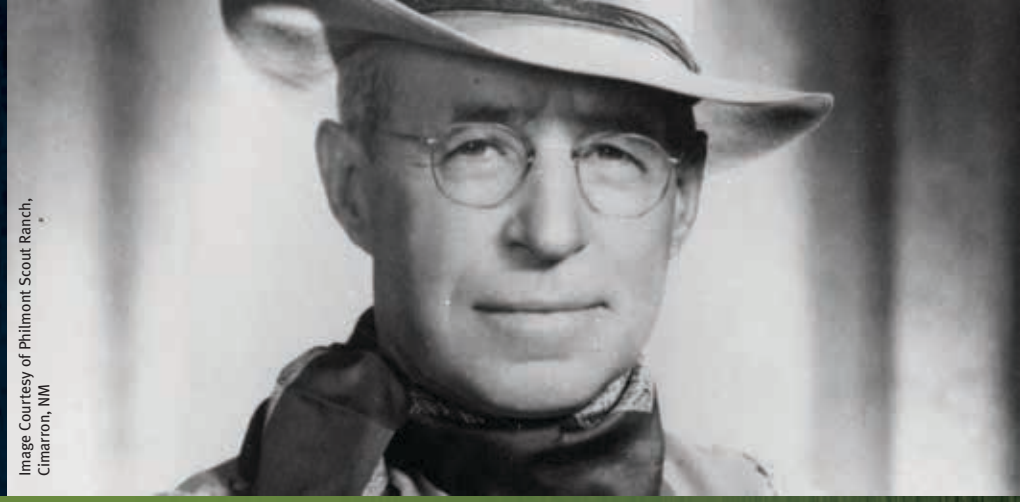
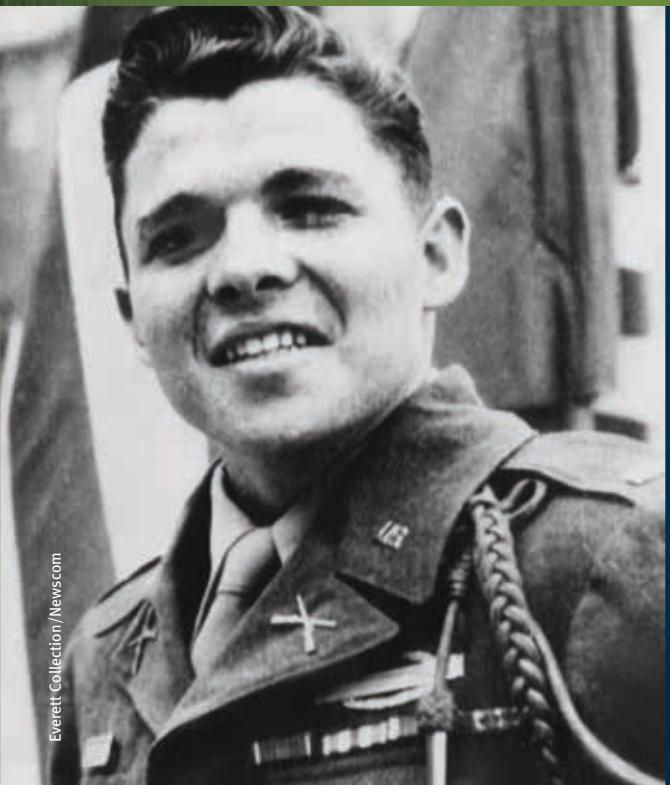


Image Courtesy of Philmont Scout Ranch, Cimarron, NM

"The greatest homage we can pay to truth is to use it."

—*Ralph Waldo Emerson*



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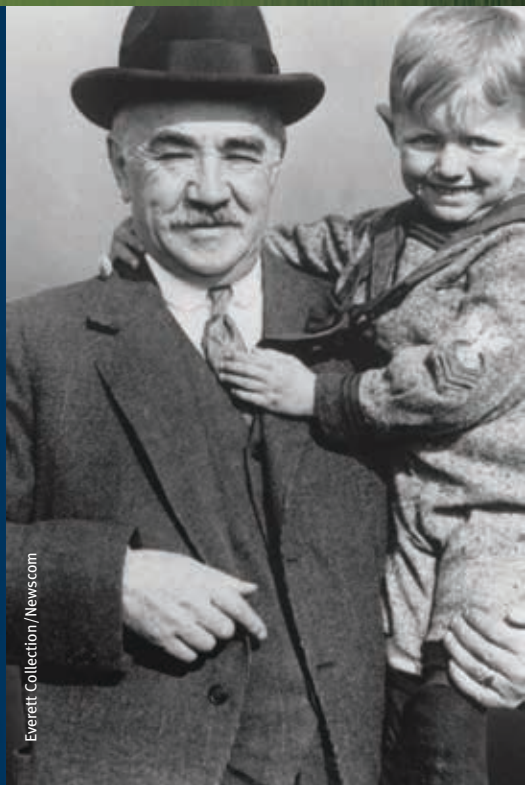

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"FAST EDDIE"

Racecar driver, flying ace, CEO … no matter what adventure he undertook, Eddie Rickenbacker sped through life at full throttle

BY BEN MUSACHIO

On an October day in 1942, delirious ramblings filled the air as seven Americans clung desperately to three life rafts in the Pacific Ocean. They had been floating in placid blue waters for more than three weeks, after the B-17 they'd been flying in had been forced into an emergency landing. Several in the group had been injured, and all were crisped brown by the relentless South Asian sun.

As the unofficial leader of the group, Eddie Rickenbacker, 52, tried to ensure that the others in the unfortunate band didn't panic or worse, drown themselves to escape the misery of starvation and dehydration.

Fortunately, Rickenbacker was no stranger to crashes: He had nearly died a year earlier in a domestic plane crash outside Atlanta and had survived countless fiery automobile wrecks during his years racing cars. "No one living has cheated the old grim reaper oftener than I have," Rickenbacker had famously uttered.

But this time, the storied racecar driver, World War I fighter pilot ace, and air transportation pioneer didn't know how he was going to get out alive …

A NEED FOR SPEED

Born on October 8, 1890, in Columbus, Ohio, to German-speaking Swiss parents, Eddie was christened Edward Rickenbacher. (The anglicization of his name would come later.) Even at an early age, he had an uncanny knack for getting hurt. Among a long list of injuries, the young daredevil sustained a nasty knock to the head from his mother's gardening hoe, survived a botched tonsillectomy and got his foot stuck in railroad tracks after leaping from a moving car.

After his father died in 1904, Eddie dropped out of school at 13 to support his family. Times were tough and

his desperate mother needed all the help she could get in feeding her seven children. The youngster shifted from job to job, eventually settling into an entry-level position at a machine shop for the Pennsylvania Railroad. Before long, he proudly presented his mother with a weekly check of $5 (about $137 today).

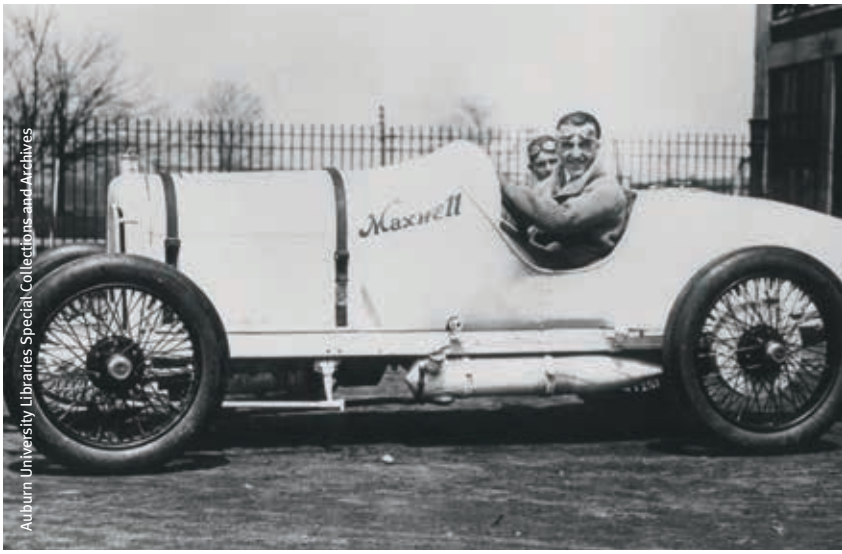
In his spare time, Eddie was drawn to the exciting new world of automobiles. His first car ride—in an early two-seater Ford Runabout that jounced around at a snail-like 10 mph—left an indelible impression. "He never forgot the thrill," noted biographer W. David Lewis in *Eddie Rickenbacker: An American Hero in the Twentieth Century.*

Eddie's talent for solving technical problems, as well as his diligent after-hours study of basic mechanics, led to a position at the Frayer Miller Aircooled Car Company around 1905. The company supplied cars for national auto races, and before long "Fast Eddie" was a regular on the auto racing circuit.

Early automobile racing was not for the faint of heart. Drivers risked life and limb as they raced their specially designed vehicles around tracks of variable quality. Rickenbacker himself crashed during one of his first races in Red Oak, Iowa. He was thrown from his car "with great violence" and "was seriously bruised and cut up about the face," according to an automotive racing reporter on the scene at the time.

Nevertheless, Fast Eddie became "one of the most successful racecar drivers of the day. He earned an average of $40,000 a year (nearly $1 million today) while racing in four Indianapolis 500s and setting a world record of 134 mph at Daytona Beach, Florida.

"You didn't win races because you had more guts. You won because you knew how to take the turns and baby your engine. It wasn't all just shut your eyes and grit your teeth," he said, in explaining the considerable skill required to achieve at such a high level during that era.



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Eddie Rickenbacker in the driver's seat of a Maxwell Special racecar. Riding mechanic Burt Brown is in the passenger seat.

In assessing his racing legacy, *Motor Age* designated Rickenbacker as "unquestionably … one of the greatest American drivers."

ADVENTURES IN THE AIR

Rickenbacker hung up his racing gloves in 1917 for a new brand of adventure: throttling through the air at more than a hundred miles an hour, evading and gunning down German pilots.

Americans during the Great War (1914-1918) had a strong distaste for everything German and the surname Rickenbacher didn't win Eddie any favors. So he replaced the "h" with a "k" ("to take the Hun out of it") when he set out to become a fighter pilot. His relatively old age (27 years in 1917) made acceptance into flight training a bit of a long shot. But

> *"You didn't win races because you had more guts. You won because you knew how to take the turns and baby your engine. It wasn't all just shut your eyes and grit your teeth."*
>
> —Eddie Rickenbacker


National Museum of the U.S. Air Force

Eddie Rickenbacker with his SPAD S.XIII.

Rickenbacker was used to betting—and winning—on long odds. Colonel Billy Mitchell of the U.S. Army Air Service was so impressed with Rickenbacker's mechanical prowess as a car repairman that he personally arranged his training in the flight school at Issoudun, in the center of France.

Rickenbacker had a tough time at first. He didn't get on well with the other, generally younger and more rigorously educated pilots-to-be. After he graduated from flight training, his strong mechanical skills actually impeded his high-flying aspirations: He was commissioned as an engineering officer.

Eventually, however, Rickenbacker was permitted to join a brand new fighter unit, the 94th Aero Squadron, informally known as the "Hat-in-the-Ring" squadron, owing to their colorful insignia.

On April 29, 1918, he made his first hit in the air, above Beaumont, when he downed a German Pfalz in his Nieuport 28. "At 150 yards I pressed my triggers. The tracer bullets cut a streak of living fire into the rear of the Pfalz' tail. … I had brought down my first enemy aeroplane and had not been subjected to a single shot!" he recounted in his autobiography *Fighting the Flying Circus*.

On May 28, just two months after donning his flight jacket, Eddie earned the widely coveted "Ace" status when he outmaneuvered and outshot two German planes in a span of a few hours to raise his kill count to five, the minimum required to receive the Ace moniker.

Before long, American engineers devised deadlier aerial capabilities in the form of the SPAD S.XIII—a fighter plane that featured awe-inspiring firepower and thick armor. The entire 94th Aero Squadron adopted this new model of warplane to great success. Rickenbacker was particularly taken with the SPAD. Over a three-month period, he bested one German pilot after another, including those in the infamous "Flying Circus" Squadron commanded by the "Red Baron," Manfred von Richthofen.

Rickenbacker took no great pleasure in the killing. "Fighting in the air is not sport, it is scientific murder," he would tell anyone who asked.

By the time the smoke cleared and the war ended on November 11, 1918, Rickenbacker had earned 26 "scores"—the highest of any American fighter pilot. He left the service with the rank of captain and a long list of military awards and accolades to his credit. (He would belatedly be awarded the Medal of Honor by President Herbert Hoover in 1931.)

Rickenbacker had also earned the undying respect of the men he led as commander of the 94th Squadron, largely due to his self-described leadership style: "[I] would never ask anybody to do anything that I would not do myself first," he said, "or do at the same time."

GETTING DOWN TO BUSINESS

After the war, Rickenbacker met and married Adelaide Frost Durant, a moneyed Michigan socialite, and the two enjoyed an expensive European honeymoon. Rickenbacker had become a sweetheart with the media and everywhere the newlyweds went, adoring reporters and photographers surrounded them. *Fighting the Flying Circus*, published in 1919, proved a hit with the American public, and Rickenbacker was frequently called upon to give speeches and lectures.

Throughout the Roaring Twenties, as the couple built their family by adopting two sons—David Edward in 1925 and William Frost in 1928—Eddie turned his attention toward the world of business.

For nearly 24 days, Rickenbacker and his compatriots drifted in rubber rafts as bloodthirsty sharks circled. As one day melted into another, the courageous band survived off of rainwater, the occasional fish and a seagull.

Rickenbacker was an innovator. And with his first company, Rickenbacker Motors, he sought to bring racecar technologies into the consumer auto industry by introducing four-wheel braking. Feeling threatened, his competitors (who relied on two-wheel braking) put out a series of advertisements alerting the consumer to the "dangers" of Rickenbacker's braking system. Their campaign worked and sales were dismal: Rickenbacker stepped down from his failing company in September 1926. Ironically, four-wheel brakes would go on to become the industry standard.

Undeterred by that business failure—and the quarter-million-dollar debt he incurred as a result ($3.2 million today)—Rickenbacker purchased the Indianapolis Motor Speedway in 1927. To get the money he needed for the purchase, he hit the road, hawking LaSalles to car dealerships in 75 different cities over the course of 81 days. Once the speedway was his, he went on to modernize it through the introduction of banked curves and other amenities.

He next turned his attention back to the sky, signing on in 1935 to lead the day-to-day operations of Eastern Air Lines. Through his sound business management, what started as a small mail carrier evolved into a commercial airline company that had a near monopoly on domestic airmail routes, particularly in the American South. Ever the innovator, he oversaw radical changes that impacted the entire commercial airline industry, in part by supporting the development of new, faster airliners, including the four-engined Lockheed Constellation and the Douglas DC-4.

As war began brewing again in Europe, Rickenbacker took a break from the business world to serve his country—this time in a more senior and non-military role. Secretary of War Henry L. Stimson dispatched him to various Allied bases to measure their preparedness and give the troops a well-deserved lift. He visited Allied troops in Hawaii, England, Egypt, and even in the Soviet Union, where he was

Eddie Rickenbacker (second from left) with a group of officers from the 94th Aero Squadron at an aerodrome in France.

hopeful that capitalism (Rickenbacker's favored economic system) would eventually win out.

It was on one of these trips, on October 21, 1942, that the B-17 he was riding in ran out of fuel after overshooting its destination and made a crash landing into the Pacific.

For nearly 24 days, Rickenbacker and his compatriots drifted in rubber rafts as bloodthirsty sharks circled. As one day melted into another, the courageous band survived off of rainwater, the occasional fish and a seagull.

Used to being in charge, Rickenbacker assumed informal command of the group, reportedly saving one comrade from an ill-conceived suicide attempt.

Miraculously, after more than three weeks at sea, the men were rescued when two low-flying Navy planes spotted them floating below—only Rickenbacker had the energy to wave at the pilots overhead. Of the original seven, six survived the trying ordeal. Stories celebrating Rickenbacker's rescue as "a national Christmas present" dominated American newspapers, pushing wartime news about the Pacific campaign to page two.

Rickenbacker at his desk in his Eastern Air Lines office in New York City, talking with news photographers after his rescue from the Pacific.

Auburn University Libraries Special Collections and Archives

"All of America is glad to see the 'Indestructible Eddie' return," noted Army Major General Barney M. Giles, in an autographed photograph of the period.

A LIFE WELL LIVED

When World War II ended, Rickenbacker was at the peak of his popularity. He resumed his business duties as CEO of Eastern Airlines, and over the next decade or so he led it to become the most profitable post-war airline.

His stint as CEO ended in 1959, after a failed merger attempt with American Airlines as well as some business decisions (including his sale of 100,000 shares of Eastern stock—a vote of no confidence in the company's future) that proved unpopular with Eastern's board of directors.

Throughout the 1960s and 1970s, ever the adventurer, Rickenbacker traveled the world with his wife, to far-flung locales including Japan, New Zealand and Nairobi.

Eddie Rickenbacker died on July 30, 1973, of pneumonia, during a trip to Zurich, Switzerland. He was a few months shy of his 83rd birthday. The quintessential American hero was interred in the Green Lawn Cemetery in Columbus, Ohio, not too far from his childhood home.

Summarizing Rickenbacker's wildly varied life of adventure is difficult, but his biographer David Lewis may have done it best: "He was a man of valor who knew that courage could not exist in the absence of fear, the eternal warrior who intuitively realized that a life well lived is not a state of existence for the timid but a combat zone."

► ***"Fast Eddie"*** **appeared in the Spring 2015 issue of *BOSS*.**

G. LOIE GROSSMAN/KRT/Newscom

Keystone Pictures USA/ZUMAPRESS.com

Mother Teresa, the recipient of the Nobel Peace Prize, being greeted by school children on arrival at Palam Airport in New Delhi on November 9, 1979.

SAINT ON EARTH

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

BY MARIA BLACKBURN

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

Tim Graham/robertharding/Newscom

> *Her greatness [lay] in her ability to give without counting the cost, to give until it hurts."*
>
> —Pope John Paul II

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 street outside a hospital and could not convince the hospital to take the woman in, she established a home

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.

The hands of Mother Teresa bring comfort and security to an orphaned baby in 1979.

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.

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."

► ***Saint on Earth*** **appeared in the Fall/Winter 2014 issue of** ***BOSS.***

HIS FINEST HOUR

Winston Churchill championed the civilized world when it counted most

BY LISA DE NIKE

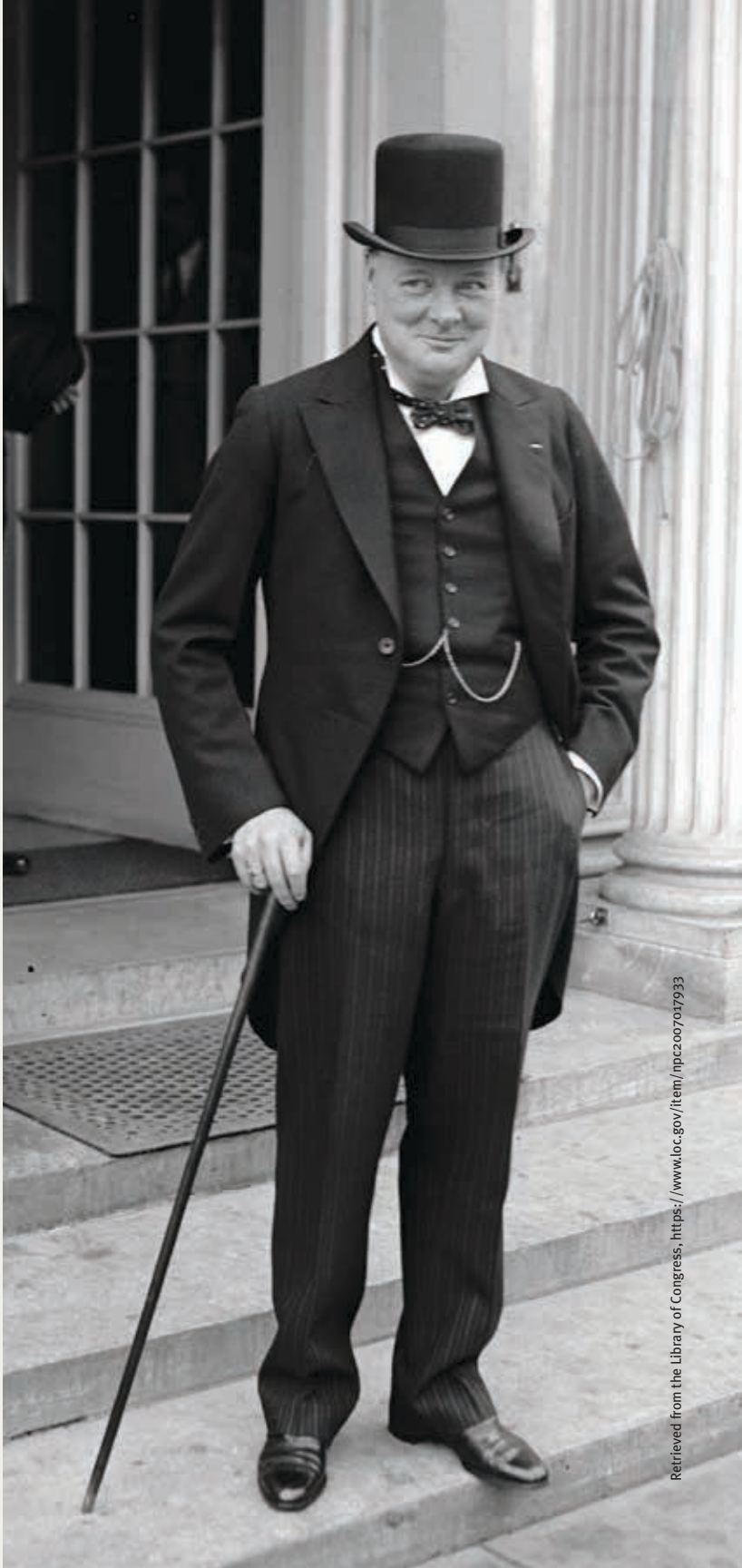
Winston Churchill's courageous and visionary leadership as prime minister of England during World War II guided the Allies to victory against fascism and terror. Indeed, historians agree that without Churchill's guidance, the world would be very different today.

Those who knew Sir Winston Churchill during his childhood and adolescence likely never predicted that the troublesome child afflicted with a speech impediment would someday become one of history's greatest figures. He was born prematurely on Nov. 30, 1874, eight months after the marriage of his parents, Tory politician Lord Randolph Churchill and Jennie Jerome, the beautiful daughter of New York businessman Leonard W. Jerome.

Churchill did poorly in the early years of his schooling, but despite early challenges, he eventually excelled in the study of history and English and became the Harrow School's fencing champion before graduating in 1893 and entering the Royal Military College at Sandhurst.

Upon graduation, he entered the British army as a cavalry officer. Over the next few years, he saw action in three campaigns: the North-West Frontier campaign in India in 1897 and the Spanish-Cuban conflict and the Sudan campaign in 1898. This is also when Churchill began what would become an illustrious, lifelong career as a writer and wordsmith, serving as a war correspondent for a number of London newspapers.

His writing career began with reports from his time as a soldier at war and eventually included a novel, two biographies, as well as a four-volume history of World War I and a set of memoirs from World War II. In addition, after he retired, Churchill wrote a *History of the English-Speaking Peoples* in four volumes, and his lectures have survived in *The Dawn of Liberation*, *The Unrelenting Struggle*, *Victory* and dozens of other volumes.



Retrieved from the Library of Congress, https://www.loc.gov/item/npc2007017933

In 1953, his historical writings won him literature's top honor: a Nobel Prize. The committee wrote that Churchill was being honored "for his mastery of historical and biographical description as well as for brilliant oratory in defending exalted human values."

Many historians, in fact, contend that it was Churchill's love of words—cultivated as he stood in front of a mirror and battled speech problems in the early years—that catapulted him onto the world stage years later. This love manifested itself in speeches (including his famous "We Shall Fight on the Beaches" and "This Was Their Finest Hour" addresses, both given before the House of Commons in June 1940) that are considered masterpieces of oratory. (The full text of his most famous speaches can be found at www.winstonchurchill.org.)

Churchill's career in politics began in 1901 when he entered Parliament at the age of 26. Nine years later, he became home secretary (the country's top security official) and a year after that, first lord of the admiralty, a position that gave him responsibility for the command of the royal navy.

Though he was credited with encouraging the development of naval aviation and of tanks, he also was blamed for what historians considered "a heroic failure": the 1915 deployment of the British navy and army to the Mediterranean to outflank the Germans at the Gallipoli Peninsula in Turkey. Though initial attacks were successful, the Turks proved to be fiercer enemies than Churchill had anticipated. On March 18, 1915, three British battleships were sunk and three more were crippled. Overall, the campaign was a disaster, with more than 200,000 Allied casualties. As a result, Churchill resigned in disgrace.

Though Churchill did occupy several other governmental positions between World War I and World War II, his real return to prominence began on September 3, 1939, the day that Britain declared war on Germany and the day that Prime Minister Lord Neville Chamberlain again appointed Churchill first lord of the admiralty and a member of the war cabinet. Historians assert that the force of Churchill's strong personality and original ideas began immediately to resonate throughout the Chamberlain administration.

Indeed, as far back as the mid-1930s, it was Churchill who had loudly declared that Adolf Hitler posed a serious threat to world peace, and that no government should make deals with the Third Reich and its despots.

So when Chamberlain (who did broker deals with the Nazis) lost the confidence of his people in 1940, Churchill became the obvious replacement. He inherited a perilous situation, with France soundly defeated and England under constant German air attack.

Still, Churchill stood strong. Instead of accepting Hitler's offer of peace in exchange for surrender, Churchill organized the successful air defense that led to victory at the Battle of Britain. Many say that America's entry into World War II marked the culmination of Churchill's leadership, with the prime minister undoubtedly exalting in the success of the D-Day invasion in 1944.

Though there is no doubt that Churchill's unwavering leadership and inspiring words held his country—indeed, the civilized world—together against its common enemy during World War II, he lost the 1945 general election to the Labor Party's Clement Attlee and retired from public life temporarily. Unable to resist the lure of political life, however, he again resumed the premiership in 1951 and governed for four years. He remained a member of Parliament until 1964, when he did not seek re-election. He died just one year later, at age 90.

Churchill is clearly one of history's great men—a person who found his own "finest hour" during one of modern history's most challenging times.

In 1921, Winston Churchill was sent to the Middle East as colonial secretary, charged with making a new and more just settlement after World War I. Here he stands with T.E. Lawrence (Lawrence of Arabia) and the Emir Abdullah of Transjordan (later king of Jordan).

► ***His Finest Hour*** **appeared in the Spring 2008 issue of** ***BOSS.***

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Image Courtesy of Philmont Scout Ranch, Cimarron, NM

OIL BARON WITH A HEART

Hardworking Waite Phillips believed in sharing the wealth

BY MARIA BLACKBURN

Waite Phillips was an oil baron and businessman whose success in the oil fields of Oklahoma and prowess as a real estate investor made him a millionaire many times over. Phillips was good at making money. But he was even better at giving it away.

Phillips' philanthropic efforts included such acts of generosity as giving his 127,000-acre New Mexico ranch to the Boy Scouts of America, donating his elaborate 72-room

Left: Waite Phillips donated most of the land that is now Philmont Scout Ranch to the Boy Scouts of America.

Italianate mansion and 22 acres of lavish gardens to the city of Tulsa for an art museum and supporting a variety of civic, educational and humanitarian causes ranging from Catholic hospitals to community centers. He enjoyed hunting for money more than he did holding it, and so he made sharing his earnings with others one of his greatest priorities.

"The only things we keep are those we give away," Phillips said once. "All things should be put to their best possible use."

Phillips was born on a 40-acre farm outside of Conway, Iowa, on Jan. 19, 1883. One of 10 children born to Lucinda and Lewis Phillips, Waite admitted he had "restless feet" and at the age of 16 he left home with his identical twin, Wiate, to explore the West. They traveled by freight train, working here and there as they went. Three years into their journey, Wiate had appendicitis and died in Spokane, Wash. Waite was devastated. "That was a terrible loss for my dad," Elliott "Chope" Phillips said in a "Voices of Oklahoma" oral history interview in 2009. "They were almost like the same person. They thought alike and they were just inseparable."

Waite worked a few different jobs before taking a bookkeeping job with his brothers Frank and L.E., who would go on to found Phillips Petroleum in 1917. He worked for his brothers for 11 years, learning the oil business from the ground up, first as a roustabout and then as a field superintendent. In 1909, he married Genevieve Elliott, a banker's daughter. Then in 1914 at the age of 31, Waite decided to withdraw from his brothers' oil interests in Oklahoma and go out on his own. Frank, who was as strong-willed as his younger brother, wasn't happy with the decision. "We Phillipses just can't get along with each other when it comes to business," he said.

Waite Phillips didn't strike it big at first in the oil fields, but his persistence and hard work paid off and within a few years he built up a fully integrated oil company that combined production, refining and marketing. By the time he was 38, his wells were producing 40,000 barrels a day.

Phillips maintained that he was lucky, but luck wasn't the sole reason for his success. He worked six days a week and believed in buying leases everywhere there might be oil. If he struck it rich, he shared the wealth with his employees. "There is greater honor in being the best ditch digger in a gang than in being a mediocre president of a company, because the first man has done something by means of his own efforts, while the latter is content to let the dignity of his position bear him along," he is quoted as saying in *Oil Man: The Story of Frank Phillips and the Birth of Phillips Petroleum by Michael Wallis* (St. Martin's Griffin, 1988).

The entrance sign at Philmont Boy Scout Ranch.

> *"There is greater honor in being the best ditch digger in a gang than in being a mediocre president of a company."* —Waite Phillips

In 1925, he sold the Waite Phillips Co. for $25 million cash ($311 million today), and by the next year, 43-year-old Waite was worth $40 million (nearly $500 million today). He turned his attention to investing in stocks and bonds, real estate investing and ranching. He bought a sprawling ranch in the mountains of New Mexico and named it Philmont; he loved to go there and fish and relax. In 1927 he built Philbrook, his grand mansion in Tulsa with marble floors and elaborate gardens. Humorist Will Rogers upon entering Philbrook's great hall remarked, "Well, I've seen Buckingham Palace, but it hasn't anything on Waite Phillips' house."

Baldy Mountain at Philmont Boy Scout Ranch.

The oil baron proved to be as smart in philanthropy as he was in businesses. When he donated his Tulsa mansion to the city and his New Mexico ranch to the Boy Scouts of America, he included office buildings as part of the gifts to provide income that would help support the properties and allow them to be shared with visitors for years to come.

"He thought that money should be used as a tool to help people, help society, help something," Chope Phillips said of his father, who died in 1964 at the age of 81. "And if you aren't going to put it to good use, then you shouldn't have it."

► ***Oil Baron with a Heart*** **appeared in the Fall 2011 issue of *BOSS*.**

Patrick Lynch/ image courtesy of Philmont Scout Ranch, Cimarron, NM

AMERICAN HERO

Youth and size proved small obstacles for Audie Murphy

BY SUE DE PASQUALE

At 5-foot-5 and 112 pounds, he was too short to join the Marines, and the paratroopers wouldn't take him either. So "Baby Face" Murphy, the sharecropper's son from Texas, signed on with the Army (lying about his age in the process). His heroic exploits over the next three years—while serving in Sicily and France—would become the stuff of legends and earn him the distinction of being the most decorated U.S. combat soldier in World War II.

By the time the war ended, months before his 21st birthday, Audie Leon Murphy had fought in nine major campaigns across the European theater, been wounded three times, and earned 28 awards and decorations, including the Medal of Honor—the highest U.S. military award for bravery.

The famous one-man stand that earned the diminutive Murphy that honor unfolded on an icy wooded field near Holtzwihr, France, on January 26, 1945. Stubbornly intent on "holding the road" against approaching German infantry, Murphy ordered his men back to cover before advancing to climb atop a burning tank destroyer. With his map and field phone in hand, he directed artillery while spraying the advancing Germans with fire from the tank's .50-caliber machine gun. At one point, when the officer on the other end

Those familiar with the events report that Murphy single-handedly killed 50 to 100 opposing infantrymen that frigid January day.

Horace Abrahams/Keystone/Getty Images

A. Y. Owen/The LIFE Images Collection/Getty Images

Closeup of the Medal of Honor awarded to Audie Murphy during World War II.

of the line asked how close the enemy had advanced, Murphy reportedly replied, "If you'll just hold the phone, I'll let you talk to one of [them]."

After more than an hour, the Germans retreated. Murphy got down from the tank, which exploded in flames soon afterward, and led his men on a successful counterattack. Accounts differ, but those familiar with the events report that Murphy single-handedly killed 50 to 100 opposing infantrymen that frigid January day.

After the war, Audie Murphy's storied battlefield heroics —and, undoubtedly, his good looks—landed him a spot on the cover of *Life* magazine, prompting actor James Cagney to invite him to Hollywood in the fall of 1945. The young Texan struggled at first but eventually signed a contract with Universal-International, where he starred in 26 films over the next 15 years. His best-known performance was in *To Hell and Back*, the 1955 blockbuster based on his autobiography of the same name. It held the record as Universal's highest grossing movie until *Jaws* in 1975.

Though he'd been forced to drop out of school to care for his siblings, Murphy had a knack with the written word. As a songwriter (hits included "Shutters and Boards" and "When the Wind Blows in Chicago") he teamed up with composers including Jimmy Bryant and Coy Ziegler to produce works for dozens of great performers, including Dean Martin, Eddy Arnold, Charley Pride and Roy Clark.

Despite the financial success of his work (it's estimated that his films alone earned him close to $3 million), Murphy had trouble holding on to his money. He was a gambler, who bet on the horses and loved a poker game. It was

Everett Collection/Newscom

Audie Murphy, pictured here in June 1945, was the most decorated U.S. combat soldier in World War II.

UNIVERSAL PICTURES / Album/Newscom

'THE MELODY WAS FREEDOM'

Audie Murphy returned to France in 1948 at the invitation of the French government. During a visit to a local school, he was overwhelmed with emotion when a group of schoolchildren sang for him. "The spirit of freedom was hovering over that play yard as it did all over France at that time," he later recalled. "A country was free again. A people had recovered their independence and their children were grateful. They were singing in French, but the melody was freedom and any American could understand that. America, at that moment, never meant more to me."

while scouting out a business opportunity that Audie Murphy died at age 46. The private plane he was traveling in crashed into a mountain near Roanoke, Va., on May 28, 1971, killing all aboard.

Audie Murphy's death came at a time when he was lobbying the government to provide more funding for Post-Traumatic Stress Disorder to veterans of the Korean and Vietnam wars. Murphy himself was plagued by recollections of battlefield horrors throughout his life.

Today, this American hero's grave—a simple, white, government-issue tombstone—is among the most visited grave sites at Arlington National Cemetery (after John F. Kennedy's and the Tomb of the Unknown Soldier). The small white slab provides room to list only a few of Audie Murphy's many military decorations, prompting Arlington's historians to note: "The stone is, as he was, too small."

► ***American Hero*** **appeared in the Spring 2006 issue of** ***BOSS.***

Audie Murphy in *The Kid From Texas*.

THE CHOCOLATE MAN

Milton S. Hershey's vision was far grander than great-tasting candy

BY SUE DE PASQUALE

In a cavernous hall at the World's Columbian Exposition of 1893 in Chicago, Milton S. Hershey stood transfixed. Planners of the exposition, which celebrated the 400th anniversary of Columbus' discovery of America, had pulled out all the stops, erecting a "White City" of gleaming alabaster marble buildings. It was here that millions of visitors from all over the world would get their first taste of Cracker Jack and Pabst beer, their first ride on a Ferris wheel, and the rollicking experience of attending Buffalo Bill's Wild West Show.

But Hershey was drawn to the Palace of Mechanic Arts, where J.M. Lehmann of Dresden, Germany, had erected a small factory that transformed raw cocoa beans into chocolate bars. At 36, the soft-spoken Hershey had built a highly successful caramel company in his native Lancaster, Pa. But now, intoxicated by the rich smell of cocoa, and the mesmerizing rolling, mixing, squeezing and molding that turned beans into delicious candy bars, Hershey decided to change the course of his confectionery zeal.

"The caramel business is a fad," he would say later. "But chocolate is something we will always have."

Hershey ordered every last piece of Lehmann's equipment, and when the exposition ended on Oct. 30, the machinery was all loaded up on a train and shipped to Lancaster, where Hershey established a small chocolate-making factory.

During the next decade, the slightly built man with the bushy mustache and the unflagging work ethic would create a brand that would make his name synonymous—all over the country and eventually around the world—with delicious, affordable milk chocolate.

But Milton S. Hershey's vision was far grander than great-tasting candy. In the rolling rural hills of Lebanon Valley, Pa., he dreamed of creating a company town where factory workers and their families could own homes and live happily on tree-lined streets, with parks, good schools and cultural

Hershey Community Archives

Hershey's first big success came with the Lancaster Caramel Company.

attractions. His dream included a place where orphaned boys could find comfort, education and the stability he had dearly craved as a child.

Today, more than a century after M.S. Hershey first began carving out streets and building homes and factory buildings, the "great American place" that he envisioned continues to flourish as idyllic Hershey, Pa.—"Chocolatetown, U.S.A."

Born on Sept. 13, 1857, Milton Snavely Hershey spent much of his young childhood on the move, as his father, Henry, chased one moneymaking venture after another. Eloquent, well-dressed and a dreamer, Henry Hershey was sure that he, and by extension his son, was destined "to do big things."

Veronica "Fanny" Snavely was her husband's opposite. Short, hard-working and practical, from a Mennonite family with means, she was at first smitten by Henry and his grand plans. But it wasn't long before she grew resentful of his get-rich-quick schemes that never panned out. Time and again, the Snavely family would swoop in to provide financial rescue. When Milton's little sister Sarena died from scarlet fever at age 4, Fanny rejected Henry for good (though the two never officially divorced). Milton, who attended seven different schools, was never a good student; he quit school at age 12. He was briefly apprenticed to a local printer but after purposely dropping his hat in the printing press, he was let go.

Fanny eventually moved with Milton to a small house in Lancaster, where the 15-year-old took on his first paying job: at Royer's Ice Cream Parlor and Garden. Just half a block from City Hall, it was a popular spot for pretty girls, ambitious men and famous visitors.

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"I have always worked hard, lived rather simply, and tried to give every man a square deal." —Milton S. Hershey

The "modern office building" of the Hershey Chocolate Corp., ca. 1936—windowless, air-conditioned and indirectly lighted.

It was here, at the side of Joseph C. Royer, that Milton first developed his passion for making candy, pleasing customers and doing honest business, notes biographer Michael D'Antonio in *Hershey*.

At 19, Milton was ready to go off on his own, and the 1876 Centennial Exposition in Philadelphia served as the perfect launching point. More than 180,000 people would visit the exposition and many would find their way to M.S. Hershey's Spring Garden Confectionery Works, just blocks away. His soft chewy caramels made with milk were an immediate hit.

Despite a promising start, business eventually went badly, due to slow payments from wholesale customers and tight credit from his main sugar supplier. Milton dismantled the business and spent a few years traveling with his father and working at candy businesses in Denver and Chicago before returning east to open a candy shop in New York City. This venture also failed—primarily because Henry had persuaded his son to invest in making and selling cough drops. The project sent Milton into debt and eventually drove him out of business.

Finally, at age 28 and back in Lancaster, Milton found success. By adding more milk to his caramels, he created a creamy candy that wouldn't stick to the teeth. Locals bought the candy up, and a British importer passing through town placed an order for a huge shipment. Working night and day with his mother, aunt and others, Milton filled the order,

shipped it off to London and then held his breath. The check from the importer arrived just days before the bank was to foreclose on Milton's bank note. "When I opened my mail and saw that, I just went round in circles," he would later say.

Over the next five years, Lancaster Caramel Co. would see tremendous growth. Hershey might well have ridden the caramel train to riches—were it not for that fateful trip to the Columbian Exposition.

At 40, despite his business success, M.S. Hershey longed for a soul mate. In 1897, while passing through Jamestown, N.Y., on business, he found her. Catherine Sweeney, 25, was the daughter of Irish Catholic immigrants. Witty and flirtatious, "Kitty" captured his heart immediately and the two began a long-distance courtship. Within a year, Milton brought her home to Lancaster as his wife. Kitty shared her husband's Progressive ideals and encouraged him over the next few years as he sold his caramel business for $1 million (worth $26 million today) to finance his dream for "Chocolatetown."

Hershey might well have ridden the caramel train to riches—were it not for that fateful trip to the Columbian Exposition.

Milton chose an isolated area in Derry Church, Pa., surrounded by dairy farms and close to railway lines. He hired an architect to create the town grid, and soon began laying trolley lines and building homes and the chocolate factory.

There was only one problem. Hershey had not yet perfected the process for mass-producing tasty milk chocolate with a shelf life; the chocolate he sold locally turned rancid quickly, limiting how far it could be shipped.

It would be a race against time. Even as the factory walls went up, Hershey and his team sequestered themselves on his homestead, experimenting 16 hours a day to find the right formula. One breakthrough came when they switched to using skim milk from local Holsteins, reducing spoilage. Then came

Left: a street light at the corner of East Chocolate Avenue and Cocoa Avenue in downtown Hershey. Right: Large candy characters crown the entrance to Chocolate World in Hershey, Pa.

Andre Jenny Stock Connection Worldwide/Newscom

©Stockphoto.com\Terry Wilson

Everett Collection/Newscom

Hershey Community Archives

Left: Hershey holds young Robert Shaeffer who attended his industrial school, 1923. Above: Students posing on the steps of the homestead at the Industrial School.

the big break: On his first day in Hershey's employ, chemist John Schmalbach introduced the idea of using liquid condensed milk. Hershey had the winning recipe he so vitally needed.

In June 1905, Hershey opened his expansive new plant—18 buildings, with six acres of floor space. The factory utilized an assembly line approach (similar to that made famous by Hershey's friend Henry Ford) and efficiently moved supplies and products by spurs that connected to nearby railroad lines. Hershey had found the formula for producing high-quality chocolate at low cost: Americans could afford a five-cent candy bar and Hershey's chocolate bars flew off the shelves. In the factory's first year, net sales of Hershey's chocolate topped $1 million.

Meanwhile, Hershey's factory town (officially named "Hershey" in 1906) flourished from the start. Hershey encouraged homeownership. His Hershey Trust offered terms that made it easy for workers to afford their slice of the American dream. And Hershey didn't skimp on small-town amenities. He provided a public library, a gymnasium, golf courses, company-sponsored sports teams—even a 150-acre park with a band shell, a zoo and a sprawling swimming pool. Because all of these amenities were subsidized by Hershey's company, residents enjoyed property taxes that were half that of other American cities.

Hershey's financial success allowed him to build a stately mansion, where he enjoyed relaxing with Kitty. But the

Hershey encouraged homeownership. His Hershey Trust offered terms that made it easy for workers to afford their slice of the American dream.

couple's loving marriage was marred by a sad reality. The youthful Kitty suffered from a debilitating illness (today, writes D'Antonio, believed to be advanced syphilis) that left her increasingly weak and unable to bear children.

So, at age 53, Milton Hershey created the family he and Kitty could never have, by establishing a home for orphan boys on the hill overlooking town. The Hershey Industrial School, which included a series of small cottages overseen by married couples, was aimed at preparing needy, wayward boys for jobs in industry or agriculture. Discipline was strict, but Milton was a frequent and benevolent presence.

On Nov. 13, 1918, Milton secretly placed all the Hershey Chocolate Co.'s stock into a trust to benefit the industrial school, effectively ensuring his legacy. The stock at the time was worth more than $60 million ($855 million today). Coca-Cola would be sold a year later by its founder for $25 million ($310 million today). The move was an unusual one, since it effectively made the school the majority owner of a wildly successful company and all its enterprises—including Hershey's amusement park, factories and a department store.

The trust effectively solved the problem of what would happen to his fortune, notes biographer D'Antonio. In Hershey's words: "I never could see what happiness a rich man gets from contemplating a life of acquisition only, with a cold and legal distribution of his wealth after he passes away. After all, what good is one's money unless one uses it for the good of the community and humanity in general?"

Milton Hershey would live to 88, outliving by decades his beloved Kitty, who died in 1915. In the years after her death, Milton turned to Cuba, where he replicated his Pennsylvania utopia with a sugar factory, railway, town and school near Havana.

The Hershey Chocolate Co. survived the world sugar crisis of 1921 and the Great Depression, and flourished during World War II, when Hershey's chocolate became a staple of U.S. troops' rations.

Milton S. Hershey succumbed to pneumonia on Oct. 13, 1945. Some 10,000 people came to pay homage.

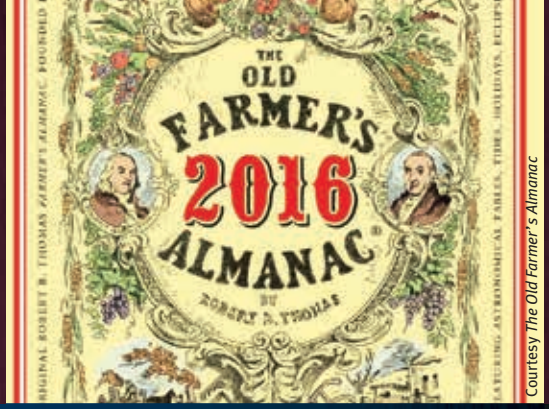
Today, Hershey's "Chocolatetown" remains a tranquil spot for its 13,000 residents. Hersheypark, popular for its roller coasters and other rides, draws millions of visitors a year. And the Milton Hershey School, now a co-ed boarding school for needy children of all backgrounds, serves 1,800 students. With a staggering $6 billion in assets, it is one of the wealthiest schools in the world.

Like the milk chocolate that financed his vision, Milton S. Hershey's legacy is surely a sweet one.

Hershey product packaging, 1925–1950.

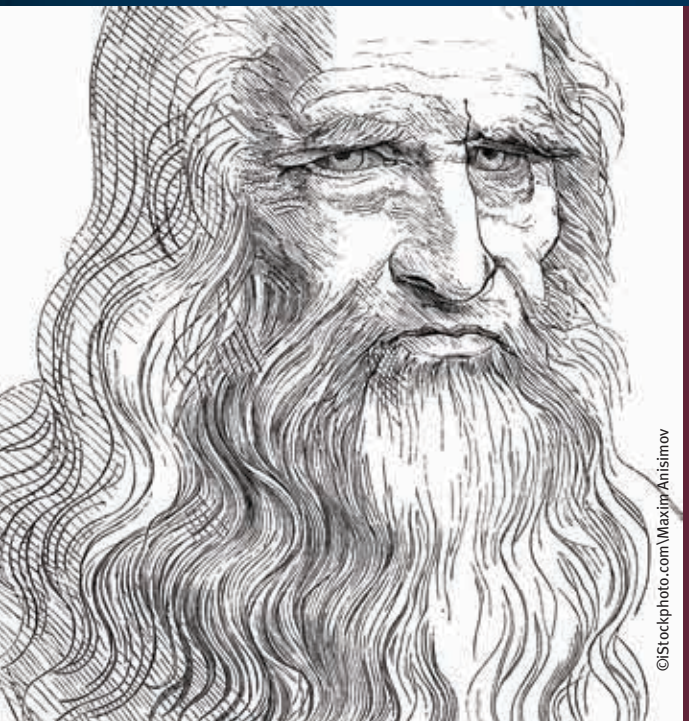
Hershey Community Archives

► ***The Chocolate Man*** **appeared in the Fall/Winter 2010 issue of *BOSS*.**



Courtesy *The Old Farmer's Almanac*

BUILDING KNOWLEDGE



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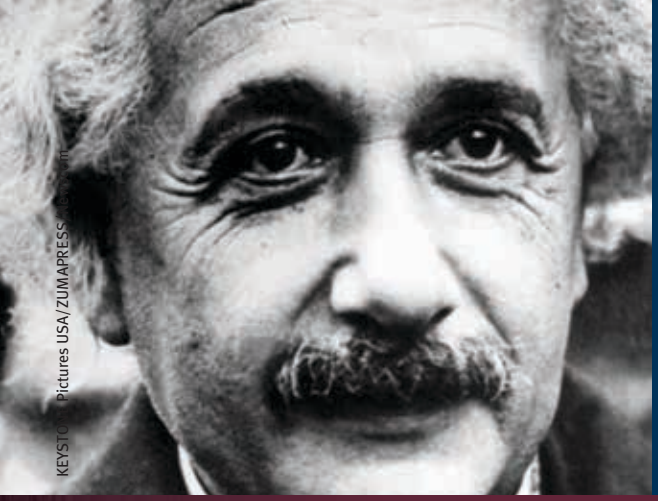
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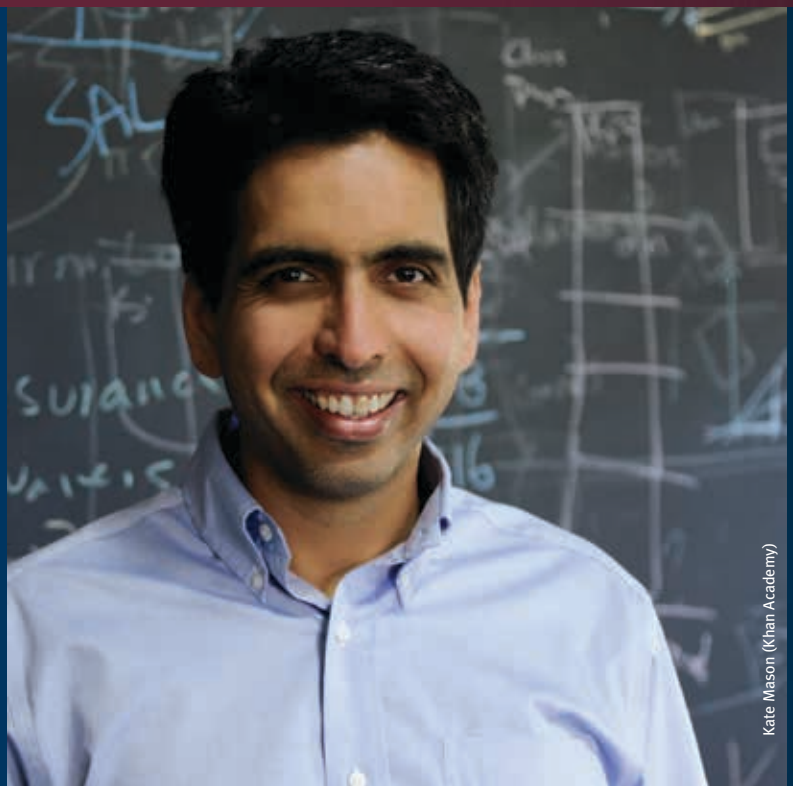
> *Once you stop learning, you start dying.*
>
> —*Albert Einstein*


Kate Mason (Khan Academy)

CENTURIES AHEAD OF HIS TIME

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

BY KRISTI BIRCH

akg-images akg images/Newscom

1452–1519. "Apostle Peter." Drawing. Da Vinci sketched a great deal before painting. A sketch for "The Last Supper" is thought to be a self-portrait.

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

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

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

©iStockphoto.com/Vaara

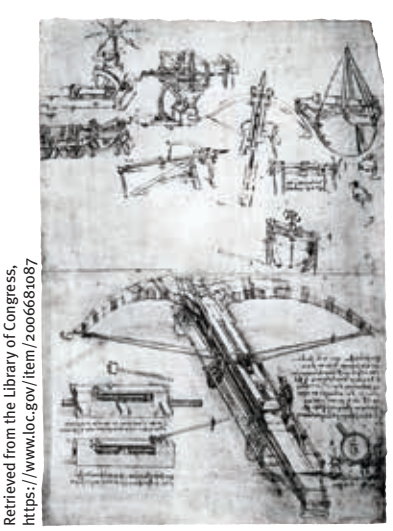
Not bad for the illegitimate son of a notary, Ser Piero, and a peasant girl named Caterina. Leonardo da Vinci was born in 1452 near the town of Vinci outside Florence, Italy. Because he was born out of wedlock, he did not inherit his father's surname—"da Vinci" means "of Vinci"—and he always signed his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

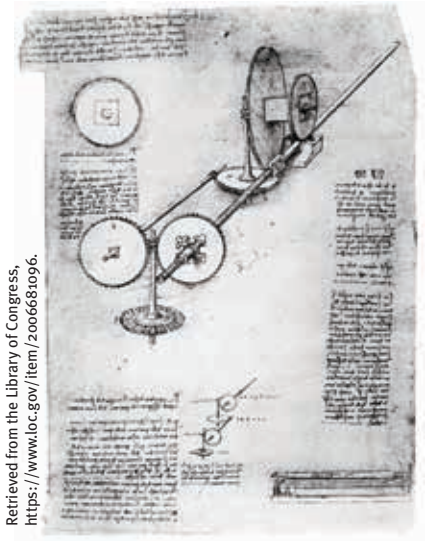
At the age of 14, when he demonstrated a talent for drawing and design, his father apprenticed da Vinci to the workshop of the renowned painter and sculptor Andrea del Verrocchio in Florence. The artists Verrocchio employed were considered craftsmen, producing dowry chests, christening platters, small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

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

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

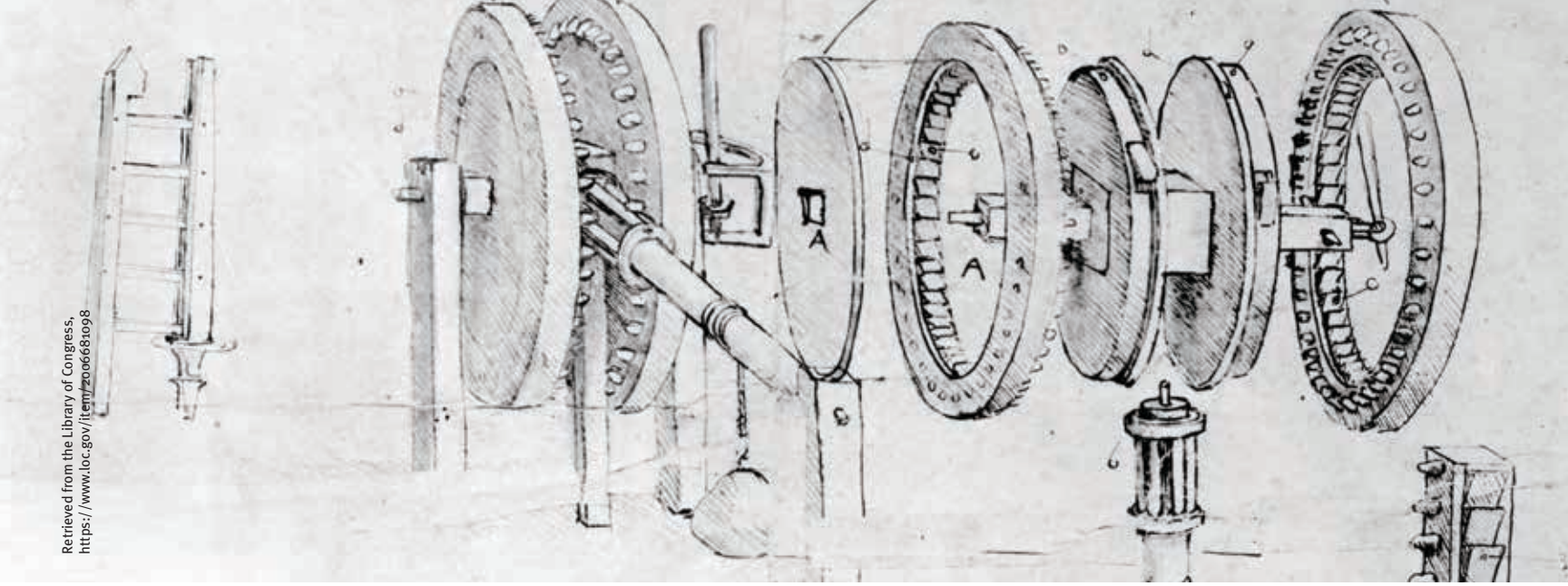
In 1483, da Vinci moved to Milan to work for Duke Ludovico Sforza and his family. When he applied for Sforza's patronage, da Vinci stressed his engineering knowledge as much as his artistic talent. He had drawn designs for submarines, catapults, armored tanks and various weapons. The designs were impressive, although they could not be





Da Vinci was a diligent note taker, producing some 4,000 pages of notes of every kind. Above: Reproduction of pages from his notebook, drawings of a giant crossbow and operation of a mechanical wing.

Da Vinci had a particular interest in locomotion, especially flight. He studied the movement of birds' wings and tails and tried to apply those principles to his many designs for flying machines.



Reproduction of a page from his notebook showing a geared device assembled and disassembled.

realized because, as with most of his other inventions, the technology at the time was simply too crude to execute his often-detailed drawings. During his 17 years under the duke's patronage, not only did da Vinci paint and sculpt, but he also supervised the making of cannons, prepared floats and pageants for special occasions, and designed a dome for the Milan Cathedral and a heating system for the duchess' bath.

THE MASTER OF INVENTION

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

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

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

PERFECTING HIS ART

As a man of the Renaissance, da Vinci was obsessed with the natural world. He remained passionate about his anatomical studies and made detailed drawings of the heart and the brain based on the cadavers he dissected, which he did even after the bodies began to decompose. He wanted the natural world to be apparent in his art, and was determined to create realistic images that showed depth and distance and human expressions, unlike flat medieval paintings. He did this exquisitely in "The Last Supper," finished in 1498 when he was 46. Painted on the back wall of the dining hall in a convent in Milan, it depicts the last meal Jesus shared with his disciples,

in particular the moment when Jesus declares that one of the disciples will betray him. What makes the painting a departure from earlier works is that the disciples are portrayed as real people, with identifiable emotions.

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

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

INNOVATOR UNTIL THE END

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

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

The *Mona Lisa*, considered da Vinci's masterpiece.

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

► ***Centuries Ahead of His Time*** **appeared in the Winter 2008 issue of *BOSS*.**

Images courtesy *The Old Farmer's Almanac*

The *Old Farmer's Almanac* covers from 1793, 1851, 1988 and 2016 reveal evolution in design but not in content.

THE OLD FARMER'S ALMANAC

An essential tool to the early American family

BY EUGENE FINERMAN

A typical 19th-century American farm required only one comprehensive reference book: an almanac. Seemingly a library in itself, within its pages were a calendar, weather forecasts, agricultural reports, recipes, essays, tales, poems and humor. It was said that a Bible addressing the hereafter, and an almanac highlighting the here and now, offered all the information a person might ever need.

Published annually since 1792, *The Old Farmer's Almanac* is the oldest continuing periodical in North America. In rural 19th-century America, the book provided farms with news from the outside world, including current events, innovations and fashions. The coronation of a young English queen named Victoria was of minor interest, but the development of a steel

plow was genuine news. Women on the farm might never see a bustle or a whalebone corset, but at least the almanac kept them informed of the latest fashions. Today, *The Old Farmer's Almanac* is not the primary source of news, but 18 million readers still find it a handy and enjoyable reference.

Although the almanac was a staple in early American life, its origins date back to antiquity and to the pagan beliefs in the zodiac. Observing the skies, one could see a relation between the movement of the stars and the changing seasons.

Ancient man later concluded that the movement of the stars could predict the future in addition to determining weather patterns. In the second century, a Greek scientist named Ptolemy wrote a table correlating the alignment of the stars with corresponding events on Earth, which could be regarded as the first almanac.

Moorish scientists in 11th-century Spain then applied their mathematical precision to astrology. Their efforts produced new astrological tables—and gave us the world almanac. "Al manakh" is Arabic for the reckoning or calendar. Written in 1088, the almanac gave the daily positions of the heavenly bodies—with a corresponding mix of scientific and astrological interpretation. It was a scholarly work and not for popular consumption. A Latin translation was soon available and inspired a renewed enthusiasm for astrology in Christian Europe.

The church regarded astrology and its predictions as relics of paganism, but tolerated its study so long as astrologers conceded that God moved the stars.

By the 14th century, Europe was experiencing the first promise of the Renaissance and the newly founded universities—at Padua, Bologna, Paris and Oxford—all had professors of astrology, who published their studies as almanacs.

Despite the almanac's intended academic audiences, the advent of the printing press in 1453 would introduce it to the general public. The first almanac was printed in 1457 by Johannes Gutenberg himself. Since the public was not fluent in Latin, almanacs soon were printed in contemporary languages, including the first English version in 1497.

The public proved interested in astrological predictions, and astrologers and publishers were all too eager to produce

Image courtesy *The Old Farmer's Almanac*

Portrait of Ceres by Randy Miller, the current *Old Farmer's Almanac* frontispiece, was inspired by the Almanac's 1797 portrait of Ceres.

almanacs. The once scholarly tabulations now were gossipy tabloids. Of course, the predictions—especially about kings—had to be vague or tactful. Publishers could be executed. Two were—after having predicted a major fire in London; when it occurred, the publishers were accused of arson.

In England's American colonies, the first almanac was published in 1639 under the auspices of the newly founded Harvard College. (The first continuously published newspaper in the colonies would not be distributed until 1704.) The "Almanack Calculated for New England" reflected the Pilgrim attitudes of its readers. It was a practical application of astrology, not a frivolous prognosticator, and provided a useful reference for agriculture and health. (If planets could affect the oceans' tides, they certainly must have influence on the fluids in a human body.) This "Almanack" became the model for the current notion of the book—the ready reference tool and the thumbnail encyclopedia.

Almanacs soon were published throughout the colonies, with calculations and articles reflecting each region. The New England book had become an American genre. According to *The American Bibliography*, between 1639 and 1799, more than 1,100 different almanacs were published in

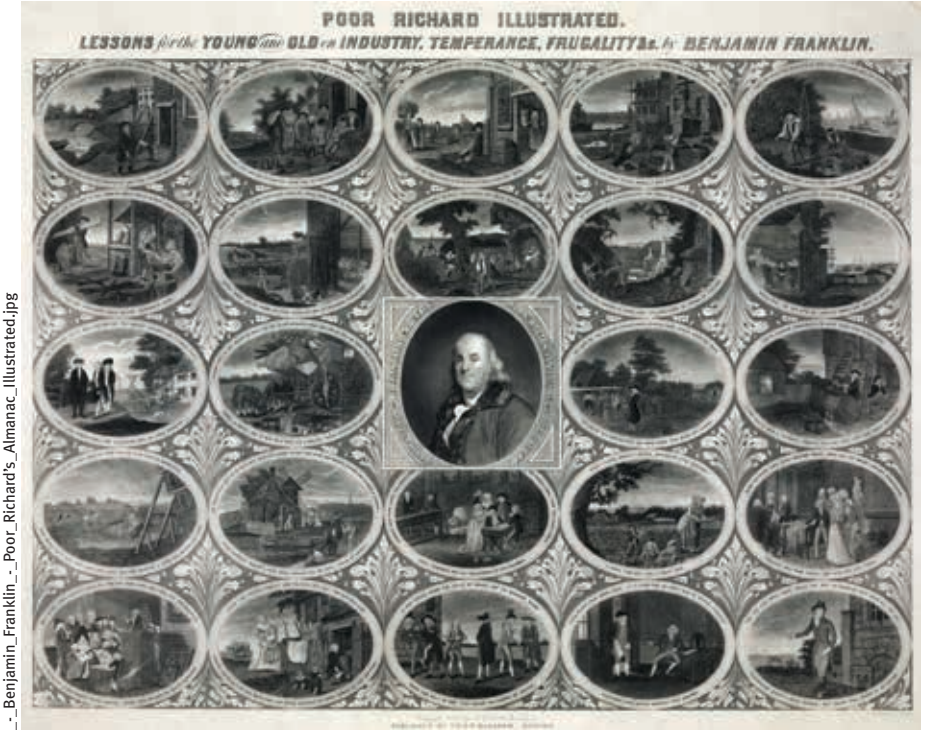
> *Most prolific, most indispensable of books, which every man uses … the supreme and only literary necessity—preferable even to the Bible or daily newspaper."*
>
> —*Moses Coit Tyler,* A History of American Literature

America—and almanacs were published in greater quantities than all other books in America combined.

Of these 1,100 works, only *The Old Farmer's Almanac* continues to be published. However, one other almanac is also honored in the American anthology. *Poor Richard's Almanac*, which appeared continually from 1732 to 1758, featured the wit and wisdom of its author: Benjamin Franklin. *Poor Richard*'s was such a success—selling 10,000 copies a year—that Franklin retired to lead a comfortable life.

Robert B. Thomas emulated Franklin's example when he began publishing his own almanac in 1792. "To be useful with a pleasant degree of humor" was the pledge of his publication. Thomas, the son of a Massachusetts farmer and schoolmaster, attended Harvard but eventually withdrew. From his own regimen of education—including astronomy, mathematics, agriculture and bookbinding, Thomas derived a secret formula for forecasting the weather. His predictions would be a major feature of his almanac. *The Old Farmer's Almanac* still uses his calculations for weather predictions and claims a 78 percent accuracy rate. That includes a correct forecast in 1816 of a snowstorm in summer. By contrast, the almanac claims that the U.S. Weather Service has an accuracy rate of 65 percent.

Originally called *The Farmer's Almanac*, Thomas' book was an immediate success despite some 20 other almanac titles that were in print in New England at the time. Selling for 9 cents a copy (when $1 was a good day's wages), its first edition of 3,000 almanacs quickly sold out. The following year, Thomas printed and sold 9,000 copies. This almanac would



https://commons.wikimedia.org/wiki/File:Oliver_Pelton_-_Benjamin_Franklin_-_Poor_Richard's_Almanac_Illustrated.jpg

A lithograph from *Poor Richard's Almanac* illustrates adages taken from Benjamin Franklin's writings.

entertain as well as educate; the long winters of rural New England required some distraction, so Thomas included comic characters including opinionated Tom Bluenose and the less-than-sober saloonkeeper Toddy Stick.

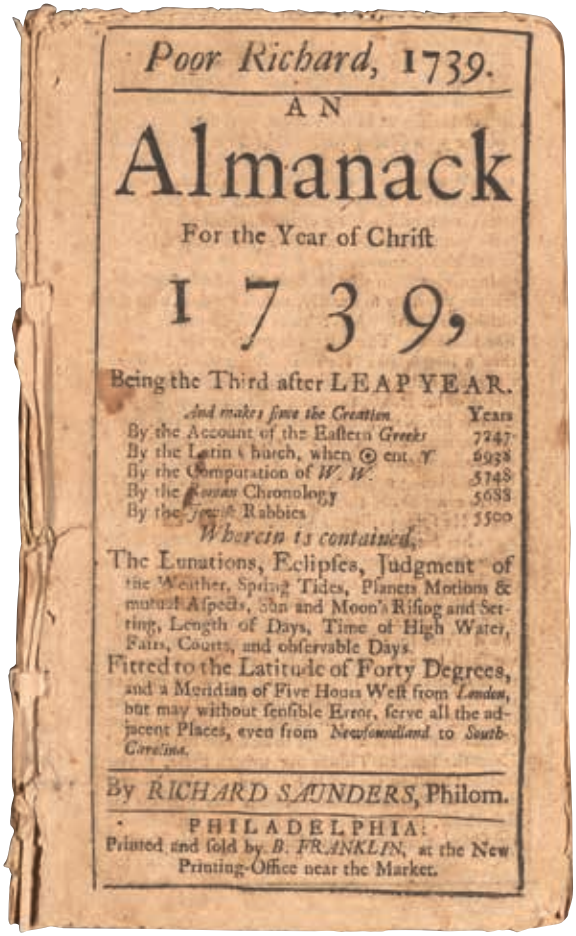
In 1832, in tribute to the enduring popularity of his publication, Thomas revised its title to *The Old Farmer's Almanac*. Thomas would write the almanac until 1846 when he died at the age of 80; the book's longevity owes something to his. The next editor, John Henry Jenks, added a distinguishing feature to the almanac. For the 1851 edition, he commissioned a cover illustration that depicted the four seasons as well as portraits of the two inspiring spirits of the almanac: Benjamin Franklin and Robert Thomas. That trademarked illustration remains the cover of every edition.

The almanac also has another unique feature: there is a hole in the upper-left-hand corner of the book. It is a reminder of the book's unrefined practicality. For easy reference, the almanac could be hung from a nail in a toolshed, workshop … or outhouse. The almanac was never meant to be a coffee-table book.

By the mid-19th century, *The Old Farmer's Almanac* had a circulation of 225,000 and extended far beyond New England's borders. A copy in Illinois was used as evidence in an 1858 murder trial. A witness had claimed to see the crime by the light of the full moon on an August evening. However, the defendant's attorney, a Mr. Abraham Lincoln, cited the almanac to prove that there was no full moon that night. Mr. Lincoln won the case, but he is remembered for other successes as well.

The Old Farmer's Almanac has survived the changes in American society and the challenges of history. During the Depression of the 1930s, the almanac experienced its only drastic decline in readership; its circulation in 1938 was less than 90,000. During World War II, the almanac's weather forecasts were subject to government censorship; a German spy had been found with a copy of the book.

Today, there are only 2 million U.S. farms; more than 80 percent of Americans live in metropolitan areas. The 18 million readers of the almanac are more likely to be weekend gardeners than farmers. Yet, in its content and tone, Robert B. Thomas would recognize *The Old Farmer's Almanac* of today.


Poor Richard, 1739.

AN

Almanack

For the Year of Chriſt

1739,

Being the Third after LEAP YEAR.

And makes ſince the Creation Years

By the Account of the Eaſtern *Greeks* 7247

By the Latin Church, when ☉ ent. ♈ 6938

By the Computation of *W. W.* 5748

By the *Roman* Chronology 5688

By the *Jews* & Rabbies 5500

Wherein is contained,

The Lunations, Eclipſes, Judgment of the Weather, Spring Tides, Planets Motions & mutual Aſpects, Sun and Moon's Riſing and Setting, Length of Days, Time of High Water, Fairs, Courts, and obſervable Days.

Fitted to the Latitude of Forty Degrees, and a Meridian of Five Hours Weſt from *London*, but may without ſenſible Error, ſerve all the adjacent Places, even from *Newfoundland* to *South-Carolina*.

By *RICHARD SAUNDERS*, Philom.

PHILADELPHIA:

Printed and ſold by *B. FRANKLIN*, at the New Printing-Office near the Market.

Library of Congress,Cover page o/Library of Congress/Newscom

Cover page of "Poor Richard: An Almanac," 1739, by "Richard Saunders" (one of Franklin's pseudonyms).

► ***The Old Farmer's Almanac*** **appeared in the Spring 2009 issue of** ***BOSS.***

©iStockphoto.com\Catherine Lane

PIONEER OF THE IMAGINATION

Walt Disney pulled magic out of men and machines. He knew he had to keep innovating to survive

BY DAVID HOLZEL

Bettmann Archives Digital Press Photos/Newscom

Whatever they were expecting as they followed the searchlights into the opulent Carthay Circle Theater, the Hollywood royalty who attended the film premiere on December 21, 1937, could not have possibly been prepared for what they saw. For 84 minutes they sat transfixed, Chaplin and Barrymore and Shirley Temple and Ginger Rogers, charmed by the songs, moved by the characters. And when the young heroine was thought to have died, there were tears shed in the sold-out, 1,500-seat movie palace. Clark Gable and Carole Lombard blew their noses.

Not a bad reaction to a cartoon.

But that cartoon was *Snow White and the Seven Dwarfs*, and there had never been anything like it. That's the way its creator, Walt Disney, wanted it. At age 36, Disney, who was already well-known for his short animations with characters like Mickey Mouse, knew he had to keep innovating and taking risks. To do that he continually adopted new technologies and created new expectations among the viewing public. *Snow White* wasn't the first time Disney had pulled magic from men and machines, and it certainly wouldn't be the last.

Walt Disney is shown on the beach at Waikiki playing a ukulele, while his brother and business manager, Roy, makes him the subject of a movie.

Snow White was the first full-length animated film. And during the three years that went into creating it, Disney and his 600 employees confronted several questions, the answers to which would determine whether *Snow White* would be a hit or be forever known as Disney's Folly: Would an audience sit and watch a cartoon the length of a full-length motion picture? Most cartoons at the time were only seven or eight minutes long. Would animated drawings tug at the heartstrings? There was even concern that staring at animation that long would tire the eyes.

The all-star audience at the Hollywood premiere dispelled those worries, and *Snow White* set the new standard for depth and realism in animation. It also put Disney Studios—owned by Walt and his older brother Roy—in the black. They were in debt for more than $1 million, but Snow White took in $6.7 million around the world by 1939 ($505 million today), with at least $2 million more coming from the sale of *Snow White* toys. This bonanza was all the more remarkable because the world was still gripped by the Depression.

In 1941, Disney acknowledged the payoff from his painstaking approach to creativity in *American Cinematographer*: "The public will pay for quality," he said. "Our business has grown by and with technological achievements. Should this technological progress ever come to a full stop, prepare the funeral oration for our medium."

RISE OF THE ANIMATOR

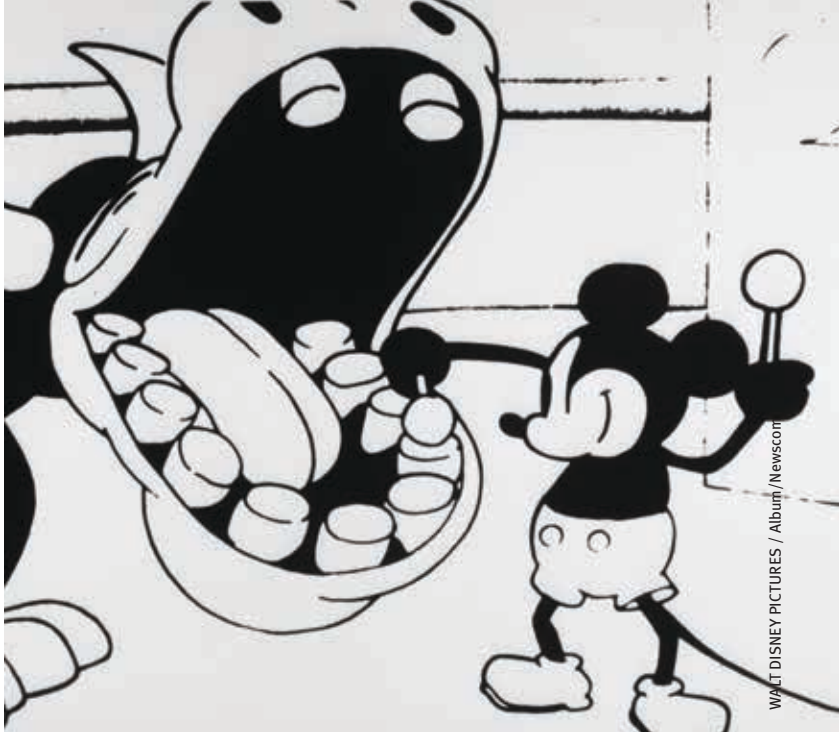
Walt Disney was one of those plucky Midwestern go-getters who made their fame after the turn of the 20th century, the fourth of five children. His father, Elias—religious, taciturn, and a socialist—put his hand to a number of occupations. When his wife, Flora, gave birth to Walt on December 5, 1901, in Chicago, Elias was working as a building contractor. Walt's parents were pioneer people of the old century, while their son was going to help define the new one.

BROTHERS IN BUSINESS

Though Roy Disney rejected the public spotlight that his brother so adored, he played a critical role behind the scenes in creating—and building—the Disney enterprise. He was the company's first CEO and in 1945 became chairman of the board, along with Walt. After Walt Disney died of lung cancer in 1966, Roy Disney put off his own retirement so that he could oversee construction of Disney World—which he would later rename Walt Disney World to honor his brother. Roy Disney served as president of Walt Disney Productions from 1966 to 1968. He retired after the opening of Walt Disney World in October 1971, and died just a short time later.

In 1906, the Disneys moved to a farm in Marceline, Missouri. That same year, "Humorous Phases of Funny Faces," believed to be the first cartoon, was released. It took advantage of stop-action photography to make whimsical drawings on a chalkboard appear to change.

Walt remembered life on the farm with delight, but in 1910, the family was forced to sell it. Elias was ill from the effects of typhoid fever and unable to do the hard work the homestead demanded. Meanwhile the two oldest Disney boys had gone out to make their own lives. That left Walt, 9, and Roy, 17, of the Disney men.



Steamboat Willie **was released in 1928.**

The Disneys landed in Kansas City, where Walt discovered his love for drawing and performing. "I think Walt was an actor all his life," Disney biographer Bob Thomas said.

With pal Walt Pfeiffer, Disney put together a vaudeville routine. The two fifth-graders called themselves The Two Walts and went off to compete in amateur shows. The act included Walt Disney doing an imitation of Charlie Chaplin. Years later, Pfeiffer recalled Disney having to sneak out his bedroom window so the boys could perform their act and make a few nickels without Elias knowing.

"We were kind of afraid of him," Pfeiffer said. "He was kind of strict."

Too young to serve in World War I like his brother Roy, Disney joined the Red Cross Ambulance Corps and went to France in 1918. He returned to Kansas City the next year and looked for a job as a commercial artist. He wound up working for the Kansas City Film Ad Company, recently renamed when it began experimenting with animation.

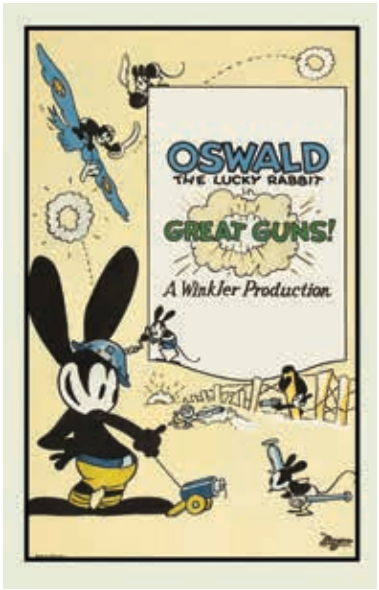


Photo by Buyenlarge/Getty Images)

Those cartoons were rough even by the standards of the day. They used paper figures with movable joints that were pinned onto a sheet. The result had a pronounced jerking motion. Disney, a born salesman, convinced his boss to let him borrow the camera to experiment. Disney later told an interviewer, "I got intrigued with the mechanics of the whole thing."

He was soon able to give his animations the feeling of continuous motion and, always ready to take a risk if it would give him the chance to fulfill his vision, decided he was ready to break out on his own. So in 1922, the 21-year-old fledgling animator created Laugh-o-gram Films. The next year, with the company sliding toward bankruptcy, he began work on *Alice's Wonderland*, in which a real-life little girl interacts with animated characters.

"It was the savior of his career, if not Laugh-o-gram Studio," said Disney historian J.B. Kaufman.

Though Laugh-o-gram went belly-up, Disney was able to use the unfinished Alice as his calling card. It won him the backing of Margaret Winkler, a film distributor in New York. Now he had a way to get his creations into wide distribution, so he boarded a train to Los Angeles in July 1923 to start getting serious about cartoons.

'EVERY SPROCKET'

The new Disney Brothers Studio, owned by partners Walt and Roy, started cranking out Alice films. That was followed by another popular series, *Oswald the Lucky Rabbit*. But in 1927, the Disney brothers learned that Charles Mintz, Winkler's husband, had stolen the rights to *Oswald* and enticed most of Disney's animators away. With an air of conspiracy hanging

over the studio, Walt, Roy and their wives (both brothers had married in 1925) along with one loyal animator worked in secret to produce a solid successor to Oswald that Disney would make sure he owned. The new animal was, one historian said, "Oswald with round ears." Mickey Mouse.

The third Mickey short, *Steamboat Willie*, premiered on November 18, 1928, along with the film *Gang War*, a long-forgotten crime melodrama. What makes *Steamboat Willie* memorable is that it was the first cartoon with synchronized sound. It was an audacious innovation because no one knew if people would accept voices coming from a drawing.

A talking Mickey was here to stay and each year saw new advances. In 1932, Disney secured the rights to exclusive use of the Technicolor process and produced *Flowers and Trees*, the first color cartoon. It won an Oscar, as did the same year's *Three Little Pigs*, whose characters were not interchangeable props for gags but distinguishable by their personalities and body language.

But Disney was thinking big. He told his staff he wanted to create something with depth. Besides, profits from shorts were small and getting smaller. In 1934, Disney and his employees began envisioning *Snow White.* As the story was embellished and refined, Disney would act it out, his talent as an actor on display.

What makes Steamboat Willie *memorable is that it was the first cartoon with synchronized sound.*

"He would recite the story to anyone who would listen and to many who had already listened," Neal Gabler wrote in *Walt Disney: The Triumph of the American Imagination*. "Anything from a short version to the full three-hour performance."

Disney was obsessive about his work and a perfectionist. These traits came out in the making of *Snow White* as he seemed to internalize each second of the film. He was involved "night and day, night and day," animator Frank Thomas said. "Walt lived every sprocket hole of this film."

In a project with a host of tough nuts to crack—more than once it was referred to as "Walt's Folly"—the principal challenge was achieving the aesthetic depth that Disney sought. Until that time, animators suggested three dimensions by shadowing the images. Cartoons rated poorly on proportions. Move the camera closer to a scene and the whole image gets larger, even though specific elements—the moon and a barn, for instance—are supposed to be at different distances and should change sizes at different rates.

NOT-SO-GRIMM NAMES

The Grimm brothers' fairy tale on which Disney based his *Snow White* is silent on the names of the seven dwarfs. What those names should be received the same careful scrutiny as other aspects of the film, according to Neal Gabler's *Walt Disney: The Triumph of the American Imagination*. Among the names considered and discarded: Cranky, Dirty, Awful, Flabby, Baldy, Deafy, Sniffy, Wheezy and Tubby. Disney's final lineup, in case you've forgotten, is Bashful, Doc, Dopey, Grumpy, Happy, Sleepy and Sneezy.

Customers line up to enter Disneyland in Anaheim, California, as the Disneyland Monorail passes above.

DISNEY'S INNOVATIONS

Disney was adamant that the colors in *Snow White and the Seven Dwarfs* be muted and easy on the eyes, rather than bright, like the colors of shorts. So the studio ground its own paint and had 1,200 distinct pigments. To measure colors exactly, Disney installed a spectrophotometer, one of 20 in the world at the time. Walt Disney continued to innovate throughout his career. Disney's other firsts include:

- 1949: Diversification into documentaries with the release of *Seal Island*.
- 1959: America's first daily-operating monorail system, which opened in Disneyland.
- 1961: The first regular color programming for TV, on NBC's *Walt Disney's Wonderful World of Color*. Disney used the show to promote Disneyland.
- 1964: The development of Audio-Animatronics, a form of robotics used at Disneyland.

That was no longer good enough for Disney, who wanted to achieve a higher level of realism. He solved the problem with a clunky technology already in existence—the multiplane camera—but he was the first to use it successfully. From 12 feet high, it looked down onto a succession of glass plates onto which images were painted. The image closest to the camera was the foreground; the image farthest, the background.

"The trick of the multiplane camera is movement," Disney explained in a 1957 exhibition film about the camera.

Sliding the glass plates sideways created the illusion of horizontal movement. Moving them closer or farther from the camera gave a feeling of depth. All this had to be done by hand. It was painstaking work, but Disney was able to achieve the effect he wanted.

To test the system, Disney produced the short "The Old Mill," shot with the multiplane. "As the camera seemed to move through the layers or panned across them, animation gained for the first time a sense of perspective and … three-dimensionality," Gabler wrote.

But time was running out. Disney was on a Christmas 1937 deadline to premiere *Snow White*. To save time, animators began to cut corners by tracing the live action images they had been using as guides to make the images realistic. The studio stopped working on shorts, which it had been doing along with full-time work on *Snow White*.

All that work paid off when the movie premiered and the audience cried as Snow White ate the poisoned apple. By May 1939, *Snow White* became the highest grossing U.S. film until then. When the Academy Awards were handed out, the film received eight Oscars.

"Disney's inspiration was not in creating *Snow White* but in creating her world," film critic Roger Ebert wrote. "At a time when animation was a painstaking frame-by-frame activity and every additional moving detail took an artist days or weeks to draw, Disney imagined a film in which every corner and dimension would contain something that was alive

When he died in December 1966 at the age of 65, Walt Disney was developing Epcot in Florida, his "city of tomorrow."

and moving. From the top to the bottom, from the front to the back, he filled the frame."

It led Disney to further experimentation: with the precursor to stereophonic sound in *Fantasia* (1940); with wide-screen technology in *Lady and the Tramp* (1955); with an optical printer that allowed a combination of live-action and animated films, as in *Mary Poppins* (1964).

Disney saw the coming of television and understood early that he could use the new medium to promote his movies and a new project he was developing. In 1954, he inked a deal with ABC-TV to produce a weekly series called *Disneyland*. In return, ABC became part owner in the amusement park of the same name. (Four decades later, Disney would purchase Capital Cities/ABC for $19 billion.) After Disneyland opened in 1955, Disney became financially stable for the first time.

There are now Disney parks in Los Angeles, Orlando, Paris, Tokyo, Hong Kong and one planned for Shanghai.

Disney was now realizing his vision free of the limitations of the movie screen. When he died in December 1966 at the age of 65, not long after being diagnosed with lung cancer, Disney was developing Epcot in Florida, his "city of tomorrow."

Just as he sought to create complete worlds within his most inspired films, Disney's last innovation (Epcot) was to try to do the same in the real world.

► ***Pioneer of the Imagination*** **appeared in the Fall/Winter 2013 issue of *BOSS*.**

Left: Spaceship Earth ride, which stands at the entrance to Epcot at Walt Disney World. Right: China presented at World Showcase at Epcot Center in Walt Disney World in Lake Buena Vista.

ORIGINS OF GENIUS

Albert Einstein's transformation from an obscure patent clerk to the world's most famous scientist began during one 'miracle year'

BY JIM SCHNABEL

Light is both particle and wave.

Time flows differently for objects in motion. Gravity is not a force but a warping of space. A little mass holds a fantastic amount of energy.

Albert Einstein's theories still boggle the mind, more than a century after he used them to ignite a scientific revolution. But who was this shaggy-haired icon of genius? Did he inherit his creativity or just have lucky breaks in life—or both?

He was born on March 14, 1879, in the city of Ulm, in the Germanic kingdom of Württemberg. His family moved to Munich soon after, where his father, Hermann, and Uncle Jakob started a cutting-edge tech business, selling generators and other electrical supplies. Thus, young Albert, almost uniquely among the children of his day, had a thorough exposure to emerging concepts of electromagnetism.

Hermann, a non-practicing Jew and an opponent of the drive to unify greater Germany, also set a clear example of stubborn, non-conformity for his son—which Albert's strong-minded mother, Pauline, reinforced.

Although he did well in math and physics at Munich's Luitpold Gymnasium (essentially a high school), Einstein chafed at its traditional, rote memorization methods, and was seen as a loner and a rebel. "Your mere presence in this class destroys the other students' respect for me," complained a Greek teacher—a fellow who also blustered that Einstein would amount to nothing in life. The school later revised its view of him enough to rename itself the Albert Einstein Gymnasium. But Einstein never forgot how its methods had nearly crushed his spirit. The natural curiosity that is essential for science, he wrote decades later, is like "a delicate little plant" that "stands mainly in need of freedom."

Einstein might well have inherited a creative bent, but if so, it was not entirely a gift. He often showed a chilly detachment from people. Presented with his newborn younger sister, he asked, "Where are its wheels?" and until the age of 7 he had the strange habit of softly repeating, to himself, sentences he had just spoken. He shunned sports and crowds, preferring to read or to play the violin. Some modern psychologists think he had Asperger's syndrome, a mild autism-spectrum disorder. Einstein himself would later admit to a "pronounced lack of need for direct contact with other human beings and human communities."

KEYSTONE Pictures USA/ZUMAPRESS/Newscom

Einstein, pictured here at age 14, showed a chilly detachment from people throughout most of his life.

Before turning 16, when he would have been called up for military service, he renounced his citizenship and moved to Switzerland. (His parents by then had moved to northern Italy after the failure of the business in Munich.) Einstein tried to get into Zurich Polytechnic two years early, but failed the entrance exams, and instead spent two years finishing high school in the nearby town of Arau.

He was in luck, though. The school used progressive educational methods, and put unusually strong emphasis on

The Albert Einstein Monument is located near the National Academy of Sciences building in Washington, D.C.

Chuck Myers/MCT/Newscom

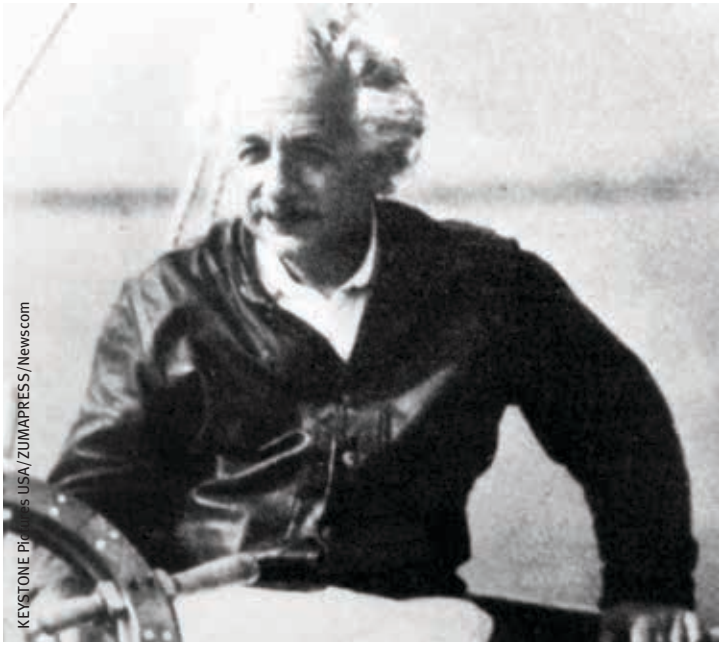
"What would it be like to move alongside a beam of light?" Einstein would later describe his teenage thought-experiment as his first step toward the theory of relativity.

visual conceptualization. One day there, Einstein asked himself: What would it be like to move alongside a beam of light? He later described this thought-experiment as his first step toward the theory of relativity.

He entered Zurich Polytechnic in 1896, and once again was a bit of a rebel. "I played hooky a lot, and studied the masters of physics alone," he remembered later. Einstein would graduate in 1900 near the bottom of his class. But he made friends at the school, and these included a rare female physics student, a Serbian young woman named Mileva Maric. "We understand each other's dark souls so well," he told her. Soon they were living together: two nerdy bohemians whose domestic talk was infused with advanced physics. "When I read [the physicist] Helmholtz for the first time," he once wrote to her, "I could not … believe that I was doing so without you beside me."

When Maric became pregnant in 1901, Einstein sent her to stay with her parents in Serbia, to avoid scandal. He seems to have rather coldly insisted that their first child, Lieserl, born out of wedlock, be put up for adoption. But the couple married in 1903, and had two more children. Although they separated in 1914 and eventually divorced (Einstein later married his first cousin, Elsa), Maric gave Einstein emotional and even intellectual support in those early years. She also

Left: The scientist enjoyed playing the violin, a pastime he began as a child; an avid sailor, Einstein loved to take his boat out on a lake, where he could relax and think.



kept house for him—which, throughout his life, he was never able to do for himself.

Einstein's poor showing at Zurich Polytechnic meant that he could not get a decent academic job. He scraped by with family money and occasional freelance teaching assignments, but his underemployment was a source of frustration.

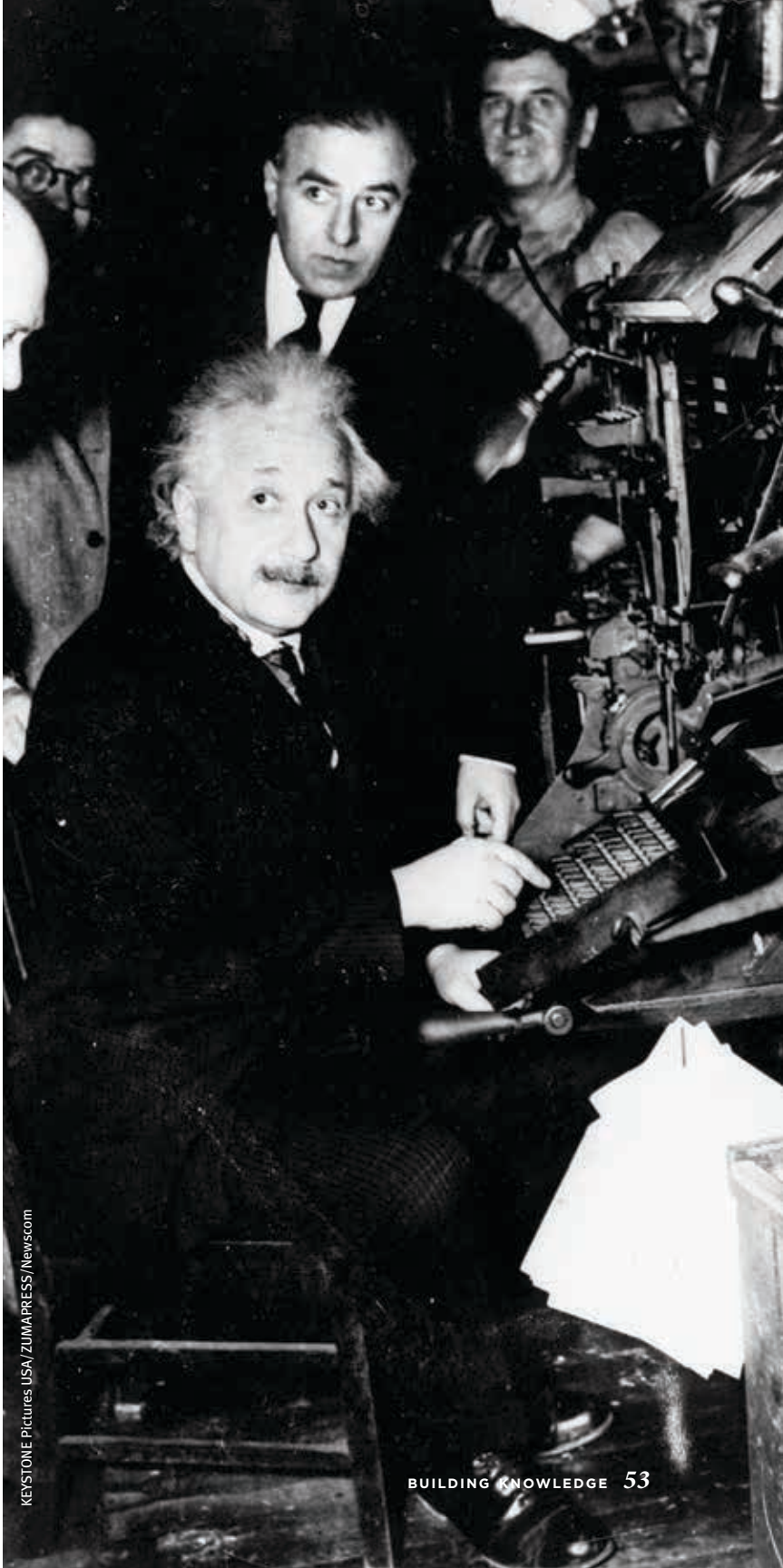
It may have been yet another stroke of luck, though, for his isolation from academia in those years freed him to move along his own creative paths. Physics at the turn of the century—especially the classical mechanics of Isaac Newton—was rattling itself loose. Experimenters were gathering new data on phenomena such as the speed of light, and these data didn't always fit the existing theories. Einstein knew that there was a vast opportunity for a theorist who could find a way to make physics whole again.

In 1902, he finally got a steady job, at the Swiss patent office in Bern, as a junior examiner of patent applications for electrical devices. Again, he was in luck. He found that he could do his patent work in a few hours daily, leaving him plenty of time for his theorizing. His office and apartment also were not far from the train station and Bern's famous clock tower, a reference for all train-timekeeping in the vicinity. Clocks and trains were to be for Einstein what the falling apple had been for Newton.

MIRACLE YEAR

Einstein's transformation from an obscure patent clerk to the world's most famous scientist began in 1905. In that year he managed, despite having no academic affiliation, to get three truly revolutionary papers published in *Annalen der Physik*, one of the top physics journals of its day.

In the first, he solved a conundrum about the way in which light knocks electrons out of metal—the "photoelectric effect" by which modern solar cells work. He proposed that light interacts with electrons as it does because it is made of discrete, albeit wavelike particles (later



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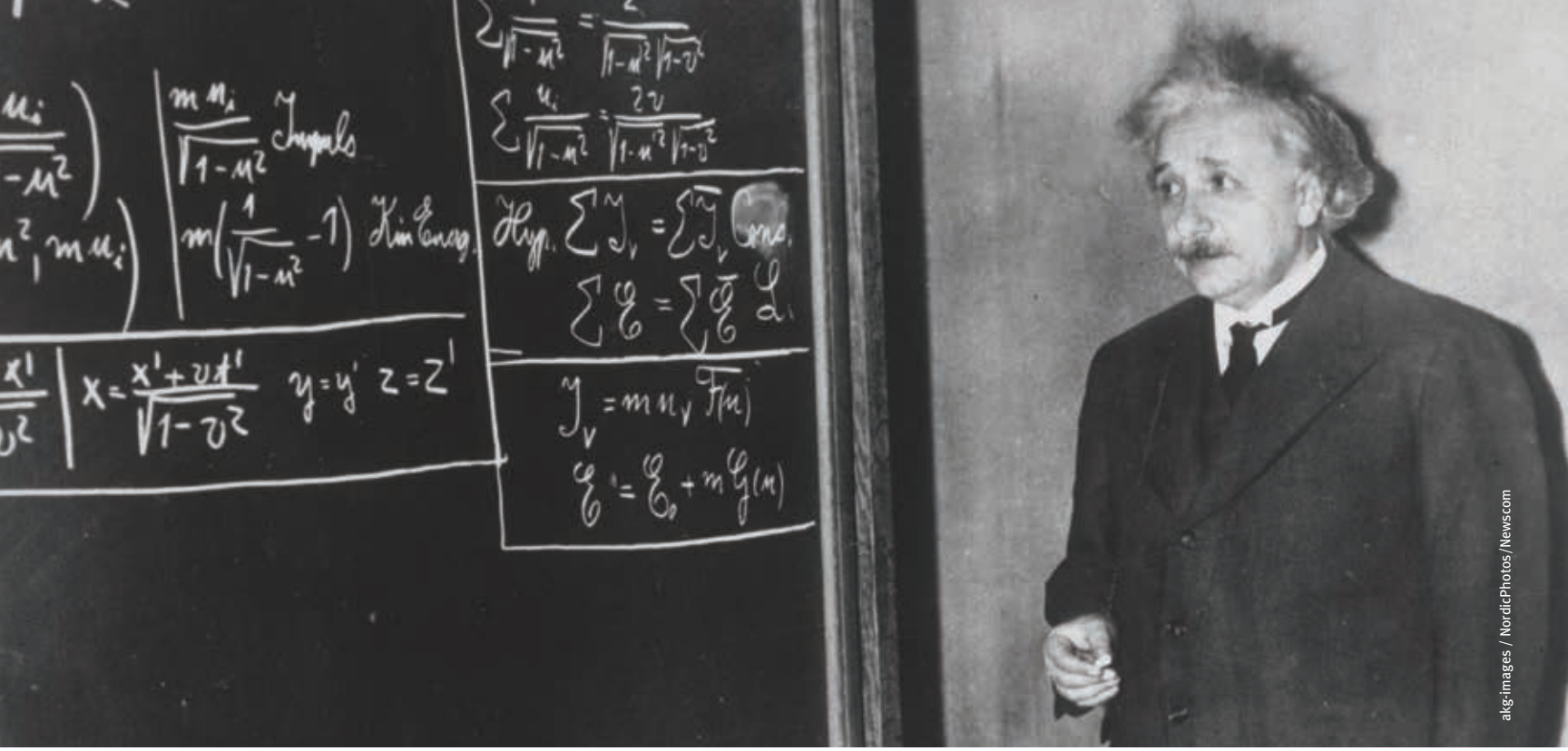
Newly transplanted in America, Einstein sets the first line of type for the first enlarged edition of the *Jewish Daily Bulletin* in 1934.



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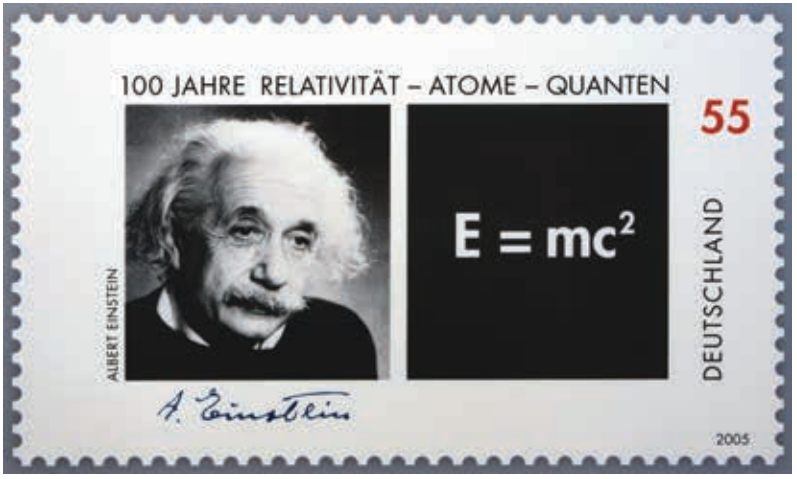


PEER GRIMM/EPA/Newscom

Above: Einstein in an undated photo. Left: An Albert Einstein special postage stamp, Berlin, Germany, June 2005.

called photons) and each of these carries a discrete level of energy, corresponding to its wave frequency.

The second big paper outlined his initial theory of relativity—later called the "special theory of relativity." Its essence was remarkably simple: New experiments showed that the speed of light (in a vacuum) was always the same in all directions and for any observer whether moving or stationary. But if the speed of light is fixed and absolute in this way, Einstein reasoned, then other properties such as time must be changeable and relative, even if the changes they undergo are usually very subtle. From a train speeding past a stationary clock tower, for example, the clock will seem to run slow. The light that carries the clock's image will take a tiny bit longer to reach the receding train, with every tick of its hands. (By the same logic, a clock on a receding train also will seem, from the platform, to run slow.)

When astronomers confirmed that the sun's mass bent starlight to the degree that Einstein's theory predicted, he became a global celebrity virtually overnight.

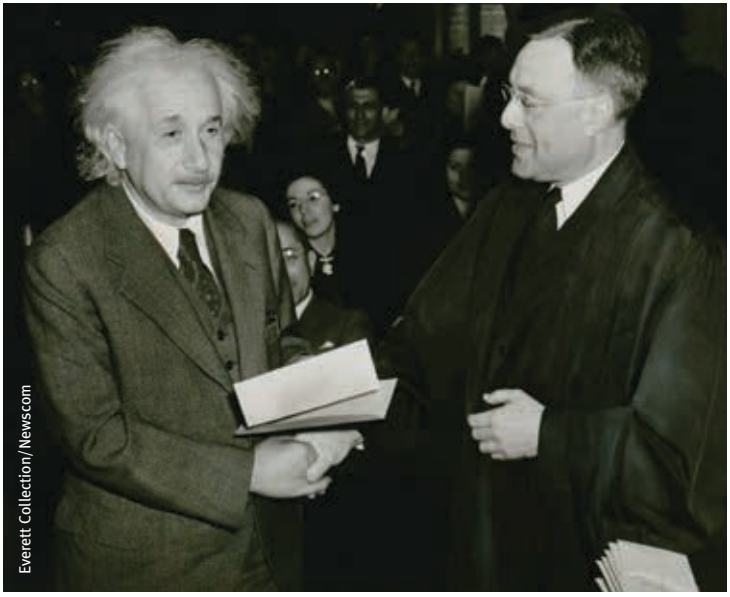
In his final paper that year, Einstein showed that, in part due to relativity, the light-speed constant c links mass to energy: E=mc2. One implication was that nothing can travel faster than c. Another was that a little mass is equivalent to a lot of energy—a key insight that would lead to the development of nuclear power and nuclear weapons.

CELEBRITY

Within a few years, Einstein began to be offered academic jobs, and his career took off. Meanwhile, he developed the "general theory of relativity." Its most revolutionary concept was that gravity reflects a warping of space—and time—in the vicinity of a large mass. When astronomers confirmed during a 1919 solar eclipse that the sun's mass bent starlight to the degree that Einstein's theory predicted, he became a global celebrity virtually overnight. *The New York Times* quoted the eminent British physicist J.J. Thomson: "It is not the discovery of an outlying island, but of a whole continent of new scientific ideas of the greatest importance …"

Einstein moved his work to the U.S. in 1933, after the Nazis came to power in Germany. By the time he died in 1955—while based at a special institute at Princeton University—he had written or co-authored more than 300 papers. Even today his ideas continue to underlie large areas of physics and the technologies derived from it.

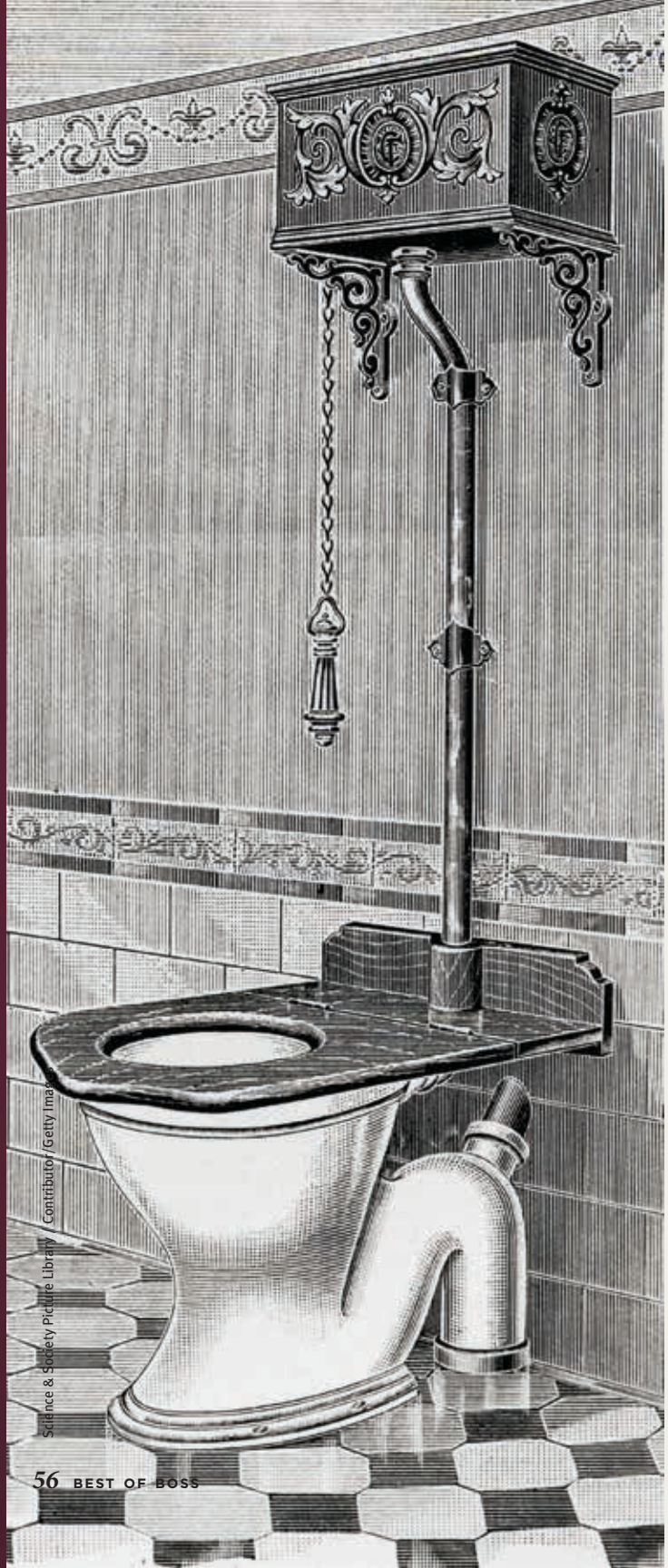
Yet the aspects of his personality that had helped him to persevere in his pre-celebrity days may have been a net liability to him in his later years. Despite being instrumental in persuading President Franklin D. Roosevelt to set up the Manhattan Project—to build an atomic bomb before Nazi Germany did—Einstein embraced an uncompromising pacifism after the war, and even publicly wished that the U.S. had never built nuclear weapons. He also somewhat obstinately resisted the emergence of quantum physics and its assertion of fundamental uncertainties, complaining that God "does not play dice"—and wasting years trying to prove that.



Albert Einstein, receiving his certificate of American citizenship. Einstein left his native Germany after the Nazis came to power in 1933.

After Einstein died of an aortic aneurysm at the age of 76, fellow Princeton physicist Robert Oppenheimer gave a eulogy that captured, in one sentence, much of the genius' character: "There was always with him a wonderful purity at once childlike and profoundly stubborn." ◆

► ***Origins of Genius*** **appeared in the Spring 2012 issue of** ***BOSS.***



Science & Society Picture Library / Contributor / Getty Images

FLUSH WITH SUCCESS

The advent of the indoor toilet made life sweeter for all

BY LISA DENIKE ERCOLANO

The thing to do when discussing the history of one of the greatest inventions of all time is to flush away what you may have heard about Thomas Crapper. Because, although the London plumber did make and patent significant improvements to the invention in the late 1800s, he did not invent the flush toilet.

That honor goes to a gentleman (another fastidious and ingenious Englishman) named Sir John Harrington, who, in 1596, came up with the idea for the so-called "water closet"—a seat perched atop a cistern of water that handily swished away whatever waste was deposited into it. The godson of none other than Queen Elizabeth I, Harrington designed it for her (leading many to speculate that's where the term, "He's on the throne," comes from).

But we're getting ahead of ourselves here. Long before there was indoor plumbing fit for royalty, there was the natural human desire to rid ourselves of the unpleasantness of what the Chinese euphemistically call "the big necessity." Since the beginning of time, people have needed a sanitary (and, in most cultures, a relatively private) place to dispose of their bodily waste, and they have put their ingenuity to work in a variety of ways.

Probably most popular across most cultures in early history was the use of a simple bowl or pot used day and night as needed and emptied outside in a field or nearby body of water. The English called this a "chamber pot."

Ancient Romans built outhouses or latrines directly over an elaborate system of sewers that emptied into the Tiber River, flushing away waste immediately. Famous for their community bathhouses, the Romans also had communal lavatories where people could come in and, well, deposit their

Engraving from the 1902 catalogue of Thomas Crapper and Company.

Album / Florilegius/NewscomContributor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The catalogue of Thomas Crapper and Company, 1902.

waste in giant toilets with long, bench-like seats while sharing gossip and the news of the day. Usually, though, ordinary Romans found it easiest just to toss their waste from chamber pots into the streets.

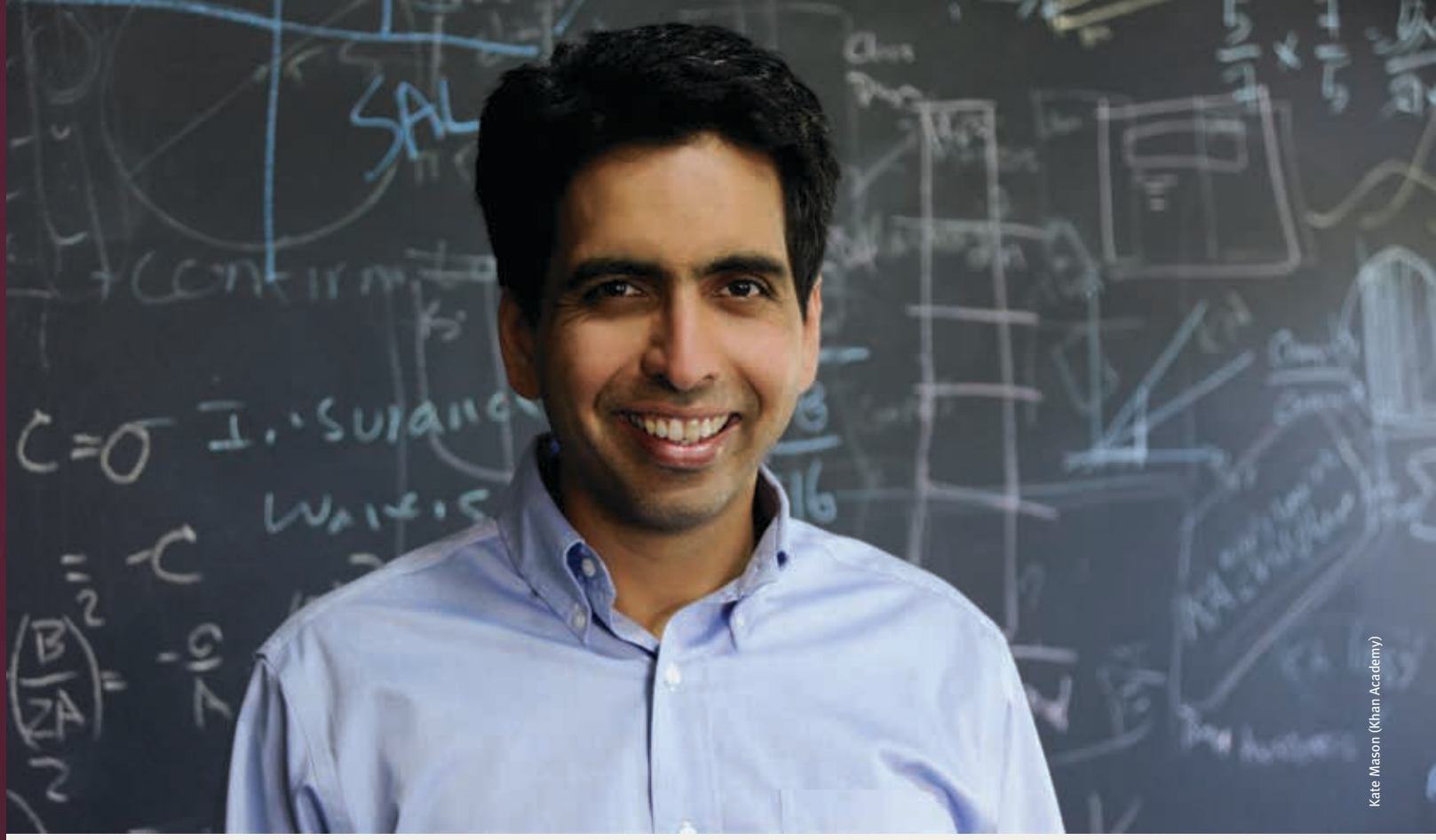
One of the more disgusting iterations of the toilet appeared during the Middle Ages with the invention of the castle garderobe: a small room jutting out of the castle wall where royalty would go to deposit their waste. The waste would be dropped into the stagnant moat water below, adding yet another impediment to any enemy foolish enough to consider storming the reeking ramparts.

Many in England breathed a sigh of relief (and a whiff of fresh air) when Harrington came along with his idea. The queen installed Harrington's invention—a raised bowl with a small pipe in which water ran down when released by a valve—in her Richmond Palace. It would be another three centuries until the appropriately named Thomas Crapper improved on the design and it began to catch on.

Today, we think of the flush toilet as a necessity and can hardly imagine our lives without it. But in truth, only 60 percent of the world has access to "proper sanitation"—that is, indoor toilets. There are many in the world using, if not garderobes and Roman communal bench toilets, their own versions of the chamber pot—something to keep in mind the next time you get up for your "big necessity" on a cold, dark night.

► ***Flush with Success*** **appeared in the Summer 2012 issue of *BOSS*.**

Today ... only 60 percent of the world has access to 'proper sanitation'—that is, indoor toilets.



AN EDUCATION REVOLUTION

Sal Khan has transformed the world of teaching—and learning

BY MARIA BLACKBURN

Back in 2004, Sal Khan was a 20-something hedge fund analyst working in Boston. In his spare time, he tutored his 13-year-old cousin Nadia in math by phone. Occasionally, when they couldn't connect, Khan created videos using Yahoo Doodle to illustrate the mathematical concepts they had discussed so that Nadia, who lived in New Orleans, could review their lessons on her own time.

Then a funny thing happened.

Nadia told Khan that instead of being tutored by phone she preferred to watch the videos he had created. "She basically said, 'I like you better in video than in person,'" Khan told *Wired* in 2011.

That realization helped launch an education revolution.

Khan took to the Internet with his homemade videos—teaching everything from art history and economics to math, physics and medicine—offering them for free on YouTube to whoever cared to watch. In 2008 he founded Khan Academy, a nonprofit funded through donations and other sources, which is dedicated to providing a "free world-class education for anyone anywhere."

He quit his job in 2009 to focus on Khan Academy full time. Today Khan's 5,500-plus short instructional videos, available in several dozen languages, reach some 1 million students of all ages and education levels per month. Khan

The beauty of learning online, Khan has said, is that it allows for pausing, rewinding and fast forwarding, and for learning on your own time.

Academy is the largest school in the world, and Khan, 37, has been lauded as a "superstar teacher" and "hero."

"This is the future of education," said Bill Gates, who donated $1.5 million to Khan Academy in 2010 after Khan's 2011 TED Talk (an annual conference of the world's leading thinkers).

Watch one of Khan's lectures and you'll see he's a natural teacher—relaxed, enthusiastic and accessible. At times he's even a little geeky. He never trained formally as a teacher, but he has experienced some of the finest educational institutions in the world.

Born and raised in New Orleans, Khan attended Grace King High School before going on to MIT, where he earned undergraduate degrees in mathematics and electrical engineering/computer science, and a graduate degree in electrical engineering and computer science. He continued his education by earning an MBA from Harvard Business School.

The beauty of learning online, Khan has said, is that it allows for pausing, rewinding and fast forwarding, and for learning on your own time. Students don't have to feel embarrassed that they don't know a certain fact, and they can move ahead at their own pace when they have already mastered the material.

Classroom students using Khan Academy.

Image courtesy of the J.A. and Kathryn Albertson Family Foundation

Khan Academy's website is filled with comments from students—ranging from elementary schoolers to senior citizens—who relate how the site has improved not only their grades but their outlooks. Siama, a middle-schooler, wrote, "Math has always been my least favorite subject because I just really couldn't get into it. Since Khan Academy I've learned so much about math. I've learned that math can be fun."

It wasn't long before Khan realized that his videos weren't just reaching individual students. They were changing classrooms. Teachers told him how they were "flipping" their classrooms by assigning their classes Khan Academy videos as homework and then having students do their regular homework assignments in class.

"By removing the one-size-fits-all lecture in the classroom, then letting them have a self-paced lecture at home, then when they do work having peers help each other, these teachers have used technology to humanize the classroom," Khan said in his TED Talk. "They took a fundamentally dehumanizing experience … 30 kids not allowed to interact with each other … and now it's a human experience where they're actually interacting with each other."

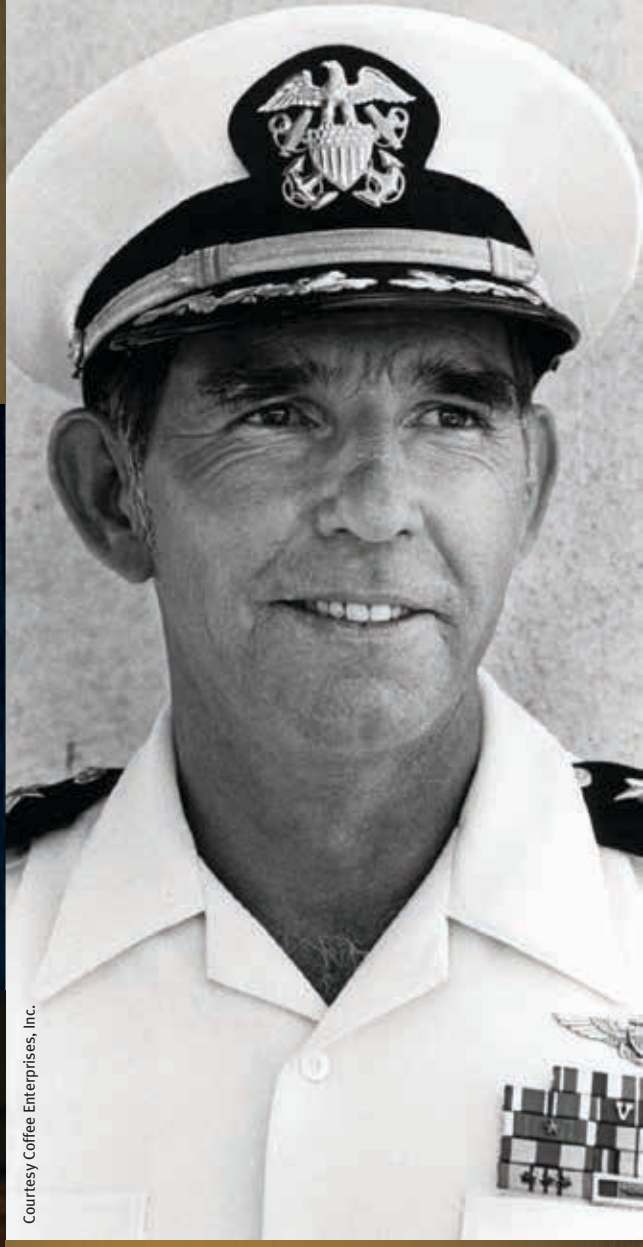
Khan has added badges and performance metrics to the site to help students see their progress and assist educators in measuring how far their classrooms and individual students have progressed. Going forward, he wants to make sure that he doesn't just provide education but that he continues to help transform it.

"When I started, you wouldn't have imagined that some crazy dude in a closet making videos would help lead this charge," Khan told *USA Today* in 2012. "But my mission is to have every precocious 13-year-old in the world have access to every bit of information they could ever want." ➨

► ***An Education Revolution*** **appeared in the Summer 2014 issue of *BOSS*.**

United States Army Center of Military History

RESILIENCE



Courtesy Coffee Enterprises, Inc.

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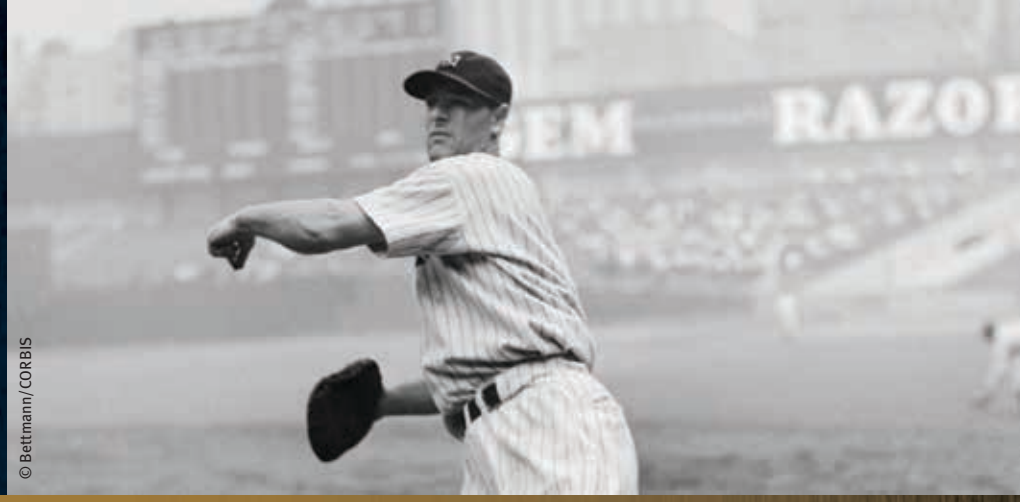

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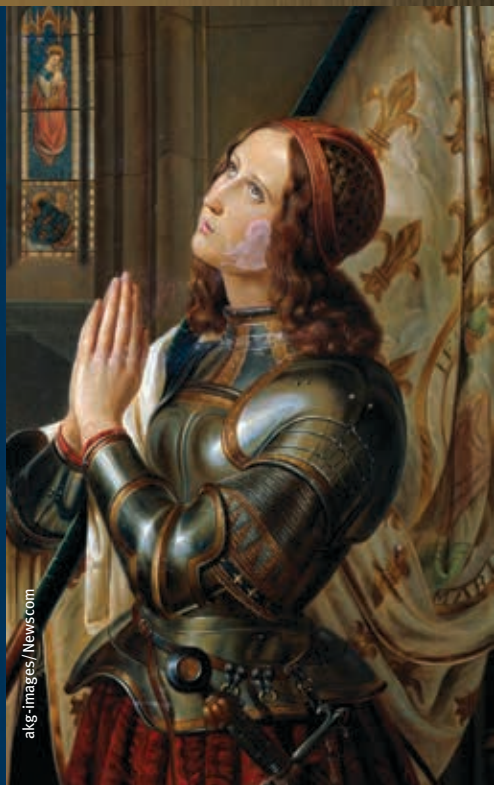
"Fall seven times, get up eight."

—Japanese proverb

Ricky Carioti/The Washington Post via Getty Images



akg-images/Newscom

Freed after three years of imprisonment as POWs, a group of U.S. Army nurses climb into trucks on Feb. 12, 1945, as they leave Manila to head home to the United States. They sport new uniforms, given to them to replace their worn-out clothing. The angels of Bataan and Corregidor arrive at Hickam Field in Hawaii on February 20, 1945.

THE ANGELS OF BATAAN

Amid the horror of war in the Pacific, a group of POW nurses bravely carried on

BY MARIA BLACKBURN

Even as bombs began falling on Manila in December 1941, the women who served as part of the U.S. Army Navy and Nurse Corps in the Philippines continued caring for their sick and dying patients.

In the years that followed, these World War II nurses endured the most trying of conditions. At times they had no hospital buildings and no hospital beds, only vine-stuffed mattresses laid out on jungle floors. There were bombs and air raids and gunfire. They suffered from malaria, beriberi, dengue fever, malnutrition, starvation and a host of other conditions that sapped their energy and strength. And even after they were captured by the Japanese and forced to live in internment camps, these nurses continued taking care of the thousands of sick and injured.

Upon their liberation in February 1945, the 78 nurses returned home, heralded as the "Angels of Bataan and Corregidor," and awarded Bronze Stars for their service. Yet for decades their story went largely untold.

"They were the largest group of women POWs in the history of [the United States]. But there was so much going on—the events at Pearl Harbor, the war in Europe—that their story has been swallowed up," said Elizabeth Norman, author of *We Band of Angels: The Untold Story of American Nurses Trapped on Bataan by the Japanese* (Pocket Books, 1999), in a *New Hampshire Sunday News* interview in 1999.

And yet the influence the women had on their colleagues and patients was nothing less than extraordinary, according to U.S. Army surgeon John R. Bumgarner, who served in Bataan with them. "One of the most remarkable things coming out of our experiences in Bataan was the presence and performance of the Army nurses," Bumgarner wrote in his 2004 memoir, *Parade of the Dead*. "In retrospect I believe that they were the greatest morale boost in that unhappy little area of jungle called Bataan. I was continually amazed that anyone living and working in such primitive conditions could remain as calm, pleasant, efficient and impeccably neat as those remarkable nurses."

Perhaps the greatest irony of their story is that many of these nurses were initially drawn to the Philippines by the promise of living and working in an exotic island paradise. Surrounded by palm groves and white gardenias, with weekends spent sunning at the beach club and dancing under the stars, the Americans stationed in the Philippines had a great life.

All that changed when the Japanese bombed Pearl Harbor on December 7, 1941, and began their attack on the Philippines. The Army and Navy nurses had never trained for combat, and yet they were now in the middle of a war zone.

The nurses jumped into action, caring for the wounded amid chaos. After Clark Field in the Philippines was bombed on December 8, U.S. Army nurse Ruth Marie Straub volunteered to help care for the casualties brought to Stotsenberg Hospital. She wrote in her diary, "The hospital was bedlam—amputations, dressings, intravenouses, blood transfusions, shock, death … Worked all night, hopped over banisters and slid under the hospital during raids. It was remarkable to see the medical staff at work."

The nurses were evacuated from Manila and moved to field hospital sites on the jungle peninsula of Bataan and Malinta Tunnel on Corregidor Island, caring for hundreds of patients each day in difficult conditions over the next several months. The situation worsened when the U.S. troops on Bataan surrendered to the Japanese on April 9, 1942. Some 72,000 soldiers (both U.S. and Filipino) were captured and sent on a horrific 63-mile march up the east coast of Bataan—the Bataan Death March that left some 10,000 dead at the hands of the Japanese soldiers.

While a handful of nurses were evacuated after the surrender, most were held as prisoners of war at two internment centers: Santo Tomas and Los Baños. The camps held civilians—thousands of Americans, British and people from other countries—who had been living and working in the Philippines when Pearl Harbor was bombed.

The nurses were held captive for almost three years—years in which they wore their uniforms and stayed busy. As Japan's prospects in the war worsened, conditions in the camp deteriorated, with many people becoming sick owing to lack of food and poor sanitation.

"We were scared and tired, but we kept working," Mildred Dalton Manning, a U.S. Army nurse and prisoner of war, told the *Atlanta Journal Constitution* in 2001. "We were under terrific strain, but we just did our job even when we were weak from not eating."

Liberated on February 3, 1945, the women returned home and were honored with medals and presidential citations, and lauded by the press as "one of the beautiful legends of the Pacific War."

Manning, the last known surviving "Angel of Bataan," died in March 2013 at 98. She was more practical than romantic when she considered how she survived amid such adversity.

"I had a job to do," she told the *Trenton Times*. "I was a nurse."

► ***The Angels of Bataan*** **appeared in the Fall/Winter 2013 issue of** ***BOSS.***

BEYOND EXPECTATIONS

Physically paralyzed for most of his adult life, scientist Stephen Hawking continues to explore the mysteries of the universe

BY SARAH ACHENBACH

The prognosis was grim: 21-year-old Stephen Hawking likely had only a few years to live. The young man was just coming into his own as a scientist, working on a Ph.D. in cosmology, the study of the universe's origin, structure and development, at Cambridge University.

"The doctors told me to go back to Cambridge and carry on with the research I had just started in general relativity and cosmology. But I was not making much progress, because I didn't have much mathematical background. And anyway, I might not live long enough to finish my Ph.D. I felt somewhat of a tragic character," Hawking writes.

Instead of surrendering to what is now known to be amyotrophic lateral sclerosis or ALS (also known in the United States as Lou Gehrig's disease), Hawking discovered with great surprise that the prospect of imminent death brought out a joy for life. His research began to progress, and he became engaged to his first wife, the former Jane Wilde, whom he had started dating about the time of his diagnosis. "That engagement changed my life," he says. "It gave me something to live for."

And live he did.

Now arguably the most famous cosmologist in the world, Hawking's dazzling intellect has secured his place as one of history's most important scientists. The Lucasian Professor of Mathematics at Cambridge University since 1979, he holds the same post that Sir Isaac Newton once held. The recipient of numerous honorary degrees, medals and prizes, including the Companion of the Order of the British Empire in 1982 and the Companion of Honour in 1989, Hawking is a Fellow of The Royal Society and a member of the U.S. National Academy of Sciences.

His boundless curiosity and the very limited boundaries of his physical self have made him an internationally known and respected figure well beyond scientific circles. His popular books—*A Brief History of Time* (Bantam, 1988), which spent a record four years on the *London Sunday Times*' best-seller list, *Black Holes and Baby Universes and Other Essays* (Bantam, 1993) and *The Universe in a Nutshell* (Bantam, 2001)—have helped stargazers everywhere better understand the universe.

REX/Newscom

Stephen Hawking at age 8.

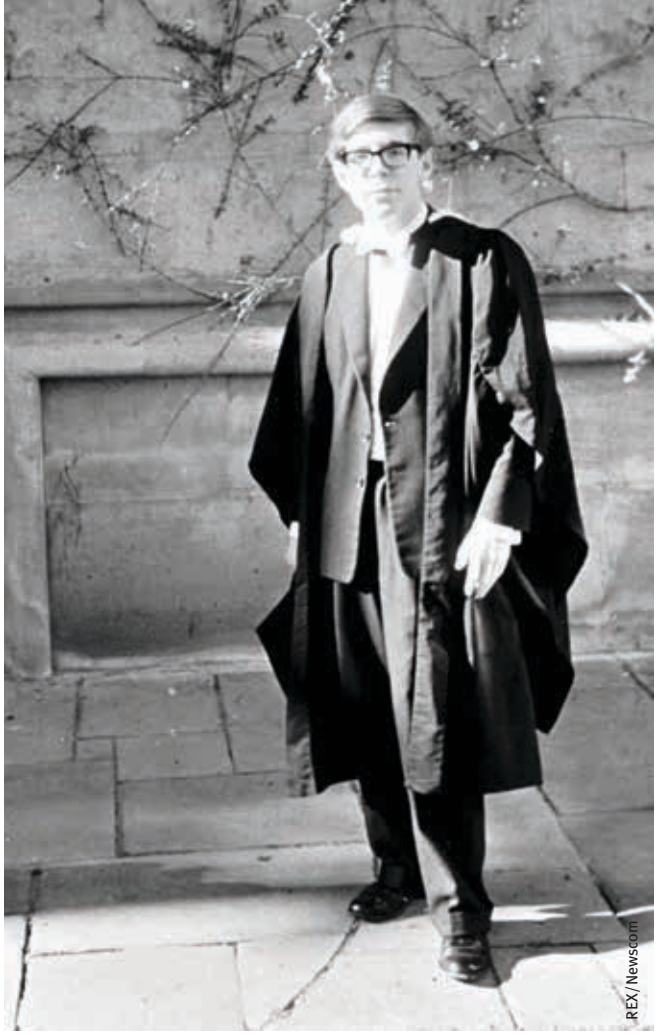
In *A Brief History of Time*, he writes, "However, if we discover a complete theory, it should in time be understandable by everyone, not just by a few scientists. Then we shall all, philosophers, scientists and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason—for then we should know the mind of God."

AT A LOOSE END

In a coincidence bordering on prescience, Hawking was born on Jan. 8, 1942, exactly 300 years after the death of Galileo. His parents, Frank and Isobel, raised him in Oxford, England—a safer place during World War II than their London home—and when the young Hawking was 8, his family moved to St. Albans, a small town north of London. At the St. Albans School, Stephen was a good, but not outstanding, student who immersed himself in books. Enrolling in his father's alma mater, University College, Oxford, Hawking intended to study mathematics, although

Stephen Hawking attends the gala screening of *Hawking* on the opening night of the Cambridge Film Festival held at Emmanuel College on September 19, 2013, in Cambridge.

Photo by Karwai Tang/Getty Images



Stephen Hawking at his Oxford University graduation.

his father, a research biologist, preferred he study medicine. Since mathematics was not offered at University College, he chose physics, earning a degree in natural science. It was during his time at Oxford that the young man started to blossom.

His physics tutor, Robert Berman, later said in *The New York Times Magazine*, "It was only necessary for him to know that something could be done, and he could do it without looking to see how other people did it. ... He didn't have very many books, and he didn't take notes. Of course, his mind was completely different from all of his contemporaries."

It was just as his world was opening up intellectually that his physical abilities were beginning to deteriorate. Never particularly graceful or athletically inclined, he was getting more and more clumsy. In his third year at Oxford, he had fallen a few times for no apparent reason. At his father's urging, Hawking went to his family doctor, who in turn referred the young scientist to a specialist.

As his disability worsened and he was confined to a wheelchair, his scientific reputation blossomed.

Just after his 21st birthday, Hawking entered the hospital for a two-week battery of tests. The results ruled out multiple sclerosis, but no specific diagnosis was offered at the time. Instead, Hawking recalls that the doctors gave him vitamins and the news that they expected his incurable, terminal condition to get much worse rather quickly. "Not knowing what was going to happen to me, or how rapidly the disease would progress, I was at a loose end," he writes.

His engagement to Jane provided the impetus to keep going: Hawking needed to find a job if he were to provide for a family. (He and Jane were married for 30 years before they divorced. They have three children, Robert, Lucy and Tim, and two grandchildren. Hawking is divorced from his second wife and former nurse, Elaine Mason.) While at Cambridge, he applied for and received a research fellowship in theoretical physics at Gonville and Caius College, Cambridge.

As his disability worsened and he was confined to a wheelchair, his scientific reputation blossomed. "This meant that people were prepared to offer me a sequence of positions in which I only had to do research, without having to lecture," writes Hawking.

The disease was causing his speech to slur. Hawking could communicate, but only those who knew him well could understand him clearly. His papers were dictated to a secretary and any lectures he gave were through an interpreter. A tracheotomy operation following a bout of pneumonia in 1985 left him unable to speak at all. Now, Hawking had to painstakingly point at letters on a card to communicate with his family, nurses and colleagues.

Stephen Hawking proved for the first time that black holes aren't completely black but emit radiation—as shown in this later image taken by the NASA/ESA Hubble Space Telescope. It provides a spectacular image of the bright star-forming ring that surrounds the heart of the spiral galaxy NGC 1097. Lurking at the very center of the galaxy, a supermassive black hole 100 million times the mass of our Sun is gradually sucking in the matter around it. The area immediately around the black hole shines powerfully with radiation coming from the material falling in.

Walt Woltosz, a California-based computer programmer, came to the rescue with Equalizer, a program that allows Hawking to select his words from menus on a screen by pressing a switch, which can be operated by head or eye movement. With his wheelchair fitted with a laptop, Equalizer and a speech synthesizer made by Speech Plus that varies intonation, Hawking is able to speak or write about 15 words a minute through an infrared sensor mounted on a headpiece that detects motion in his cheek. "The only trouble is that it gives me an American accent," he quips.

MYSTERIES OF THE UNIVERSE

Hawking's early research focused on using Einstein's Theory of Relativity to explore the creation and extreme conditions of black holes. Coupling for the first time General Relativity (gravity) with Quantum Mechanics (the physical laws that govern atoms), Hawking and his Ph.D. adviser Roger Penrose proved the radical theory that black holes aren't completely black, but rather that they emit radiation. As massive stars shrink, they become black holes radiating substance into space, ending in an explosion and an eventual, inevitable disappearance.

Now referred to as Hawking Radiation, this theory combines the concept of "space-time singularities"—events during which the laws of physics appear to collapse—the thermodynamics of black holes, and highly complex mathematics. Hawking's research is one of the most significant contributions to the Grand Unified Theory through which physicists use a single equation to explain all physical matter in the universe.

This revolutionary research led Hawking and Penrose to equally radical discoveries about the Big Bang Theory implying that the laws of science entirely determined the cosmos' creation and will predict its end. On his Web site, Hawking elaborates in a lecture titled "The Beginning of

Time": "…The universe has not existed forever. Rather, the universe, and time itself, had a beginning in the Big Bang, about 15 billion years ago. This is probably the most remarkable discovery of modern cosmology."

Hawking and Penrose predicted that time begins and ends within a black hole or "singularity," at which point Einstein's Theory of Relativity breaks down—and can no longer be used to predict what might emerge from the singularity. The universe, he theorizes, has no edge or boundary, but exists in a unique state of constant transition with one universe changing into another. Hawking's current research focuses on the new idea of imaginary time (measuring time in imaginary numbers), further defining space and time's intricacies and infinities.

His life's research and writings have greatly broadened modern knowledge of how the universe is expanding, how galaxies developed and the role black holes played in their creation—and will play in their extinction. Through it all, Hawking has never stopped dreaming about traveling through the very galaxy he's spent a lifetime quantifying.

On April 26, 2007, he took a short flight—and a small step toward that goal—aboard the Zero Gravity Corp.'s modified Boeing 727 jet that simulates the experience of weightlessness. During the flight from NASA's Kennedy Space Center in Florida, Hawking went weightless for about 25 seconds at a time—about four minutes total—during the jet's eight parabolic dives from 32,000 feet to 24,000 feet. Hawking hopes to be part of Virgin Galactic's suborbital space tours, which the company plans to begin in 2009.

"I think the human race doesn't have a future if it doesn't go into space," Hawking told the BBC News Web site prior to his flight. "I also want to show," he said in an e-mail interview with The New York Times, "that people need not be limited by physical handicaps as long as they are not disabled in spirit."

Hawking has helped to explain the mysteries of the universe to millions. But it is his perseverance in the face of daunting physical limitations that teaches the real lesson of life. "My expectations were reduced to zero when I was 21," he says. "Everything since then has been a bonus."

Hawking delivers a lecture entitled "Why We Go into Space" as a part of a lecture series honoring NASA's 50th Anniversary, at the George Washington University in Washington on April 21, 2008. Hawking spoke on the benefits of space travel and said we should be actively pursuing a colony on the moon and a manned Mars mission.

KEVIN DIETSCH/UPI/Newscom

► ***Beyond Expectations*** **appeared in the Fall 2008 issue of *BOSS.***

Photo Courtesy Coffee Enterprises, inc.

A LIFE WITH PURPOSE

Determination and focus helped Capt. Gerald Coffee survive seven years as a prisoner of war

BY SARAH ACHENBACH

Photo Courtesy Coffee Enterprises, inc.

"Eject! Eject!" Capt. Gerald Coffee screamed to Lt. Robert T. Hanson, the navigator of the RA-5C Vigilante aircraft. The Navy plane, piloted by Coffee, had just been hit by enemy fire during a Feb. 3, 1966, reconnaissance mission off the USS Kitty Hawk. Coffee and Hanson had been gathering intelligence against a heavily defended area of North Vietnam.

Not hearing a response from Hanson, Coffee immediately pulled the face curtain on his own ejection seat. Both men were automatically released from the aircraft, which was still speeding across the sky at 680 miles per hour.

The crewmen managed to send a signal on an emergency survival radio beeper before ejecting safely from their burning plane. The aircraft then exploded and plummeted into the Gulf of Tonkin off the coast of the North Vietnamese Nghe An Province. As Coffee and Hanson's parachutes hit the water, enemy boats raced to pick them up. Coffee was captured immediately, and though he reported seeing Hanson nearby when they landed in the water, Coffee never saw him again. (In November 1988, Vietnam returned Hanson's remains to the U.S. government.)

Though only 32, Coffee, who joined the Navy in 1957 after graduating from UCLA with a degree in commercial art, had seen his share of danger. He was one of the first reconnaissance pilots to fly low-level missions over Cuba during the Bay of Pigs Crisis in October 1962. The photos from his mission proved to the United Nations that Cuba was stockpiling Soviet nuclear missiles, and he was awarded the Distinguished Flying Cross. For the next three years, Coffee was a flight and reconnaissance training instructor assigned to Heavy Reconnaissance Attack Squadron Three in Sanford, Fla., before being deployed to Vietnam in 1966.

For seven years and nine days after he was plucked from the water by his captors, Coffee was held as a prisoner of war

Photo Courtesy Coffee Enterprises, inc.

Lt. Gerald Coffee (left) and Lt. Arthur Day (right) being debriefed by Rear Admiral Joseph Carson, Commander of Fleet Air Jacksonville.

and was tortured by the North Vietnamese. Much of his time was spent in solitary confinement. Coffee's first prison cell—a dank, squalid cubicle 6½ feet long and barely wider than his body—had a tiny, double-barred window with a view of the prison wall. When he moved, the heavy wooden shackles around his ankles knocked into the small, lidless bucket that served as his bathroom. The tiny space did not prevent him from moving. To pass the hours, Coffee "walked" several miles each day by taking three steps around the perimeter of his cell, turning with each step.

Any communication with another prisoner meant severe punishment. Using a tap code system based on 25 letters except "K" arranged in five rows of five, Coffee and his fellow POWs—many of whom he would never meet face-to-face—tapped out covert conversations on cell walls. Though there was no formal teaching of the tap code, most new "residents" of POW camps caught on within a matter of days. Through tapping, they comforted and encouraged one another.

"We encouraged and cared for each other. We passed information, learned poetry, even learned languages," says Coffee. They also relied on humor to bolster spirits. "My first shower was in a dank, converted cell with water dripping down from a rusty pipe," says Coffee. "Totally dejected, I looked up to let the water splash on my face and saw scratched on the wall the words: 'Smile. You're on *Candid Camera*'."

In 1970, the North Vietnamese transferred Coffee to the "Hanoi Hilton," the infamous Hao Lo prison in downtown Hanoi. There he met fellow POW John McCain, who would later become a U.S. senator and run for president in 2008. Over tapped conversations late into the night, the two men became close friends and were released together on Feb. 12, 1973.

Upon release, Coffee was decorated with the Silver Star, two Bronze Stars, two Purple Hearts, the Vietnam Service Medal with 13 stars and other awards. He served an additional nine years in the Navy before retiring with a total of 25 years of military service. His sense of duty also extended to the political arena. Coffee made two unsuccessful bids for office: first for state office in 2004 and for a U.S. Senate seat in 2006; and he worked for his fellow POW as head of the John McCain 2008 presidential campaign in Hawaii.

Coffee earned a master's degree in political science from Cal-Berkeley after his release, and the California native, who now lives in Hawaii (a dream he held while in captivity), has forged a new career as a motivational speaker. To survive in captivity, Coffee learned to rely on both a personal creed he developed—faith in yourself, in others, in America and in God—and the POW's guiding principles of "Return with Honor" and "Unity Over Self."

Through his speeches and in his autobiography, *Beyond Survival: Building on the Hard Times—A POW's Inspiring Story* (Coffee Enterprises, 1990), Coffee, now 75, speaks of his POW experience as a metaphor for human survival: "I quit asking God 'Why me?' … and asked him to help me to use this time productively so [the time] is not … a vacuum in my life," he says. "After that realization … every day took on a new meaning because there was purpose."

► ***A Life with Purpose*** **appeared in the Fall 2009 issue of *BOSS*.**

‘IRON HORSE’ LOU GEHRIG

The legendary Yankees slugger became known not only for baseball greatness, but also for incredible courage and dignity

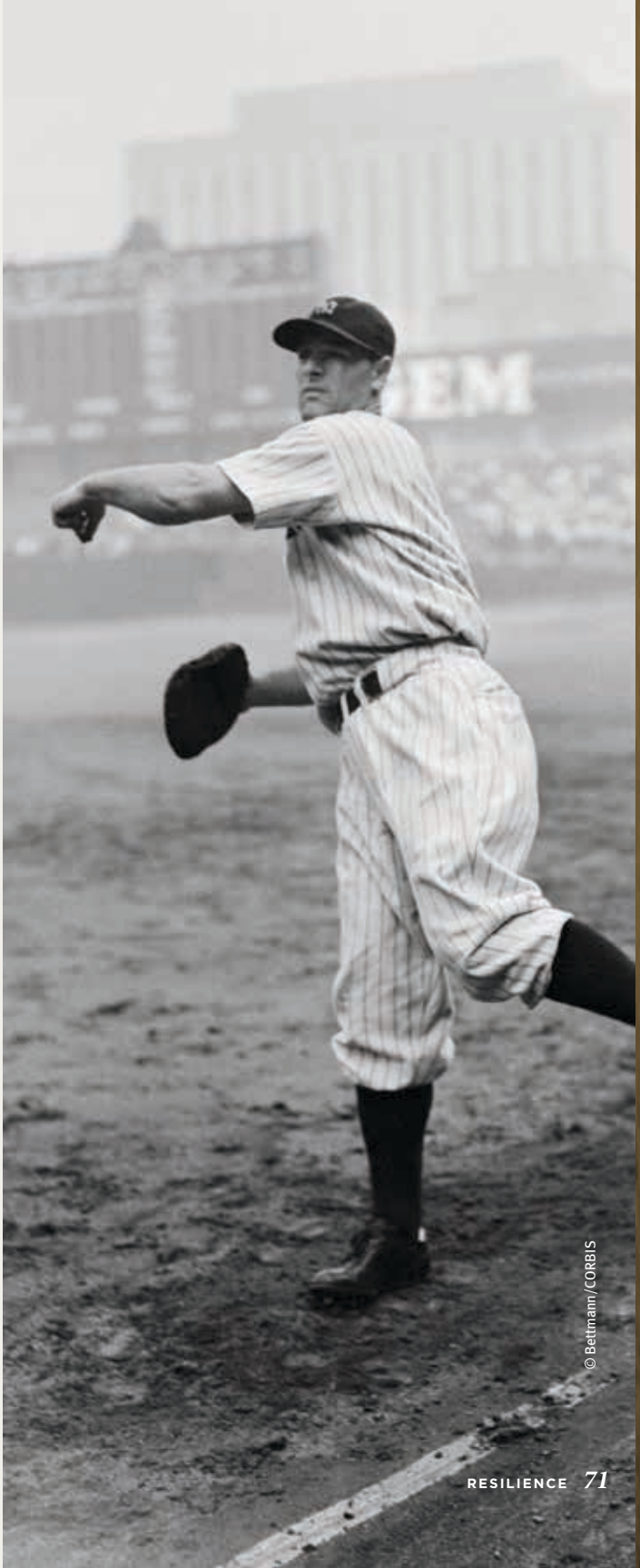
BY SUE DE PASQUALE

The moment is one that will go down in the annals of sports history.

The mighty slugger Lou Gehrig, the “Iron Horse,” stood on the Yankee Stadium diamond on July 4, 1939, a pile of trophies and gifts at his feet. In the stands, tens of thousands of admiring fans were silent. Wiping away tears, Gehrig leaned into the microphone and began, “Fans, for the past two weeks you have been reading about the bad break I got. Yet today I consider myself the luckiest man on the face of the Earth ….” His voice catching, Gehrig went on to praise by name the “grand men” he had known on the field and off, his parents, and wife Eleanor, a “tower of strength.” He concluded, “I may have had a tough break, but I have an awful lot to live for.”

The “tough break” he referred to, of course, was ALS (amyotrophic lateral sclerosis)—the progressively fatal neurological disease that came to bear his name. The affliction had cruelly struck him down in his prime, as the 36-year-old came off two world championship seasons for the Yankees in 1936 and 1937. Though ALS felled the nation’s favorite first baseman with heartbreaking swiftness, the grace and dignity Gehrig showed in facing his illness ultimately sealed his legacy as one of the most heroic sports figures of all time.

Born in New York City on June 19, 1903, young Louis was the only one of four children born to German immigrants



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Lou Gehrig, hard-hitting first baseman for the New York Yankees, played 14 straight seasons without missing a game.

The 'Iron Horse' kept chugging along, leading the mighty Yankees to postseason victories while playing through injuries that would have benched lesser men.

Christina and Heinrich Gehrig to survive. An imposing woman, Christina plied her only child with food and worked tirelessly to make ends meet, earning her son's lifelong devotion. "If there were a Hall of Fame for mama's boys, Gehrig would have been a shoo-in," writes Jonathan Eig, in *Luckiest Man: The Life and Death of Lou Gehrig* (2005).

Young Lou enjoyed pickup baseball, but wasn't particularly coordinated. "Some ballplayers have natural born ability," the left-hander once said. "I wasn't one of them." He practiced relentlessly and by his teens was hitting balls out of the park at New York City's High School of Commerce. In 1921, he enrolled at Columbia University on a football scholarship, though he also played pitcher and first base for the Columbia Nine. Amazed by his hitting ability, baseball scout Paul Krichell signed him to the Yankees with a $1,500 bonus (about $93,000 in today's U.S. dollars). On June 2, 1925, Gehrig was tapped to replace an ailing Wally Pipp at first base. He would not miss a Yankee game for the next 14 years.

American League baseball greats in the line-up of the 5th All-Star Game played on July 7, 1937. President Franklin Roosevelt watched the game at Griffith Stadium in Washington, D.C. From left: Lou Gehrig, Yankees; Joe Cronin, Red Sox; Bill Dickey, Yankees; Joe DiMaggio, Yankees; Charley Gehringer, Detroit Tigers; Jimmie Foxx, Red Sox; and Hank Greenberg, Detroit Tigers.

Everett Collection/Newscom

Lou Gehrig, No. 4, was a powerhouse at the plate. From 1926 until 1938, his batting average never dropped below .300. He clouted home run after home run, and hundreds of runs batted in. And, on June 3, 1932, he became the first American League player to hit four home runs in a game. "To see his broad back and muscular arms as he spread himself at the plate was to give the impression of power as no other ballplayer I ever saw gave it," teammate Joe DiMaggio would later recall.

Throughout the late 1920s and early 1930s, Gehrig played in the shadow of fellow slugger and teammate Babe Ruth, whose outspoken, fun-loving nature compared to the reserved Gehrig made Ruth a favorite with sportswriters and fans. "The fact that he was being taken for granted didn't bother Gehrig a bit," DiMaggio remembers. "He was courteous, gracious and informative whenever the writers asked him anything, but he didn't mind being left to himself."

Like the dependable train he was nicknamed for, the "Iron Horse" kept chugging along, leading the mighty Yankees to postseason victories while playing through injuries that would have benched lesser men: a broken thumb, broken toe, back spasms, lumbago. (X-rays later showed 17 different fractures in his hands that had healed while he played.)

It was in 1933, when sportswriters first noted that Gehrig was on a "streak" of consecutive games played. That year he married the outgoing Eleanor Twitchell of Chicago, who became Gehrig's "manager." She urged him to start signing autographs, get chummier with the press and (for the first

Everett Collection/Newscom

Washington, D.C., c. 1926. The Yankees' Lou Gehrig scores head first in the fourth inning as Joe Harris's throw gets away from catcher Hank Severeid of the Washington Senators. The Yanks beat the Senators 3-2.

time) negotiate with Yankees management for a higher salary. With his wife's encouragement, the dimpled Gehrig even went to Hollywood, starring in the 1938 Western, *Rawhide*.

But during spring training in 1938, Gehrig began to falter. He tripped rounding base more than once, and developed painful blisters and bruises on his hands. Gehrig went hitless the first four games of the season and ended April with a dismal .133 batting average. The frustrated slugger had no idea that his once bulging shoulder muscles were atrophying, his calves shrinking; refusing to give up, he tinkered with his stance, ordered lighter bats, changed his grip—and continued to play in game after game. Named to the American League All-Star team that July, he came back after the break with a vengeance, recording 12 hits—including three home runs—in 33 at-bats. Though his body was betraying him, Gehrig pushed himself to the limit, ending the regular season with a .295 average and 29 home runs. The Yankees went on to win the World Series, handily beating the Chicago Cubs.

By the following spring, however, Gehrig realized his "slump" was inescapable. On May 2, 1939, he sadly told Yankees manager Joe McCarthy that he was removing himself from the lineup, ending his streak of consecutive games played at 2,130 (a record that stood until the Baltimore Orioles' Cal Ripken Jr. broke it in 1995). "It's a black day for me," McCarthy told reporters. "And the Yankees."

At Eleanor's insistence, Gehrig traveled to the Mayo Clinic in Minnesota in a desperate effort to discover what was sapping his strength. It was there, in May, that Gehrig received the diagnosis of ALS. He died two years later, on June 2, 1941, with Eleanor at his side.

"His records will attest to future generations that Lou Gehrig was one of the greatest baseball players who ever lived," noted then *Herald Tribune* writer Richards Vidmer. "But only those who have been fortunate enough to have known him during his most glorious years will realize that he has stood for something finer than merely a great baseball player—that he stood for everything that makes sports important in the American scene."

► ***'Iron Horse' Lou Gehrig*** **appeared in the Fall 2007 issue of *BOSS.***

Photo by Ricky Carioti/The Washington Post via Getty Images

HEALING HANDS

Ben Carson overcame tough odds to become one of the world's top neurosurgeons

BY LAUREN GLENN

He was, by his own admission, a horrible student.

It was just one of many hurdles blocking Benjamin Carson's path to success. Anger issues and low self-esteem also ranked. And, of course, there were other obstacles—growing up poor as the son of a single mother who had only a third-grade education and another son to provide for.

Carson's rise from poor and quick-tempered inner-city Detroit teenager to internationally renowned pediatric neurosurgeon has catapulted him into the spotlight—in a made-for-television movie on TNT, in books, in numerous television interviews—and garnered him countless awards, including the nation's highest civilian award, the 2008 Presidential Medal of Freedom.

Best known as the first physician to successfully separate conjoined twins connected at the back of the head, Carson has traveled the world performing separations that most believed impossible. Meanwhile, as his successes gained attention, his personal story began to resonate as well.

Often, in that narrative, it is the violent and unmanageable temper of his adolescence that plays one of the most defining roles. By his own account, he once tried to attack his mother with a hammer and, later, attempted to stab a friend during a fight over a radio station. The knife's blow was deflected by the young man's belt buckle, so no harm was done. But Carson walked away shaken.

Terrified of his own actions, Carson realized he had to gain better control of his temper and himself. Having long dreamed of becoming a physician, Carson decided to immerse himself in his studies. He graduated from high school with honors and then worked his way through Yale University, where he earned a degree in psychology. He continued on to medical school at the University of Michigan, where he made a fascinating self-discovery: While his temper once proved unsteady, his hands never did.

"I became acutely aware of an unusual ability—a divine gift, I believe—of extraordinary eye and hand coordination," Carson wrote in his autobiography, *Gifted Hands*. "It's my belief that God gives us all gifts … and the gift of eye and hand coordination has been an invaluable asset in surgery. This gift [encompasses] the ability to understand physical relationships, to think in three dimensions. Good surgeons must understand the consequences of each action, for they're often not able to see what's happening on the other side of the area in which they're actually working."

After medical school, Carson accepted a neurosurgery residency at Johns Hopkins Hospital. When his training was finished, he began work as a neurosurgeon at Sir Charles

> *It's my belief that God gives us all gifts ... And the gift of eye and hand coordination has been an invaluable asset in surgery."*
>
> *—Dr. Ben Carson*

Gairdner Hospital in Australia. A year later in 1984, he returned to Hopkins, where, at age 33, he was appointed director of pediatric neurosurgery. From there, his accomplishments continued mounting.

In 1987, Carson made history when he successfully separated 7-month-old twins Patrick and Benjamin Binder, who were joined at the head. The surgery, which took 22 hours and a team of 70 doctors, nurses and other support staff, was the first in a long series of separation procedures. In a career filled with operations that most surgeons would never dare attempt, not every case was as successful. "Every time a patient dies, I'll probably carry an emotional scar just as people receive an emotional wound when a family member dies," Carson has said. "As I look back on my own history of surgery and the work we do at Hopkins, I remind myself that thousands would have died if we hadn't operated."

Aside from his work with conjoined twins, Carson has broken medical ground in other ways. He was the first surgeon to perform an intrauterine procedure to relieve pressure on the brain of a hydrocephalic fetal twin. He is also known for his pioneering work in radical hemispherectomies—removing a portion of the brain to restore quality of life for patients with profound epilepsy.

In 2002, Carson was diagnosed with prostate cancer, and he cut back his workload significantly. Today he is cancer-free and still performs about 300 surgeries each year. He also has written several books, including *Think Big: Unleashing Your Potential for Excellence*, which offers advice for success.

Today, the neurosurgeon who got his start on the tough streets of Detroit actively works to inspire disadvantaged young people through the Carson Scholars Fund. The nonprofit, which he founded with Candy, his wife of more than 30 years, awards scholarships to children in grades 4 through 11 who exemplify academic excellence.

And, prompted by the way that reading transformed his own life, Carson and his wife also have established the Ben Carson Reading Project, which provides funding and support to schools to build and maintain Ben Carson Reading Rooms—warm, inviting spots "where kids can escape into the world of books."

"Knowledge is the key that unlocks all the doors," Carson writes in *Think Big*. "You can be green-skinned with yellow polka dots and come from Mars, but if you have knowledge that people need, instead of beating you, they'll beat a path to your door."

Carson answers a question at a press conference after separation surgery performed on German conjoined twins.

JOE GIZA/REUTERS/Newscom

UPDATE

In 2013, Ben Carson retired after nearly 30 years as a neurosurgeon, and in 2015 he began campaigning to become the Republican nominee for president in the 2016 national election. Despite a strong showing in early polls, Carson couldn't get the support he needed in early primary voting. He suspended his campaign in March 2016.

► ***Healing Hands*** **appeared in the Spring 2012 issue of** ***BOSS.***

A TEENAGE HERO

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

BY LISA DE NIKE

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

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

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

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

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

Despite the fact that she was an uneducated farm girl who knew much about sheep but nothing of warfare, Joan's voices were insistent: she must shear off her hair, put on men's

This oil painting of Joan of Arc, created by N.M. Dyudin in 1848, captures the reverent young woman deep in prayer.

akg-images/Newscom

clothing and pick up arms in order to drive the English from French soil.

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

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

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

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

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

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

Statue of St. Joan Of Arc, Reims Cathedral.

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

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

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

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

► ***A Teenage Hero*** **appeared in the Winter 2008 issue of *BOSS*.**

EVER INNOVATING

> *Daring ideas are like chessmen moved forward; they may be beaten, but they may start a winning game.*
>
> —Goethe

BUILDING HOOVER DAM

An engineering wonder, it was an American triumph over the Great Depression

BY EUGENE FINERMAN

"Ten years ago the place where we are gathered was an unpeopled, forbidding desert. In the bottom of a gloomy canyon, whose precipitous walls rose to a height of 1,000 feet, flowed a turbulent, dangerous river."

So began President Franklin D. Roosevelt, speaking in Nevada to a crowd of 10,000 and a radio audience of millions. What had once been a desolate chasm now was the site of "the greatest dam in the world," and the president had come there to celebrate its completion. Today we know Hoover Dam as a national landmark, but in 1935 it was an engineering wonder. Beyond the heroic feat of harnessing the Colorado River, the dam had a psychological importance to the American people. It seemed a triumph over the Depression.

The desolate Black Canyon in 1933, site of the Hoover Dam, before excavation began.

Courtesy of U.S. Department of the Interior - Bureau of Reclamations

The construction of Hoover Dam is remembered as a hallmark of the New Deal. Yet the dam was rightfully named for Herbert Hoover. Now remembered as the hapless president in charge during the collapse of the American economy, Hoover had enjoyed the highest regard as secretary of commerce (1921–28). In that capacity, he was the advocate and arbiter of the plan to build a dam on the Colorado River. Hoover brought a unique insight to the project. Before his life in public service, he had made his name and fortune as an engineer. He fully understood all the project's challenges —and he was engrossed by them.

Dixon founder H.W. Goodall at Hoover Dam during its construction.

River seems too placid a term for the Colorado, a 1,400-mile torrent. Its wild power carved out the Grand Canyon, but such raw energy also defied man's attempts to utilize the river. In the early 20th century, Southern California had built channels on the river to irrigate the Imperial Valley. During one of its periodic floods, the Colorado raged through those channels, inundating the valley and creating California's largest lake: the 350-square-mile Salton Sea. That disaster proved the futility of half measures and wishful thinking. If the river was ever to be controlled, it required the construction of a dam.

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Courtesy of U.S. Department of the Interior - Bureau of Reclamations

Before the dam could be built, the Colorado River had to be diverted through tunnels. This piece of equipment, named a "jumbo rig," was designed to speed up the tunnel drilling process. Built on the back of a 10-ton truck, the rig contained 24 to 30 drills that could be operated at once.

But where would that dam be located? The Colorado flowed through seven states: Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming. All had to agree to a federal project on their land and the subsequent allocation of the river's waters. In 1922, Secretary Herbert Hoover helped forge that agreement: the Colorado River Compact. Then began the groundwork—literally: Government surveyors spent four years along the river's route looking for the most promising site for a dam. Geology was not the only consideration. California, with its burgeoning population, had the loudest demand for the water and the electricity that would be generated by the dam. The sale of that electricity would recoup the dam's cost. So politics and geology had to find a juncture: It was the Black Canyon, along the Arizona and Nevada borders.

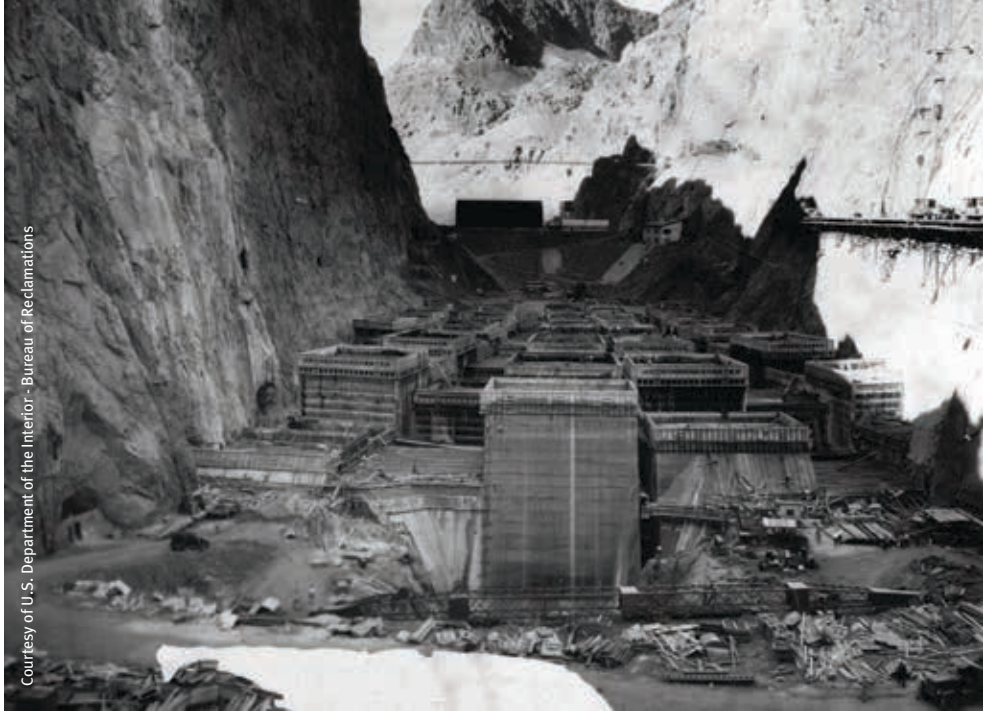
Such a project would be under the U.S. Bureau of Reclamations. Its surveyors and engineers undertook a feasibility study of the site. Their report was favorable but contained significant and daunting concerns. The chosen site was a desolate canyon, 30 miles from any roads. Factories would have to be built in the middle of the desert. The dam itself would be the world's largest and a masterpiece of engineering; taming the Colorado required nothing less.

With the exception of wars, the construction of the dam would be the most expensive undertaking by the federal government to date. Yet, the dam was possible; it certainly would benefit the Southwest, and the costs eventually would be recouped. In 1928, with a booming economy and limitless optimism, Congress and President Coolidge could afford the world's most expensive dam. The construction of Boulder Dam was approved.

When Herbert Hoover was elected president that same year, the unemployment rate was 4 percent. When he was voted out of office four years later, the rate was 23 percent. The brilliant engineer proved a tone-deaf politician. He consistently underestimated the growing Depression, claiming "prosperity is just around the corner." However oblivious he was to the Depression, Hoover remained committed to

Everett Collection/Newscom

Drillers excavating the dam foundation on the Nevada side of Boulder Dam, 1933.



Courtesy of U.S. Department of the Interior - Bureau of Reclamations

Setting the dam's foundation.

Boulder Dam. It would provide employment, stimulate the economy and foster future growth. The work at Black Canyon would not begin until 1931, but the unemployed began streaming into nearby Las Vegas a year early. The aspiring laborers camped out in public parks. Some were able to find immediate work: the laying of rail lines from Las Vegas to the canyon.

In January 1931, the Bureau of Reclamations opened bidding for the construction of the dam. Described in a 100-page book, the project would require building a 700-foot-high dam; at the time, the world's highest dam was only 420 feet. In addition, two power plants were to be built. All this was to be completed in seven years. The government would provide the construction material. As a guarantee of performance, a $5 million bond would be required of the construction firm. In the economy of 1931, no single construction company could afford that bond. However, a group of firms formed a joint venture to bid on the project. They named themselves Six Companies and calculated their lowest possible offer. It was $48,890,995 (about $748 million today)—and the winning bid.

In the spring of 1931, Six Companies could hire 3,000; four times that many people applied. The average wage was 65 cents an hour ($11 an hour today). Men worked eight-hour shifts, every day of the week. The first phase of the project was the diversion of the Colorado River. Its waters would be diverted around the dam construction and flow out farther downstream. To channel that water, four tunnels were dug and blasted through solid rock. Each tunnel was 56 feet in diameter and three-quarters of a mile in length. Fifteen million cubic yards of debris were removed. That debris would be used in an earthen dam to block the river and divert its waters into the tunnels. By November 1932, the tunnels had been completed—11 months ahead of schedule.

With the river diverted, construction now began on the dam. The work started with the excavation of the riverbed, digging down through 40 feet of mud and silt to bedrock. A half million cubic yards of river bottom was dredged. The dam now had its foundation of solid rock. At the same time, the walls of the canyon were being blasted smooth by jackhammers and dynamite—work done by men suspended by ropes, harnesses and tenuous luck. Above the canyon the company had constructed a factory for making concrete. Through a series of aerial cables, a 20-ton bucket of concrete

The work at Black Canyon would not begin until 1931, but the unemployed began streaming into nearby Las Vegas a year early.

Generators at the Hoover Dam power house, 1937.

could be transported anywhere within the construction site. As the construction got underway, the buckets arrived every 78 seconds.

The work was nonstop: three eight-hour shifts a day, every day of the week, and the workforce was now 5,000. Those workers lived on the site in a community called Boulder City. The government subsidized housing and food. Neither Six Companies nor the government had anticipated that men would bring their families, too. So schools had to be improvised.

Millions of tons of concrete were being poured into trapezoidal blocks, which held steel pipes inside, through which cool water flowed to speed the concrete curing process. (Once the concrete block had stopped contracting, the pipes were filled with grout.) In turn, the blocks formed interlocking columns, and the dam began to take shape. It was convex; the curving arch would face the water. At the same time, two

What had once been a desolate chasm now was the site of "the greatest dam in the world," and the president had come there to celebrate its completion.

power plants were being built. One was on the Nevada side, the other in Arizona. Water from the river would power its turbines, which then would produce 2 billion watts of electricity. That would serve the needs of 1 million people.

On February 6, 1935, the last bucket of concrete was molded into the dam. The construction was not quite finished; some grouting was needed, and there were cosmetic touches as well. But its majestic structure was evident. Boulder Dam was 726 feet high, 1,244 feet wide and 660 feet thick at the base, tapering to a thickness of 45 feet at the top. It surpassed the masonry of the Great Pyramid of Egypt, the first man-made structure to do so. The diversionary tunnels were plugged, and the Colorado River began to fill behind the dam and form a lake—a process that would take two years. That lake, which would store 9.2 trillion gallons of water, would be named for the director of the Bureau of Reclamations: Edward Mead.

Boulder Dam was dedicated on September 30, 1935. The American public saw it as a triumph, a testament to the American spirit even in those dark times. The dam seemed like a reassuring promise. Its look was modern, clean and streamlined, ready for the future. In 1947, the dam was renamed for Herbert Hoover. He had described the dam as "the greatest engineering work of its character ever attempted by the hand of man"—and he was alive to enjoy some credit for that achievement.

► ***Building Hoover Dam*** **appeared in the Summer 2015 issue of** ***BOSS.***

MIND CONTROL

Welcome to the world of thought-powered prosthetics

BY ANDY MYERS

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, M.D., Ph.D., 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.

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

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.

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.

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. ➨

► ***Mind Control*** **appeared in the Fall/Winter 2014 issue of *BOSS*.**

SIPA USA/SIPA/Newscom

SIPA USA/SIPA/Newscom

Dr. Wernher von Braun stands in front of a Saturn IB launch vehicle at Kennedy Space Flight Center.

ROCKET MAN

The life and times of Dr. Wernher von Braun

BY KAREN BAXTER

"I have learned to use the word impossible with the greatest caution."

As a child, Wernher von Braun dreamed of exploring space. The young German, born in 1912, could never have imagined though that one day he would play a key role in America's space flight program.

Von Braun was born in Wirsitz, Prussia, the second child of Baron Magnus von Braun and Baroness Emmy von Quistorp. According to a biography from the Marshall Space Flight Center in Huntsville, Ala., von Braun's early years were indicative of his life's path with a visionary interest in helping to "turn the wheel of time." Von Braun composed music and salvaged used auto parts to build a new car—a project that he says he found more interesting than school, and which led to his status as a less than "star pupil."

Von Braun conducted his first rocket experiment when he was 12. He rigged a half-dozen of the biggest skyrockets he

Dr. von Braun surrenders to U.S. Army Counterintelligence personnel of the 44th Infantry Division in Ruette, Bavaria, on May 2, 1945. Left to right are Charles Stewart, CIC agent; Dr. Herbert Axster; Dieter Huzel; Dr. von Braun (arm in cast); Magnus von Braun (brother); and Hans Lindenberg.

could find to an unmanned wagon and lit them.

He later wrote about the incident: "It performed beyond my wildest dreams. The wagon careened crazily about, trailing a tail of fire like a comet. When the rockets burned out, ending their sparkling performance with a magnificent thunderclap, the wagon rolled majestically to a halt.

"The police, who arrived late for the beginning of my experiment, but in time for the grand finale, were unappreciative. They quickly took me into custody. Fortunately, no one was injured and I was released to the minister of agriculture [my father]."

Von Braun's grades improved after his father transferred him to a boarding school near Weimar. There, he was greatly influenced by Hermann Oberth's book *By Rocket to Space*. Following his graduation, von Braun joined other members of the German Society for Space Travel as one of the professor's assistants on the proving grounds of the Chemical and Technical Institute, the German equivalent of the U.S. Bureau of Standards.

Von Braun received his bachelor's degree in mechanical engineering from the Berlin Institute of Technology in 1932 at the age of 20 and his Ph.D. in physics two years later from the University of Berlin, where he studied liquid-fueled rocket engines. Around that time, he became involved in the Verein fur Raumschiffarht (rocket society), according to a biography by the NASA History Division.

Also in 1932, he began building rockets for the German army. He was a part of what was dubbed the "rocket team," which operated at a secret laboratory at Peenemünde on the Baltic coast, and was responsible for developing the V-2 ballistic missile—which flew at speeds in excess of 3,500 miles per hour—for the Germans during World War II.

Making him somewhat of a controversial figure, von Braun joined the Nazi party in 1937. He says he was pressured to do so.

"I was officially demanded to join the National Socialist Party. At this time [1937] I was already technical director of the Army Rocket Center at Peenemünde ... My refusal to join the party would have meant that I would have to abandon the work of my life. Therefore, I decided to join. My membership in the party did not involve any political activities …"

In a letter to author R.W. Reid, he also said:

"With the tight press censorship imposed by Hitler, the abuses of his regime were not nearly as visible to the average German … I never realized the depth of the abyss of Hitler's régime until very late. … While right from the beginning I deeply deplored the war and the misery and suffering it spread all over the world, I found myself caught in a maelstrom in which I simply felt that, like it or not, it was my duty to work for my country at war."

After being arrested by the SS for "crimes against the state" (for reportedly saying the war was not going well) in 1944, and then released, von Braun led the surrender of 500 of his top rocket scientists to the Americans before the Allied capture of the rocket complex. A team of American scientists was dispatched to the complex to collect documentation and

missile components. Von Braun and his men were brought to the United States in a transfer known as "Project Paper Clip."

The men were transferred to Fort Bliss, Texas, where they were not allowed to leave the installation except with a military escort. They sometimes referred to themselves as "PoPs," Prisoners of Peace, according to the Marshall Space Center biography. Nearby, in White Sands Proving Grounds, in New Mexico, they worked with American associates to refurbish and launch some of the V-2s that had been shipped in from Germany.

During this time, von Braun mailed a marriage proposal to his first cousin, Maria von Quistorp. In March 1947, they married in a Lutheran church in Germany. Their first child, Iris, was born at Fort Bliss Army hospital in December 1948, later to be followed by Margit and Peter.

In 1950, the team moved to the Redstone Arsenal near Huntsville. Five years later, von Braun became a U.S. citizen. It was in Huntsville that his team built the Jupiter ballistic missile, which successfully launched the Western Hemisphere's first satellite, *Explorer 1*, in 1958. America's space program had been born.

Dr. von Braun explains the Saturn Launch System to President John F. Kennedy. NASA Deputy Administrator Robert Seamans is to the left of von Braun.

Everett Collection / Newscom

"He was an instant hero," writes author Diana Semler, who in a biographical article describes von Braun as "a social charmer who hated to get up early and got his best ideas at midnight." Semler goes on to say, "This tall, blond genius not only had an unquenchable enthusiasm for space flight but also played the cello and piano. His favorite foods were spaghetti, steak, fish and Chinese food."

NASA opened the Marshall Space Flight Center in 1958 and transferred von Braun and his team there to work for the newly created NASA. Von Braun served as director of the center from 1960 to 1970.

In 1969, von Braun's dreams were realized when a Saturn V rocket developed at Marshall launched the Apollo 11 crew. Six teams of astronauts explored the moon's surface as part of the Apollo program.

Von Braun moved to Washington, D.C., in 1970 to serve as NASA's deputy administrator of planning. Less than two years later, he retired from NASA to become vice president of engineering and development for Fairchild Industries, a defense company in Germantown, Md., where he helped establish the National Space Institute, a precursor of today's National Space Society.

In addition to his work at NASA, von Braun left his mark on popular culture, by serving as a technical consultant on three space-related Disney television movies in the 1950s, including "Man in Space." He even appeared on camera in the "science-factual" films, as they were dubbed.

Von Braun died of cancer in 1977 at the age of 65 in Alexandria, Va., leaving behind a great legacy.

"There have been ups and downs, feasts and famines, and stop-and-go progress," von Braun wrote of his more than 30-year career. "But through the years there has always been a singleness of purpose, a certain consistency, that has guided my efforts and those of my teammates. And while for many years, and on two continents, the more immediate task … was to build rockets as weapons of war, our long-range objective has remained unchanged to this very day—the continuous evolution of space flight."

► ***Rocket Man*** **appeared in the Spring 2008 issue of** ***BOSS.***

akg-images / Gilles Mermet/Newscom

THE PANAMA CANAL: FEAT OF ENGINEERING

An ambitious expansion will double the cargo-carrying capacity of the canal, which famously unites the Atlantic and Pacific oceans

BY KEN STIER

When the Panama Canal opened 100 years ago to great fanfare, few could have imagined that the marvel of engineering would ever need to be enlarged.

But as the canal marks its centennial anniversary this year, it is indeed getting its first major expansion—a third set of locks that will double its cargo capacity and along the way alter trading patterns, particularly for East Coast ports in the United States.

Album/Prisma/Newscom

Ferdinand de Lesseps

The $5.2 billion expansion, which got under way in 2007, is expected to be completed in 2015. In addition to a new three-step lock complex, the original American-built canal will have new approach channels, a 2.3-kilometer-long dam, and wider and deeper navigational channels going to and through Gatun Lake, an artificial lake long ago created in the middle of the isthmus to provide water for transporting ships from one coast to the other.

While only 12 to 14 additional vessels will be able to pass through each day as a result of the Panama Canal expansion, total cargo capacity will double, since the third set of locks will be able to handle the very largest ships plying the seas—the so-called post-Panamax class. These megaships are 1,200 feet long and 165 feet wide, allowing them to carry nearly three times as much cargo as older ships (which were 965 feet long and 106 feet wide).

The new mammoth ships represent a growing portion of the world's shipping fleet, roughly 40 percent now, where size translates into lower transportation costs.

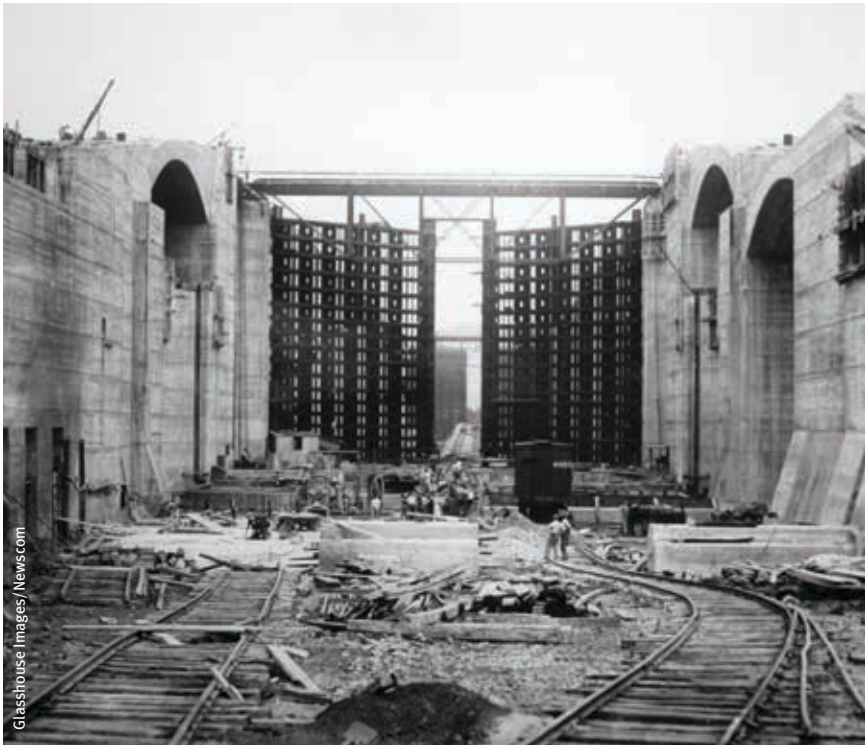
By uniting the Atlantic and Pacific oceans, the Panama Canal saves shippers 3,000 miles en route from the East Coast of the United States to Japan (the alternative would be to go around the tip of South America through the Strait of Magellan). Ships sailing from South America's West Coast to European cities—say from Ecuador to Holland—shave some 5,000 miles off the voyage. So it's no wonder that the global shipping industry has been clambering for years to enlarge the canal to allow more cargo to pass through.

'A PROFOUNDLY IMPORTANT HISTORIC EVENT'

The monumental accomplishment of the Panama Canal—celebrated as the Seventh Wonder of the World by the American Society of Civil Engineers (ASCE)—casts a long shadow on those working on today's expansion project.

Although the current expansion is technically comparable to the original canal project, it does not come close to having the same sense of historical import. "It was a profoundly important historic event and a sweeping human drama not unlike that of war," writes historian David McCullough in his book *The Path Between the Seas—The Creation of the Panama Canal, 1870–1914*. "Apart from wars, it represented the largest, most costly single effort ever before mounted anywhere in the world. It held the world's attention over a span of forty years."

Although Europeans had dreamed of a Central American canal as early as the 16th century, the first attempt at cutting a canal across Panama did not start until 1870, when Ferdinand de Lesseps, the French developer of the Suez Canal, stepped up to the task. He envisioned blasting a "big ditch" across the isthmus to create a 50-mile-long, sea-level canal without any locks, like those in Egypt. Importantly, the canal would follow the path of the Panama Railroad, which would be crucial for delivering workers, equipment and supplies, and carrying spoils away from the construction area.



Construction of Locks, The Panama Canal, circa 1912

Unfortunately, the Frenchman's effort wilted under multiple blows, not the least of which was the loss of 40,000 men to malaria and yellow fever. After years of slow digging, torrential rains and death to tropical disease, de Lesseps' efforts ended with just 11 miles of canal being dug (to the tune of $287 million, about $344 billion today).

Enter the United States and President Theodore Roosevelt, who famously declared to Congress: "No single great material work which remains to be undertaken on this continent is as of such consequence to the American people." After all, sailing from New York City to San Francisco at that time required a 13,000-mile trip over many months, around Cape Horn, the dangerous southernmost tip of South America.

By the time the canal opened on August 15, 1914, the United States had lost 8,000 men to disease, from an initial work force of 42,000.

This November 1906 file photo shows President Theodore Roosevelt (center) sitting on a steam shovel at the Culebra Cut of the Panama Canal.

When officials in Colombia began to shy away from Roosevelt's negotiations, he shifted his support to rebels on the isthmus who wanted to break away from Colombia, offering them timely protection by U.S. naval ships. The result: a new Republic of Panama, established on November 3, 1903.

No wonder, then, that McCullough describes the canal as "the first grandiose and assertive show of American power at the dawn of the new century."

When the Americans took over the project in 1904 under U.S. Col. George Washington Geothals, they vowed to eradicate every nearby mosquito. Nevertheless, by the time the canal opened 10 years later, on August 15, 1914, the United States had lost 8,000 men to disease, from an initial work force of 42,000.

The original canal excavated 200 million cubic meters—enough earth to bury the island of Manhattan 12 feet under, or to open a 16-foot-wide tunnel to the center of the Earth, according to the ASCE.

Of course, the current expansion project is no cakewalk. It requires excavating 150 million cubic meters—enough to fill the Empire State Building nearly 150 times.

A general view of the expansion works project of the Panama Canal in the Pacific area.

IMPROVING ON THE ORIGINAL DESIGN

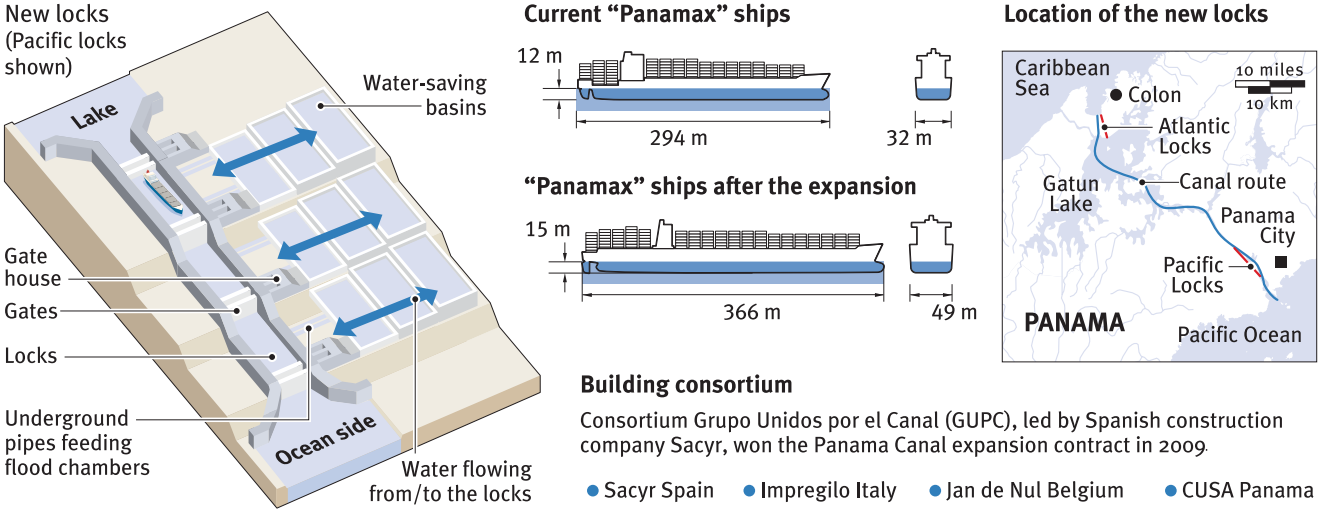
Even before the 2006 national referendum on the expansion—overwhelmingly approved by Panamanians (76.8 percent)—the canal was showing signs of being maxed out. Dry season slowdowns left jumbles of ships at anchor at the canal entrances, burning through as much as $40,000 a day in operating costs, sometimes for as long as a week. Taking advantage of such a seller's market, canal officials staged auctions to jump the queue. One BP oil tanker bid an extra $220,300 which, with regular transit fees, brought the total passage cost to $400,000, noted an account in *Popular Mechanics* magazine.

"Much like an aging bridge or highway, the Panama Canal has become a transportation paradox—at once a vital artery and a worrisome bottleneck," noted the 2010 article.

The United States had actually begun work on a third lock in 1939 to accommodate its largest warships, but this effort was discontinued soon after the United States joined the fighting in World War II. After reviewing dozens of options,

PANAMA CANAL EXPANSION

General specifications for the Panama Canal expansion project, finished in 2016.



RNGS/RTR/Newscom

the Panama Canal Authority decided to pick up the exact same route the Americans had earlier begun excavating; much of it was usable for the current expansion.

It is just as well that the Americans stopped when they did because they could not have imagined how much larger ships have gotten over the last seven decades, notes Ilya Marotta, executive vice president for engineering and programs management, Panama Canal Authority (in Spanish, the ACP). The new locks are projected to be able to handle traffic for the next 60 years—but "we have left enough real estate for a fourth set of locks if we need [it]," says Marotta.

Marotta says she is daily aware of the "sheer magnitude" of the expansion, which has required design and fabrications work in several places around the world.

There are some 10,000 workers on the eight-year-long project, she says, which is being financed with toll revenues and $2.3 billion in bilateral and multilateral development bank loans.

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Panama Canal, Gatun Locks, closing of the gates.

The Panama Canal currently services some 14,000 vessels a year—close to 300 million tons of cargo—but for all its prominence that only accounts for roughly 5 percent of the world's ocean cargo. But for the United States, the canal is vitally important. That's especially true of East Coast ports, which accounted for more than half of total canal traffic in 2011.

Workers and cranes are seen at the construction site of the Panama Canal expansion project on the Atlantic side on the outskirts of Colon City on January 15, 2014.

The new locks—the largest by far in the world—give some sense of the scale of the expansion. The reinforced-concrete lock chambers will be 1,400 feet long, 180 feet wide and 60 feet deep, with each lock complex measuring more than a mile and a half in length. The gates—changed from the old miter ones to more compact rolling gates—have doors that weigh 2,000 tonnes. These also allow easier, on-site maintenance, as do the new filling and emptying systems.

Another key improvement involves the delicate task of positioning ships into the locks: With just two-foot margins, big ships can look like sumo wrestlers in an undersized bathtub.

Currently ships are positioned by electric locomotives—known as mules—which run on lock-side rails with precious little room for error. In the newer locks, far more nimble tugboats will take over, one at the bow and another at the stern, for faster positioning, replacing the need for 12 to 16 mules that would be required for post-Panamax vessels.

Perhaps the expansion's most important design improvement relates to water—critical since the canal is at its core a hydrologic engineering feat.

Ships pass through the Panama Canal by being raised up from the coast-level entrance some 85 feet higher to the level of the Gatun Lake, which covers much of the 48-mile-wide isthmus, and then back down on the other side to the coast. This is accomplished in the lock complexes, which are composed of interconnected water chambers that lift boats up, usually in three "steps."

Currently each ship passing through these locks requires 52 million gallons of water—twice (once up and then back down). That water is "lost" in the sense that it simply drains away, eventually making its way to the ocean. That's a huge amount of water, some 200,000 cubic meters (enough to supply a city of 250,000 people for a day), for each of the 40 ships that pass through every day.

It helps that Panama has prodigious rainfall—100 inches a year (about three times Chicago's annual rainfall). That's the product of a seven-to-nine-month rainy season that supplies some 500 rivers, coursing first as mountain streams before cascading steeply down either side of the continental divide, to the Pacific or Atlantic oceans.

This water is a blessing that engineers say should not be taken for granted, especially in the face of potential climate change. The new canal locks include water-saving basins for the first time. These help capture and reuse 60 percent of the water needed to lift the ships through the lock's three steps. Even though the new chambers are significantly larger than the old ones—holding 65 percent more water—they will ultimately use 7 percent less water. "This is technology that has been used in Germany for 100 years," notes Marotta.

The politically unpalatable alternative would have been building even more dams to create new reservoirs, a project that would have necessitated relocating residents, even entire communities.

Left: Transport ship at Panama Canal. Right: A tanker ship in the MiraFlores locks on the Panama Canal.

The U.S. trade lane most likely to be impacted by Panama Canal expansion is Northeast Asia-East Coast U.S. trade because it is the largest trade lane (as shown here) and because it is where larger ships are most likely to be deployed. East Coast U.S.-West Coast of South America trade, the second-largest trade lane in terms of tonnage, could also be affected. There is likely to be minimal impact on trade lanes with smaller volumes, such as U.S. East Coast trade with the West Coast of Central America, which are handled by feeder services using smaller vessels and trans-shipment through Panamanian ports.

PRINCIPAL PANAMA CANAL TRADE ROUTES BY CARGO TONNAGE – FY 2012

Panama Canal Principal Trade Routes	Volume *(million long tons)*	Percent of Total 2012 Tonnage
Northeast Asia-East Coast U.S.	84.3	38.7%
East Coast U.S.-West Coast South America	27.6	12.7%
Europe-West Coast South America	14.4	6.6%
South America Intercoastal	11.1	5.1%
East Coast U.S.-West Coast Central America	12.2	5.6%
Europe-West Coast U.S./Canada	9.8	4.5%
U.S. Intercoastal	5.7	2.6%
East Coast South America-West Coast U.S./Canada	3.7	1.7%
East Coast U.S. Canada-Oceania	2	0.9%
All Other Routes	47.6	21.7%
TOTAL	**218.1**	**100%**

Source: Panama Canal Authority, Statistics and Models Administration Unit, October 2012.

TOTAL U.S. TRADE VALUE – 2010 & 2040 (in $ billions)

World Region	IMPORTS 2010	IMPORTS 2040	IMPORTS CAGR *(Compound Annual Growth Rate)*	EXPORTS 2010	EXPORTS 2040	EXPORTS CAGR *(Compound Annual Growth Rate)*
Canada	$261.9	$684.3	3.3%	$230.6	$628.0	3.4%
Mexico	$219.4	$553.2	3.1%	$149.8	$441.0	3.7%
Rest of Americas	$175.2	$515.4	3.7%	$196.0	$630.0	4.0%
Europe	$271.6	$958.2	4.3%	$228.5	$909.6	4.7%
Africa	$86.0	$154.5	2.0%	$22.7	$69.1	3.8%
SW & Central Asia	$122.3	$251.0	2.4%	$82.8	$254.4	3.8%
Northeast Asia	$613.5	$2,327.4	4.5%	$251.9	$1,052.3	4.9%
SE Asia & Oceania	$65.7	$224.0	4.2%	$54.7	$210.7	4.6%
World Total	$1,815.6	$5,667.9	3.9%	$1,217.1	$4,195.1	4.2%
Asia Share of World	44.1%	49.4%	-	32.0%	36.2%	-

Source: Federal Highway Administration, Freight Analysis Framework 3, December 2011.

Forecasted trade patterns underscore the importance of Asian trade to the future of the U.S. economy and the need to accommodate a forecast of more than threefold increase in the value of imports from, and almost a fourfold increase in exports to, the whole of Asia (NE, SW, and SE) from 2010 to 2040. The value of trade with other regions will also grow significantly.

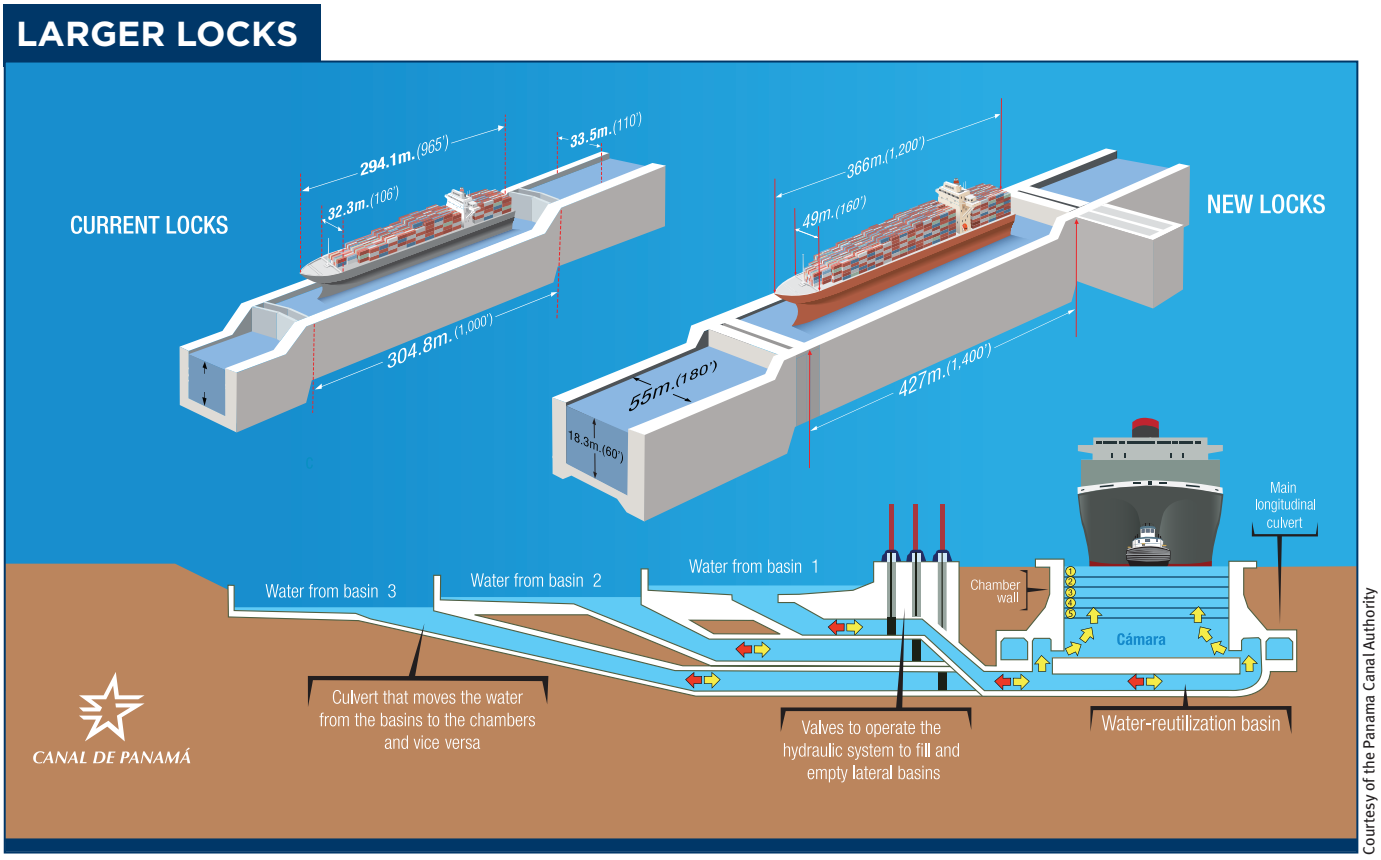
DIVINING THE IMPACT

The canal's expansion is largely driven by the intensely cost-competitive shipping industry, and by the fact that larger vessels mean less expensive operating costs per cargo unit. Bunker fuel (fuel used aboard ships that is so-named from the containers it is stored in) is the biggest cost, and the larger, newer vessels have more efficient engines.

The expanded canal's enhanced economies of scale are expected to have a meaningful impact on global trade, but divining what those possible impacts are is a major analytic challenge, now the subject of an increasing number of studies.

The U.S. Department of Transportation's Maritime Administration is currently funding one of the most comprehensive examinations, which will likely shape public and private infrastructure investment choices to come. "We think it is going to be a huge tool for [policymakers and the private sector] to reference," says Keith Lesnick, a senior Department of Transportation (Maritime Administration) official.

Phase One of the 202-page *Panama Canal Expansion Study*, released in November 2013 (and conducted by consultants led by the Economic Development Research Group in Boston), offered some preliminary findings rooted in the most basic expected change: "Because larger ships transiting the canal will mean lower unit costs for transporting a container via the Panama Canal, volumes may be shifted to Panama Canal routes to take advantage of the lower relative



Courtesy of the Panama Canal Authority


CARLOS JASSO/REUTERS/Newscom

The first four new gates for the Panama Canal's third set of locks are seen on top of a cargo ship during their arrival to Colon in Colon City on August 20, 2013. The third set of locks has a total of 16 rolling gates, eight for each new lock complex.

cost." These costs savings will be most attractive to key U.S. trade routes—U.S. trade with Asia, Australia/New Zealand, and the West Coast of Central and South America.

The report noted that the East Coast ports of the United States are the dominant users of the canal, accounting for 51.6 percent of total canal traffic, up from 42.9 percent in 2000.

These are also the routes that are expected to be the main potential beneficiaries of the canal expansion. Their all-water routes—to be plied by ships double the previous capacity, from 5,000 TEU (20-foot equivalent unit) vessels to 13,000 TEU—should offer significant transportation cost savings. That should make the landed price of goods at Eastern and Gulf ports cheaper and more competitive than those being delivered now from West Coast ports, where goods from the largest (post-Panamax) ships are currently received after being trucked or hauled by rail across the continent.

That natural waterborne advantage is explained by the Maritime Administration's Lesnick: "One of the things we are focused on in this agency is that we want to keep freight on water as long as we possibly can before it reaches the ultimate consumer—because waterborne is so much more efficient, environmentally sound and is extremely beneficial for the economy in general."

But whether these potential cost reductions are realized—and who pockets the savings—depends on myriad, currently unknowable, factors. These include the toll rates Panama intends to collect, and how current transportation providers—ports, railroads and truckers—will respond, possibly by reducing prices to retain market share.

A key factor: how smartly the East Coast ports of the United States prepare for the gargantuan ships that could come calling by 2015. Those ports with greater capacity for container handling, storage and movement to inland destinations will be in a better position to win port calls. So far only Baltimore, Norfolk and Miami are believed prepared.

Veteran engineer Stephen Curtis, who has testified before Congress on transportation issues, says megaprojects like the Panama Canal expansion are measured not only by the usual terms—of coming in on budget and on time—but whether the project fulfills its larger objective over a time frame that could stretch a century or longer.

When the expansion project was first suggested by then Panamanian President Martin Torrijos in 2006, he promised it would transform Panama into a First World country. If that does come to pass—the country already has a relatively high per capita income level of $7,910 but also one of the most highly skewed income distributions in the region—it might serve as a kind of final vindication for Panama's U.S.-orchestrated breakaway from Colombia, more than a century ago.

With unemployment in Panama now at the lowest levels ever experienced, about 4 percent, the future definitely looks bright, notes *Port Technology International*, which calls the expansion project "an economic engine capable of offering a myriad of opportunities for generations to come."

UPDATE

While planners initially predicted completion of the Panama Canal expansion project in 2015, work continued into 2016. As of February, final testing was being conducted and less than 4 percent remained to complete the overall expansion project. Authorities expected the expanded waterway to be inaugurated before the end of 2016.

► ***The Panama Canal: Feat of Engineering*** **appeared in the Summer 2014 issue of *BOSS*.**

THE MAGIC MATERIALIZER

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

BY ALLEN ABEL

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

Left: A rendering of the 3D Printed Canal House in Holland.

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.

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.'" ➨

► ***The Magic Materializer*** **appeared in the Fall/Winter 2014 issue of** ***BOSS.***

Bottom left: The house's building blocks, forged by a 3D printer. Right: Opening day.


DUS architects

Marije van Woerden

https://corporate.goodyear.com

CHARLES GOODYEAR

Determination fed the inventive fire for the ultimately penniless inventor

BY SARAH ACHENBACH


Everett Collection/Newscom

In 2005, the world's multibillion-dollar rubber industry produced more than 20.8 million tons of natural and synthetic rubber and, across the globe, there is one cultivated rubber tree for every two humans on earth.

With such staggering statistics, it's hard to imagine the rubber manufacturing industry ever had a shaky start. Shakier still was the life and livelihood of Charles Goodyear, the determined, sickly inventor who created the first weatherproof rubber to be manufactured from the oozing sap of the gum rubber tree.

His fanatical vision to create what he called "elastic metal" drove Goodyear in and out of prison for unpaid debts and in courts over dozens of patent battles. But it also led him to his subsequent discovery of the vulcanization process for rubber—a process that remains nearly unchanged from 1844, when Goodyear patented it, to today. Still, when Goodyear died at the age of 59 in 1860, he was penniless.

The father of modern rubber and the sole inventor of the vulcanization method, neither he nor his family were connected to the company named in his honor: the Goodyear Tire & Rubber Co., the world's largest rubber company.

During the early 1830s, "rubber fever" was sweeping America. Inventors, including a bankrupt hardware merchant named Charles Goodyear, worked hard to develop a year-round rubber from natural, waterproof gum rubber. Manufacturers hurried to build factories to meet the demand for new rubber products. In the summer of 1834, the 34-year-old, typically morose Goodyear excitedly presented his rubber valve for life preservers to the Roxbury India Rubber Co. in New York, the country's first rubber manufacturer. After being shown stinking, melted products sitting useless on the factory shelves, Goodyear was shown the door. Pencil erasers notwithstanding, it turned out the new rubber goods so in demand cracked in the cold of the winter and melted into a gluey substance in the summer. Customers were livid, factories were closed, and manufacturers and investors went bankrupt. The rubber revolution, it seemed, wouldn't bounce back.

Goodyear's rejection sparked an idea about rubber's gummy properties—a curiosity that led five years later to his discovery of the vulcanization process. Eager to experiment, he returned home to Philadelphia, only to end up making an immediate and familiar detour: serving time in debtor's prison. With a batch of raw rubber and a rolling pin supplied by his wife, Clarissa, Goodyear conducted experiments in his cell. He had struck upon the idea of adding a dry powder to the naturally adhesive, raw rubber to absorb the substance's stickiness. The "magic" powder for his earliest experiments was magnesia.

After his release from jail, the bankrupt Goodyear talked a friend into investing in the promising results. Using their kitchen as a factory, Goodyear, his wife and small children made hundreds of rubber over-soles only to watch the entire inventory melt. Neighbors complained of the smell, so Goodyear moved his "factory" to a squalid, fourth-floor tenement in New York City.

Relatives and friends urged him to stop his experiments and find a venture that could feed his family, but he continued

Tire production at an early Goodyear plant.

undaunted, certain that he could single-handedly rekindle the country's faith in rubber. One key to his ultimate discovery came about while trying to remove paint using nitric acid from one of his rubber product samples. The sample turned black, so Goodyear threw it away only to retrieve it days later to marvel at the smooth, dry rubber that had resulted.

With an advance from a New York investor, Goodyear began producing clothes, life preservers, shoes and other products laced with nitric acid. Once again, Goodyear's luck wouldn't hold. The financial panic of 1837 wiped out both investor and inventor, and Goodyear, now 37, moved his family to an abandoned rubber factory on Staten Island, scrounging for food and financial backing.

Investors in Boston offered him another chance and convinced the government to order 150 rubber mailbags made from Goodyear's nitric-acid process. So confident of his product, Goodyear stored the completed order in a warm room and took his family on a month-long vacation. Every mailbag melted, and he was now destitute. Again, the family packed up, this time moving to Woburn, Mass., so that he could continue his experiments in local factories. Farmers took pity on the inventor and his family, allowing Goodyear to dig in their fields for half-ripe potatoes.

It was in Woburn that Goodyear discovered how to vulcanize rubber during the bitter cold of a New England winter in 1839. By this point, he had abandoned adding magnesia and nitric acid and began using sulfur. Legend has it that Goodyear—now racked with gout—hobbled through the snow on crutches to the Woburn general store to show off his latest experiment. The locals around the pot-bellied stove took one look at him and laughed at the penniless, crippled inventor. Goodyear started to wave his experiment. It flew from his fist and hit the stove, resulting not in a sticky mess, but rather a charred, leathery strip with a springy edge.

Goodyear's daughter writes of a less colorful version. After an experiment, Goodyear brushed some useless rubber and sulfur from his hands onto a hot stove. His daughter observed, "As I was passing in and out of the room, I casually observed a little piece of gum which he was holding near the fire, and I also noticed that he was unusually animated by some discovery which he had made. He nailed the piece of gum outside the kitchen door in the intense cold. In the morning he brought it in, holding it up exultantly. He had found it perfectly flexible, as it was when he put it out."

Whatever the event that sparked the discovery, Goodyear was adamant that his discovery of heating the rubber mixture was due not to circumstance but to providence, that it was meant for the man "whose mind was prepared to draw an inference," and who had "applied himself most perseveringly to the subject." With renewed vigor, he now spent day and night experimenting with different heat levels from roasting the foul-smelling rubber in hot sand to using the family oven to bake it. To finance his endeavors, he pawned his children's schoolbooks and household furniture. He even sold the dishes, making rubber dishes for the family—though there was little, if any, food to eat. When spring 1839 arrived, he traveled to Boston to find friends who might finance him and was thrown in jail for not paying a $5 hotel bill. Upon return, he found that his infant son had died, one of six of the 12 Goodyear children to die during his lifetime.

Soon, he discovered the perfect level of heat needed for his sulfur and gum mix: steam applied for up to four to six hours at around 270 degrees Fahrenheit. Ironically, for Goodyear, whose family wore rags, the textile industry would be the first to manufacture a product that introduced his discovery to the world. His wealthy brother-in-law and Springfield, Mass., textile manufacturer used Goodyear's suggestion to weave rubber threads to create a better ruffled shirt front, which was the fashion rage in the mid-1800s. Once a manufacturing and consumer nightmare, rubber was now a rousing success, and factories across the world reopened to manufacture rubber products.

Choosing not to invest in manufacturing, Goodyear returned in earnest to his experiments, envisioning uses for rubber in a variety of goods from musical instruments and jewelry to sails and even ships. He fashioned for himself rubber vests and hats and used a rubber calling card. In 1844, in what would be his last smart business move, Goodyear applied for and received a U.S. patent for his invention (#3,633). Thus began the legal battles that would plague the remaining 16 years of his life. Goodyear went to court more than 36 times for patent infringement rights. In 1852, he famously hired Secretary of State Daniel Webster to defend him in the Circuit Court of the United States. With a legal oratory that made headlines, Webster was successful in defending his client's right to be named the sole inventor of vulcanized rubber, named for Vulcan, the Roman god of fire and craftsmanship.

When Goodyear died on July 1, 1860—emaciated and huddled over from sickness—he held more than 60 patents for rubber products. He had also perfected India rubber cloth, a mixture of fiber and rubber gum. He had lived to see his discovery result in hundreds of rubber goods and produce $8 million worth of products annually. Manufacturers were making fortunes from Goodyear's invention, yet numerous court battles over infringements on his 60-some patents cost him dearly. He owed $200,000 when he died. His family eventually became comfortable from royalties, though no Goodyear was ever connected to the company founded in 1898 that bears the family name.

The debt the world owes this disease-addled, debt-ridden inventor with unwavering curiosity and dogged perseverance is immeasurable. In his autobiography—printed on gum elastic sheets and rubber-bound—Goodyear eloquently expressed the philosophy that drove his lifelong fanaticism to create usable, modern rubber. "The writer is not disposed to repine and say that he has planted and others have gathered the fruits," Goodyear wrote. "The advantages of a career in life should not be estimated exclusively by the standard of dollars and cents, as is too often done. Man has just cause for regret when he sows and no one reaps."

► ***Charles Goodyear*** **appeared in the Spring 2007 issue of** ***BOSS.***

https://corporate.goodyear.com

Though Charles Goodyear had no connection to the tire company that bears his name, his discovery of the vulcanization process made success possible for manufacturers around the world.

A CENTURY OF INNOVATION

It's a momentous milestone few privately owned companies ever reach: In 2016, Dixon celebrates its 100th anniversary.

Headquartered in Chestertown, Md., with distribution centers around the globe, Dixon has grown to become a leading innovator in the hose coupling industry.

However, the heart of the company and its success is the work ethic and founding philosophy of the man who created Dixon on March 21, 1916. Howard W. Goodall and his vision and drive still inspire the men and women of Dixon today.

"I am convinced that we are successful because we've always had leaders who value the contributions of employees at all levels," says CEO Richard L. ("R.L.") Goodall, grandson of Howard W. ("H.W.") Goodall. "It's about treating people right—about applying the Golden Rule, with both our customers and our employees. It's really that simple."

Dixon President Bob Grace, who has been with the company for a quarter of its 100-year run, says, "It's the people we've had at Dixon over those 100 years who have made the company so successful." Though Dixon has grown from a single plant in downtown Philadelphia to a thriving business with manufacturing and distribution centers spread across four continents, its founding values have never wavered, he says. These values continue to infuse every level of the company today, from the factory floor to a far-flung distribution site in Perth, Australia.

Grace points to the "Six Pillars" of character—trustworthiness, respect, responsibility, fairness, caring and citizenship—as being central to the company's mission of uncommon excellence. "It's very reassuring to know that these are the values we live by here at Dixon," he says. "They aren't just words on a paper. We live and breathe the Six Pillars."

In 1887, with an eighth-grade education, 15-year-old H.W. Goodall quit school to take a job as a general clerk and errand boy for Philadelphia rubber distributor Latta & Mulconroy Company. As the son of a cabinetmaker, he loved to tinker and was soon designing hose couplings and clamps as accessories to Latta & Mulconroy's hose line. With Mulconroy's blessing, H.W. promoted the new couplings to a few accounts. When Goodall requested permission to expand Mulconroy's business model and introduce his products to the region's leather tanning industry, Latta refused—and fired the ambitious young man.

Goodall saw the setback as an opportunity. He went on to found the Goodall Rubber Company and the Knox Manufacturing Company to manufacture and sell hose and couplings. He was more than an astute inventor and engineer—he was a gifted salesman who recognized the importance of asking industry leaders what products they needed to do their jobs better. In an age before airplanes made travel easy, he crisscrossed the country, visiting every

ca. 1900s

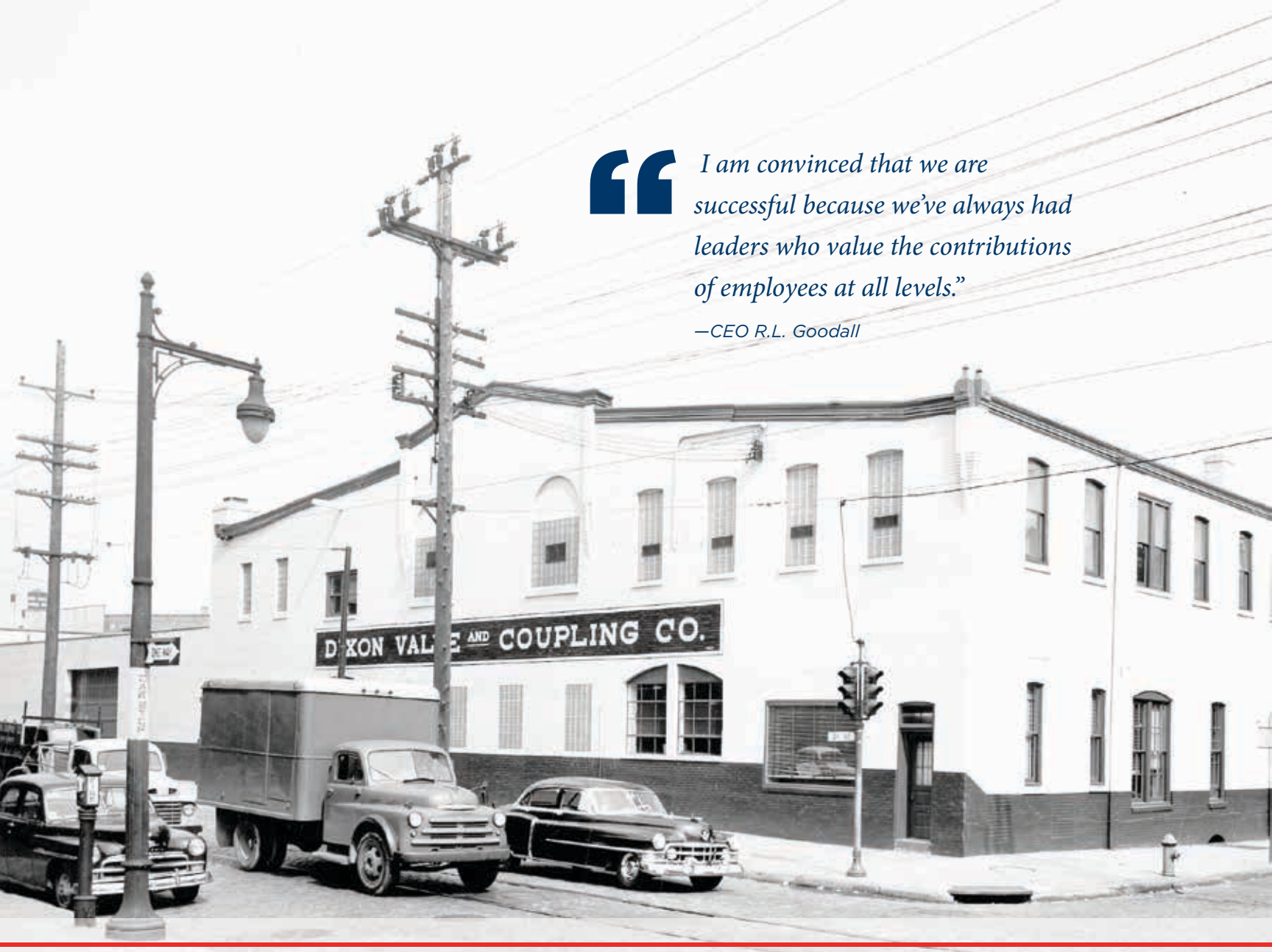
Product catalog for the Goodall Rubber Company

1916

Dixon is founded by Howard W. Goodall.

I am convinced that we are successful because we've always had leaders who value the contributions of employees at all levels."

—CEO R.L. Goodall



As Dixon grew, it moved several times to larger locations, settling in 1929 at Hancock and Columbia Avenues in Philadelphia. That would remain the company's headquarters until 1976.

major construction site he could locate, identifying its hose and coupling needs and then manufacturing the necessary products.

On March 21, 1916, armed with firsthand knowledge of the needs of the United States' growing mining, oil drilling, construction and railroad industries, H.W. Goodall founded Dixon Valve & Coupling Co. in Philadelphia. Eight years later, urged to slow down for health reasons, he sold the Goodall Rubber Co.—he previously had sold the Knox Co.—to concentrate exclusively on Dixon.

As the company grew, it moved several times to larger locations, eventually settling in 1929 at Hancock and Columbia avenues in Philadelphia. That year, and for the next 15 years, the largest selling item in the Dixon line was rotary hose couplings, a high-pressure fitting used in oil drilling. Early items in the product line, which remain Dixon products today, were Boss™ couplings, King™ single and double bolt hose clamps, air hammer couplings, suction couplings, Air King™ universal couplings and King™ combination nipples. Prior to World War II, Dixon promoted and sold these basic products while continually adding new hose fittings and accessories.

On October 12, 1934, Dixon opened its first international distribution center, in Canada (Dixon Group Canada Ltd.) This successful investment has since expanded to four locations throughout Canada.

In 1940, some half a century after he had launched his career at Latta & Mulconroy Co., H.W. Goodall led Dixon's purchase of the company (at that point known as the Mulconroy Co.) and incorporated its products into the Dixon line as Holedall™ couplings.

With brisk sales and ongoing innovation, the future looked bright for Dixon. But the advent of World War II, which transformed the business landscape across the country, threw a wrench in the wheel of the company's expansion.

Many Dixon products fell under the federal government priority system and were used by industry and the military in the war effort. Before long, Dixon manufacturing facilities were used almost entirely for military contracts. The largest was to produce 380,000 fuse plugs for anti-aircraft shells,

1934

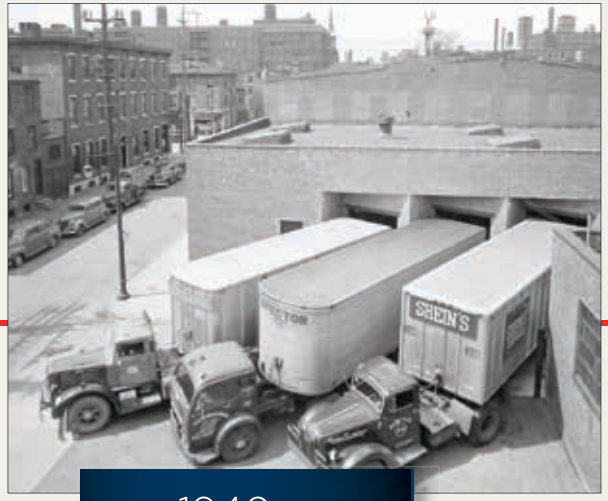
The *Dixon Driller*, launched in 1918, is the longest continually running corporate advertising publication in the United States.

1938

Dixon Driller

1939

Dixon product catalog cover



ca. 1940s

Distribution trucks prepare to head out from the Philadelphia warehouse.

A FEW DIXON FIRSTS

- Ground Joint Boss™ and air hammer couplings
- Air King™ malleable iron universal couplings with safety locking features
- Steel King™ combination nipples
- Plated hose fittings
- Dredge sleeve clamps
- Steel hose menders
- Boss-lock™ cam and groove
- Vent-lock™ cam and groove

which were run on a brand new six-spindle automatic screw machine, the only one in the Philadelphia area at the time. Since Dixon was forced to adhere to the government's wartime manufacturing priorities, the company could no longer supply standard product to its commercial hose distributor base.

During this time, a former Dixon sales manager created a partnership and started the Hose Accessories Company, later known as Le-Hi Valve and Coupling Company. With Dixon production going almost 100 percent to the military, Le-Hi Valve was able to make large inroads into the company's distributor business.

When the war ended, all the government contracts dried up—seemingly overnight. Thousands of Dixon couplings sat gathering dust at the Columbus Depot and would eventually be sold by the government for commercial use.

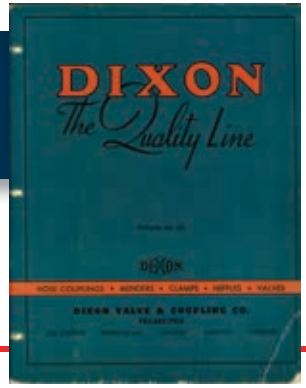
It would take fresh energy and vision to rebuild the company's customer base. Fortunately, Richard B. ("R.B.") Goodall, son of H.W. Goodall, was up to the task. The Virginia Military Institute graduate, who also held a degree from Babson College, gradually assumed more leadership in the company as his father slowed down.

In 1951, H.W. Goodall became ill while on a sales trip to California and died 10 days after his return. R.B. Goodall became president and chief operating officer. Dixon continued

1940
Dixon purchases the Mulconroy Co. and incorporates its products into the Dixon line.

ca. 1940s
Mulconroy Co. product catalog cover

1940
Dixon product catalog cover



1948
Dixon Driller

to grow and prosper under his leadership, and much of what the company is today can be attributed to his long-range thinking and understanding of the industrial hose and fitting business. He was known as being a leader who would listen to employees and offer encouragement. "His door was always open," recalls son R.L.

In 1952, Dixon purchased Buck Iron Company located in Lancaster, Pa. Eventually, this company became a major source of malleable iron, brass, aluminum and ductile castings for Dixon. Buck Company is now a leading U.S. jobbing foundry with the capability to produce medium and long-run orders in a wide variety of ferrous and non-ferrous metals.

During the 1950s, Dixon pioneered the use of non-metallic hose fittings. The Tuff-Lite™ line of nylon fittings was revolutionary in the industry and has been successful in agricultural, food and medical applications.

Beginning in the 1960s and continuing today, Dixon has demonstrated its commitment to customer service by broadening its distribution efforts. Until that time, it could take days, sometimes weeks, to ship products to customers across the country. The Dixon management team recognized the wisdom of establishing distribution centers—warehouses that could be stocked with products—at locations across the country (and later around the world). With this breakthrough, customers could be assured of prompt and efficient delivery of whatever they needed to keep their businesses rolling.

During these years, Dixon leaders also began forging partnerships with other manufacturers, a move that enabled Dixon to offer its customers important products—such as worm gear clamps—that weren't being made in-house. Though Dixon would continue to manufacture most of the products it sells, the company did begin marketing a limited number of hose fittings and accessories made by other manufacturers.

By 1976 Dixon had outgrown its Philadelphia facilities, so the business moved to a 10-acre location in Chestertown, Md.—the site of a former pickling plant. Some 15 employees and their families moved with the company to the picturesque waterfront community on Maryland's Eastern Shore.

1950
Dixon Driller

1950
The Buck Foundry

1951
Richard B. Goodall becomes the company's second president.

Dixon entered the cam and groove market in 1980 by applying for a patent for the Boss-Lock™, a fitting with a safety-locking handle. In 1985, the assets of the Andrews Division of Parker Hannifin were purchased, thus providing Dixon with the Andrews line of cam and groove fittings.

The company's international footprint also broadened during this period, with the opening in 1981 of Dixon Adflow Ltd. (now Dixon Group Europe) in Preston, United Kingdom (today's European locations also include facilities in Germany, France and Russia).

Dixon further expanded its mix of products into the hydraulic and pneumatic quick disconnect coupling market in 1993 by purchasing the Perfecting Coupling Company (now Dixon Quick Coupling). The acquisition of Dixon Quick Coupling also provided additional manufacturing and warehouse facilities; currently a 170,000 square-foot-facility.

R.B. Goodall passed away in 1994 after 65 years with the company. Sons R.L. (president) and Douglas (vice president of operations) took over to become the third generation to lead Dixon.

UNCOMMON EXCELLENCE™ DEFINED AT DIXON

- Quality products
- 12 distribution warehouses in the U.S.
- Unparalleled "product mix" of hose accessories
- World-class customer service
- Innovation Center with dedicated engineering staff for product development
- U.S.-based manufacturing
- Commitment to employees
- 98 percent same-day shipping

In 1996, Dixon made a significant move by expanding to the land down under with the purchase of Australian manufacturer Minsup. Now known as Dixon Asia Pacific, the company has expanded its product offering to include

1963

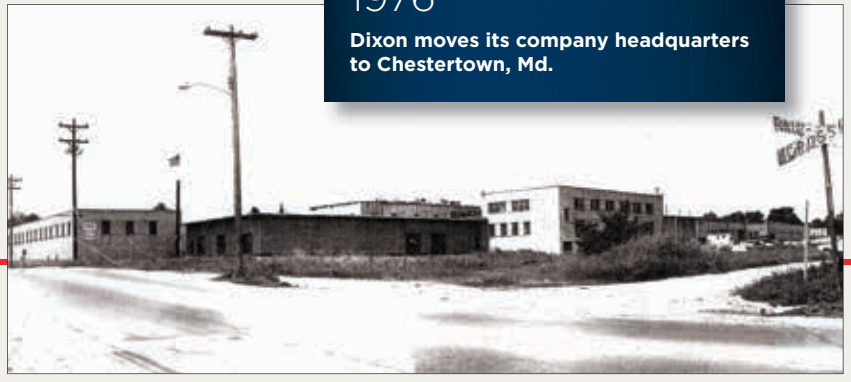
Dixon Driller

1966

Dixon Driller **marks the company's golden anniversary.**

1976

Dixon moves its company headquarters to Chestertown, Md.



OUR MISSION

- Work together to delight our customers and generate profit.

OUR VISION

- Lead in our chosen markets by setting and achieving ambitious goals.
- Provide quality products, rapid delivery and superior customer service worldwide.
- Encourage and assist all employees to reach their full potential with opportunities to influence the decision-making process.
- Be accountable for executing our plans.

OUR VALUES

- Conduct our business with honesty and integrity.
- Operate our facilities in a safe, clean and healthy manner.
- Act responsibly as a corporate citizen.
- Promote respect, responsibility, caring, citizenship, trustworthiness and fairness.

fire-protection products and has grown to incorporate six locations across Australia.

Other acquisitions quickly followed. In 1999, the purchase of American Couplings Company (now Dixon Brass) added manufacturing of brass hose fittings to the company's capabilities. That year also saw the acquisition of Bayco Industries and a merger with the already present Dixon operation in Canada. The U.S. operation became Dixon Bayco. This purchase expanded the company's product line to include petroleum and dry bulk fittings, overfill protection and accessories.

Dixon extended its reach into the food and beverage market in 2000 with the addition of Bradford Fittings (now Dixon Sanitary). A full line of 304 and 316L stainless steel fittings used in the food, dairy, beverage, cosmetic, pharmaceutical and industrial markets became available to Dixon distributors.

In 2001, Richard L. Goodall became CEO, and Lou Farina was named president, the company's first non-family member to hold the position. Under their

1978
Dixon product catalog cover

1983
Dixon product catalog cover

1990
Dixon product catalog cover

1994
Richard L. Goodall becomes the company's third president.

We've set ourselves apart in delivery by getting things quickly to our customer. That's part of our vision." —Taylor Goodall

leadership, Dixon global expansion continued on January 22, 2003, with the creation of Dixva, a distribution and sales operation in Monterrey, Mexico. In 2004, the company created Dixon Fire to serve the fire protection industry; and in 2006, it added more brass fire hose fittings to its line with the acquisition of Powhatan.

In April 2006, Dixon continued to fulfill its goal to provide quality Dixon products to the global community by opening a sales office in St. Petersburg, Russia. With the vast increase in product offerings has come a strategic decision to establish sales offices and distribution sites in locales all over the world: In addition to Australia, Mexico and Russia, Dixon today has a presence in Europe, China, India, Singapore and the Middle East.

"We've set ourselves apart in delivery by getting things quickly to our customer. That's part of our vision." says Taylor Goodall, great grandson of H.W. Goodall. "Customers have come to rely on Dixon to carry the inventory they need, and in most cases they can get what they need the same day or the very next day. Looking ahead, we will continue to find new ways to increase the speed of our delivery."

President Bob Grace, like other key members of the company's management team, spends a significant amount of time traveling to the company's far-flung facilities. "While we do a fair amount of videoconferencing, you can't replace the face-to-face," Grace says. "It's so important to spend time with Dixon employees, going over business plans, letting them know just how important they are to the company."

And that personal connection is extended to Dixon customers, says Scott Jones, vice president for sales and marketing. "We want Dixon to be the easiest company to do business with, and we're not going to compromise," he says. "When a customer calls a Dixon phone number, they'll get a live person who picks up the phone within the first two rings.

1999
Dixon purchases American Couplings Company (now Dixon Brass) and Bayco Industries.

2002
Dixon product catalog cover

2001
Louis Farina Jr. becomes the company's fourth president.

2004
Dixon Fire is created.

2009
Dixon product catalog cover

It all goes back to our core mission: We are 'wrapped around' our customers."

In 2010, when Bob Grace became president, Dixon set forth a strategic plan to reinforce its commitment to developing new products, focusing on North American manufacturing. This included continuing to make the "core" products that had served the company so well over the years, while adding innovative new products that the industrial hose market needed. A year later, Dixon acquired Northline Couplings Systems, absorbing it into the Dixon Fire product line.

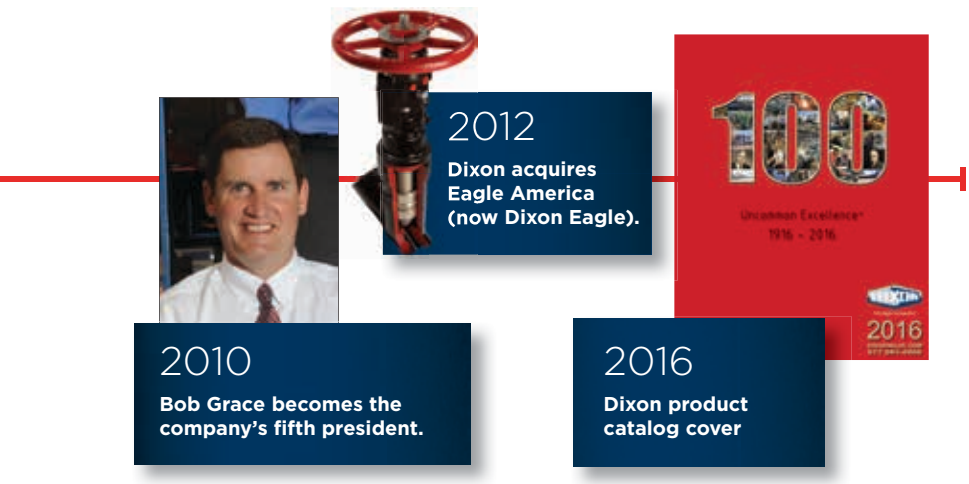
In 2012, Dixon acquired Eagle America (now Dixon Eagle), a bellows seal valve manufacturer for critical applications. That same year, the company opened its 12,000-square-foot Innovation Center. Dixon committed itself to focusing outside sales efforts on face-to-face visits and then funneling ideas and challenges back to the Innovation Center, where Dixon engineers welcome the challenge of coming up with creative solutions. To support their work, the center houses technologically advanced machine tools, testing equipment and computer-aided design using SolidWorks modeling and simulation. In addition, the Innovation Center conducts training sessions for Dixon distributors and end-users in a large, interactive training facility suitable for serving groups up to 50 people.

In recent years, the energy market has become a key area of focus at Dixon. The company has developed and acquired products that fit into every level of the petrochemical lifecycle: Boss™ Low Pressure System products for exploration, bellows seal valves for refineries, and API valves and dry disconnects for the terminals. Additionally, Dixon has also expanded its offering in the food and beverage industry to include pumps and valve actuation.

Today, a century after Dixon's founding, the company continues to promote the perfect blend of core hose accessories and solutions-based engineered products—a strategy that effectively positions Dixon to be a world leader in fluid transfer solutions.

What does the future hold for Dixon? Grace predicts continued growth and reinvestment in the company's infrastructure. "What's more," he says, "we'll continue to focus on North American manufacturing, which is very important to us, and we'll continue to innovate ever-more sophisticated ways to manufacture, mostly through automation."

CEO R.L. Goodall emphasizes the importance of staying focused on the company's founding mission—the mission his grandfather set out back in 1916. "We know about manufacturing hose couplings. We must continue to be the best at that," Goodall says. "As long as we focus on people, product and service, everything else will fall into place, and we will achieve uncommon excellence."



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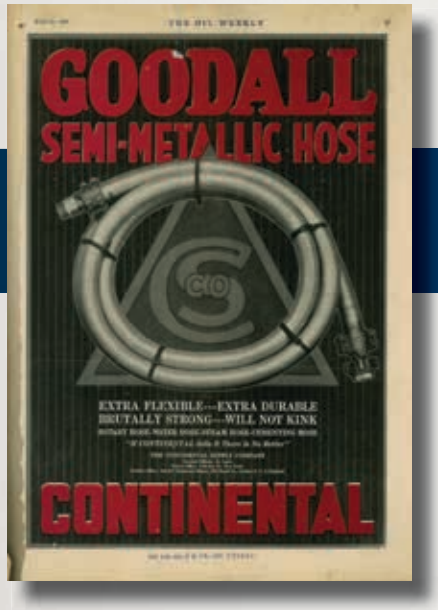
DIXON

DIXON ADS
CONNECTING OVER THE DECADES

Over the years, Dixon's advertisements have evolved to reflect the times ...

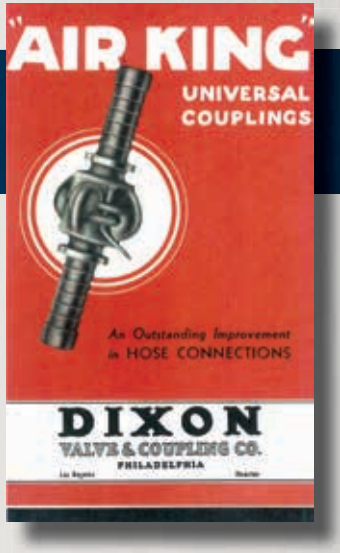
1929



1937

1937

1938



1938

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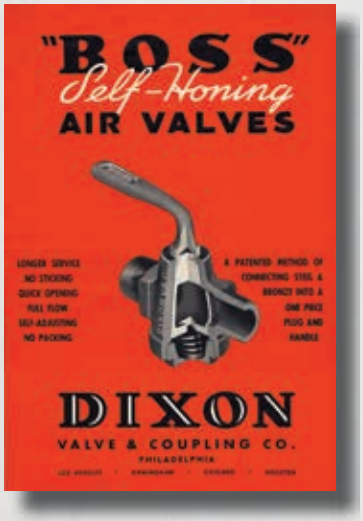

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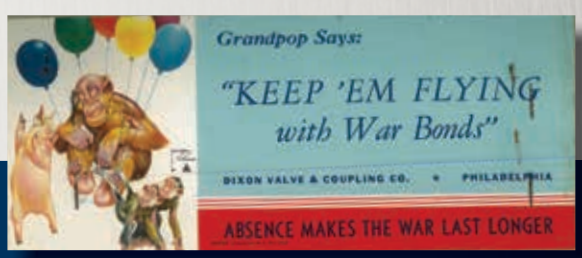
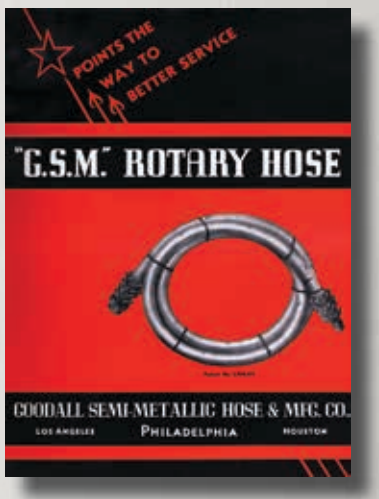
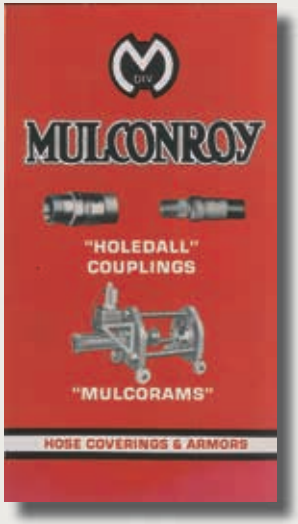


1942

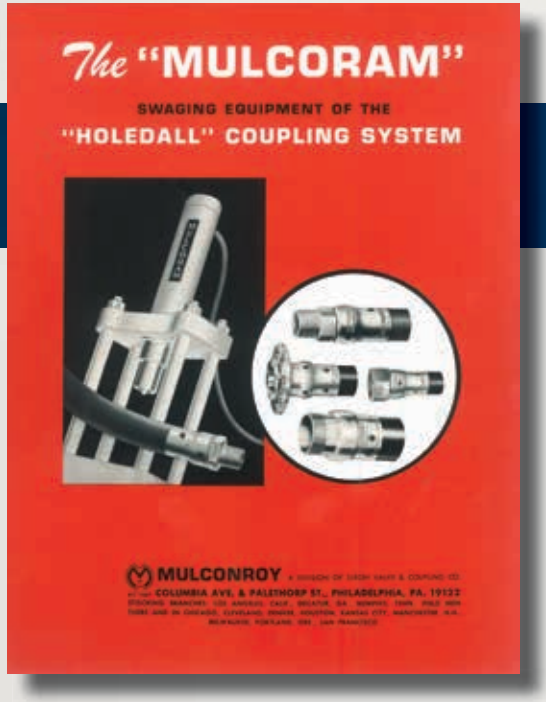
1948



1968



1991



1968

1986

1999

1999

2008

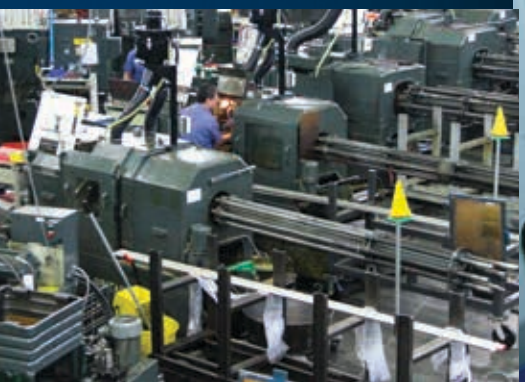
2005

2012

DIXON
AT WORK TODAY

Floor of manufacturing facility in Dallas, NC

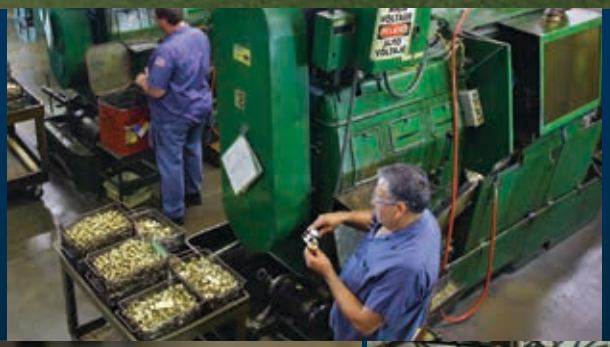
CAM-operated screw machines in Dallas, NC



Processing an order for shipment in the Chestertown warehouse

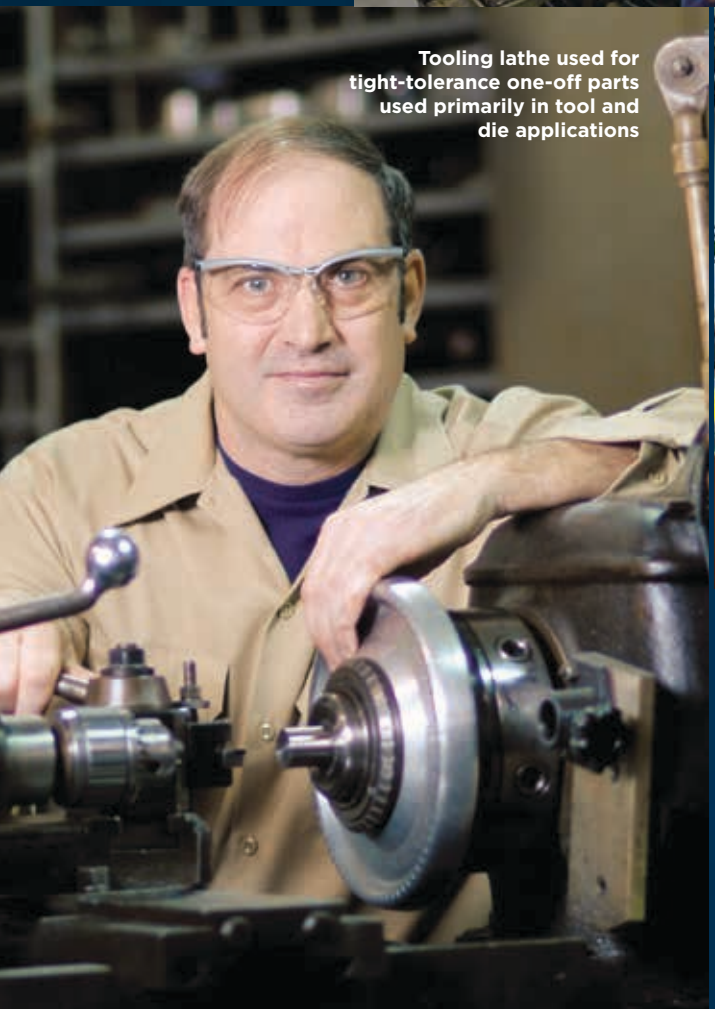
Doosan CNC Barfeed machine used to make screw machine parts from solid bar stock

Manufacturing and warehouse facility in Dallas, NC



Drilling and measuring product at Dixon Brass

Machining King Combination Nipples in Chestertown



Tooling lathe used for tight-tolerance one-off parts used primarily in tool and die applications

Chestertown warehouse

Dixon Innovation Center

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