Pittsburgh ENGINEER

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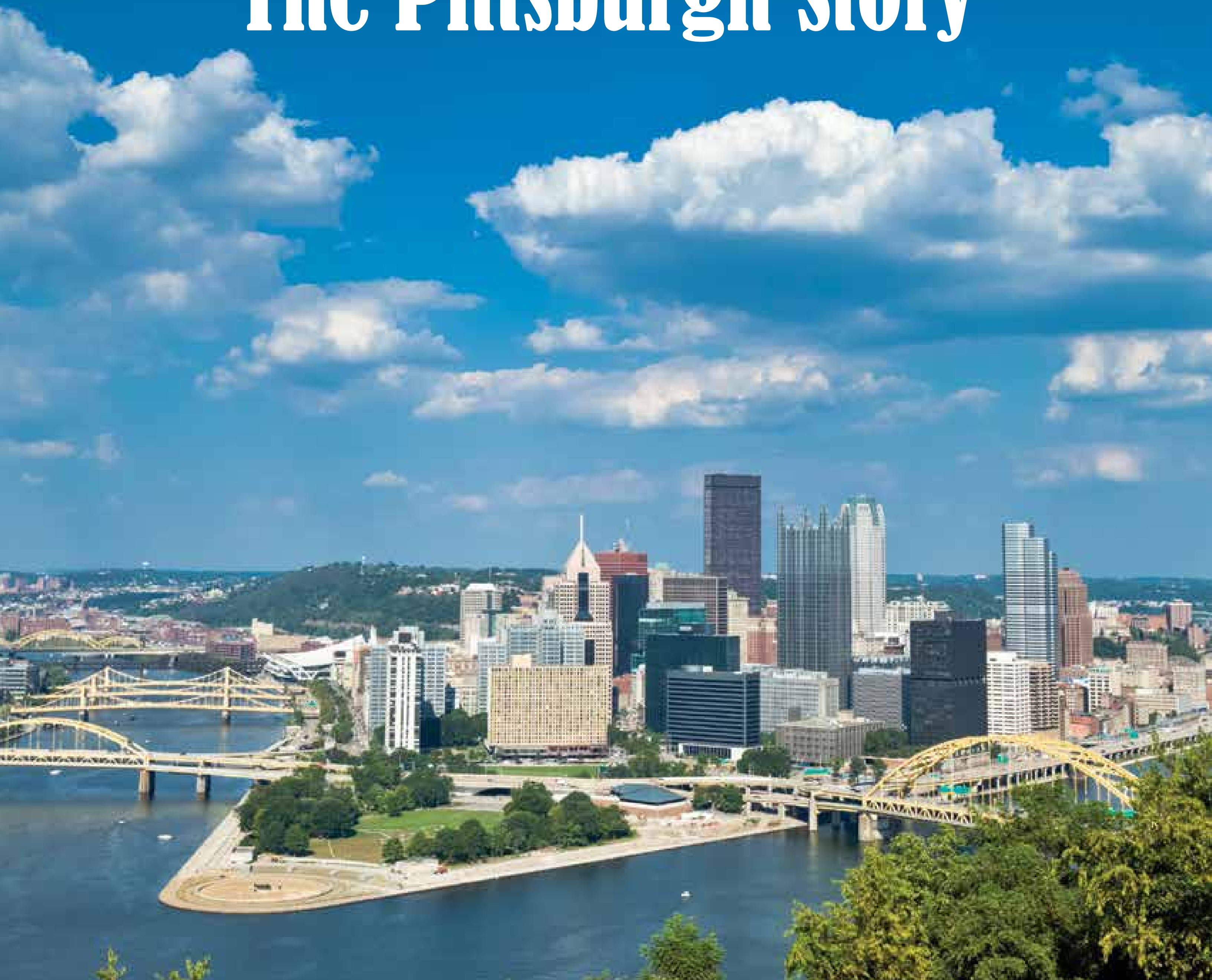
Quarterly Publication of the Engineers' Society of Western Pennsylvania

ENGINEERING A REGION:
The Pittsburgh Story



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In this issue...

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA
Pittsburgh Engineers' Building
337 Fourth Avenue
Pittsburgh, PA 15222
P:412-261-0710|F:412-261-1606|E:eswp@eswp.com|W:eswp.com

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Guest Editor Column

Engineering a Region:
The Pittsburgh Story

By Bill Flanagan

The almost half a million passengers who take the Duquesne Incline to the top of Pittsburgh's Mount Washington each year are treated to a truly exceptional view, rated by USA Today as one of the top ten views in America. (To be precise, the publication rated the nighttime view from the mountain as number two – but who's counting?) There are few vantage points that offer such height so close to the core of a major city, high enough on a clear day to see all the way to the Laurel Highlands, yet low enough for the viewer to feel immersed in the vitality of the city at the confluence of the three rivers.

USA Today ranked the view right up there with the nation's greatest natural wonders, from the Red Rock Country of Sedona, Arizona to the Grand Canyon. Not bad company for a cityscape. But in some ways it is not a fair comparison. The view from Mount Washington is not a natural wonder; almost everything visible from the platform outside the station house has been shaped by people. In fact, the view is as heavily engineered as a visitor is likely to enjoy anywhere in the world.

Pittsburgh is an engineering town, a place that has shaped engineers and has been shaped by them. The story is almost as old as the name of the place itself. It was back in 1758, during the French and Indian War, that Pittsburgh got its name. And it was only two years later that miners began to dig for coal under Coal Hill, the name Mount Washington had for much of its history. The hill just across the Monongahela from what became Pittsburgh turned out to be filled with one of the richest coal seams in the world, the Pittsburgh Coal Seam. Miners have been digging away at it ever since.

Bill Flanagan

Coal, even more than the rivers, was the reason that Pittsburgh became one of the world's great centers of industry and engineering. Foundries supplied settlers pouring onto the Ohio River to settle the continent. With seemingly endless energy resources in such close proximity to the major transportation systems of the day – first rivers and later railroads – Pittsburgh provided the resources and the technologies that made possible the modern world.

Stand atop Mount Washington and it is easy to see how the need to move people and material affected everything. The railroads claimed the easy grades of the riverfronts and roll today at the base of the mountain and along the North Shore. The rights of way affected the placement of neighborhoods and factories, parks and highways. The routes of the railroads even made possible today's regional network of biking and hiking trails, including the Great Allegheny Passage, a continuous trail that stretches from The Point across the Alleghenies to Washington, DC.

The rivers themselves are heavily engineered, tamed by a series of dams and locks that support the nation's third largest inland port. The annual flooding that claimed portions of Downtown and low-lying areas well into the 1930s is less of an issue today, controlled by a network of reservoirs high in the mountains surrounding Pittsburgh. As one of the less-trumpeted achievements of Renaissance One, to this day it preserves life and property, and makes possible a thriving whitewater recreation industry at Ohiopyle State Park.

From high atop Mount Washington, or at ground level, Pittsburgh's cityscape cuts a striking view

Perhaps most incredible is that a visitor to Mount Washington can see the view at all. Although air quality issues remain, the thick black smoke for which Pittsburgh was known for more than a century has been gone for a generation or more.

At one time 15 inclines toiled along Mount Washington, hauling people, horses and freight from bottom to top and back. Many were created to service the coal mines that honeycombed the mountain. The coal fueled the furnaces first in the Strip District and later all along the Three Rivers. As industry grew, so did the smoke.

The view from Mount Washington is not a natural wonder...the view is as heavily engineered as a visitor is likely to enjoy anywhere in the world.

In the mid-1940s, seventy years ago this year, civic leaders in Pittsburgh embarked on an ambitious program of "civic engineering," Renaissance One. Through a new private sector non-profit called the Allegheny Conference on Community Development, they set out to clean up the smoky skies, redevelop industrial slums at the confluence, remove the raw sewage that regularly flowed into the rivers, and once and for all control the flooding that had plagued the Point since its earliest days of settlement.

Renaissance One was engineering on a grand scale, based on public policy that set out to remake a region's quality of life and assure its competitiveness in the postwar era. Steelmakers and railroads adopted new technologies that made it possible to make products and move them more cleanly. Individual homeowners converted from coal to natural gas for home heating. Nuclear engineers at Westinghouse Electric deployed the world's first commercial nuclear power plant, in part to provide a cleaner source of electricity to power the region's mills.

Over the course of a generation engineers did their work. By the end of the 1970s, just 35 years after they began, the smoke was largely gone, the Point had been redeveloped, the floodwaters had been contained and a regional sanitary authority, ALCOSAN, was treating sewage from across Allegheny County.

In the years since, Pittsburgh's skyline has been transformed by a second Renaissance, a comeback from the collapse of its industrial base in the 1980s. Pittsburghers engineered many of the iconic skyscrapers across the country from the Chrysler Building in New York to the Willis Tower in Chicago. Here at home the buildings have gotten ever greener. The Tower at PNC, under construction in the heart of Downtown Pittsburgh is billed as the greenest "skyrise" anywhere, extending regional leadership in green building that began more than a decade ago with PNC Firstside and the David L. Lawrence Convention Center, successively the two largest green buildings in the world.

Inside the buildings that dot the landscape software engineers are transforming the financial services industry; and biomedical engineers are advancing Pittsburgh's healthcare and life sciences sector, our region's largest employer. Overhead, passenger jets fly lighter and cleaner thanks to new specialty metals and composites engineered in our region. In Oakland, just beyond Downtown, nano-engineers are advancing new technologies based on the science of things unimaginably small, and electrical engineers are developing more efficient ways to produce, distribute and conserve energy, continuing the work begun by Westinghouse more than 125 year ago.

Our region's natural resources are far from exhausted. Coal continues to play an indispensable role in steelmaking and power generation, while researchers explore new ways to use it more cleanly and efficiently. Natural gas is undergoing a renaissance of its own, as a result of the discovery of the world's second-largest proven natural gas reserve in the Marcellus Shale just ten years ago this year. Our human resources are just as abundant. The Pittsburgh region is home to one of the best-educated workforces in the United States, especially among younger workers, who are now moving into the region instead of moving out.

Today, atop Mt. Washington, a visitor can enjoy the view without fully appreciating how it came to be and how it evolves even today. Looking back at Renaissance One, historian and native son David McCullough once said, "It didn't just happen. People made it happen."

In Pittsburgh, many of the people who have made and are making it happen are engineers.

Science and Engineering at the Heart of PPG Industries' Innovations

Technology, innovation and engineering have been central to the history of PPG Industries. PPG is the world's leading coatings and specialty materials company. The company, which has global headquarters in Pittsburgh and operates in nearly 70 countries around the world, helps customers in industrial, transportation, consumer products, and construction markets and aftermarkets to enhance more surfaces in more ways than does any other company. Many homeowners are familiar with the company's architectural coatings brands - Glidden, Olympic, PPG Pittsburgh Paints and Liquid Nails, to name a few – which are sold at a variety of home centers.

The company's roots in science and engineering can be traced back to the company's founding in 1883, when Captain John B. Ford and John Pitcairn established the Pittsburgh Plate Glass company near Pittsburgh. From the beginning, innovation was at the heart of how PPG was built. The company aimed to evolve its product offering to better meet the needs of its customers. The company's first acquisition in the coatings industry in 1900 was the Patton Paint Company, in Milwaukee, WI.

To further expand its offering, the company began to dedicate resources to engineering and innovation. In 1910, it opened its first research and development facility. Today, PPG operates three major R&D facilities in the Pittsburgh region and many more around the world. That research has led to addressing very real issues faced by businesses and consumers. One very tangible example is the near elimination of rust on automobiles. In1963, PPG introduced the electro-deposition coating process – or e-coat – which virtually eliminates rust. Fifty years ago, this innovation was born in the company's labs in Allison Park, Pa. and tested and commercialized at its manufacturing site in Springdale, Pa. Today, more than 95 percent of the world's cars use this technology.

PPG Facility in Harmar, PA

In 1968, to reflect its diversification, Pittsburgh Plate Glass Company changed its name to PPG Industries. This same year, the company reached $1 billion in sales. In 1989, PPG began a flurry of more than 20 acquisitions over the next decade, which included Olympic Paint and Stain, Porter Paints and many other automotive, industrial, aerospace and packaging coatings companies around the world. This activity accelerated PPG's shift from a diversified chemicals portfolio to one more focused on coatings and specialty products.

In 2008, PPG made the largest acquisition in the company's history when it spent $3 billion to buy SigmaKalon. This large Dutch coatings company fit with its strategy to broaden its European coatings footprint. PPG continued its portfolio transformation in 2012 and into last year with a number of other strategic moves. This included the separation of its commodity chemicals business and merging it with Atlanta-based Georgia Gulf Corporation to form Axiall Corporation, which now has locations in Pittsburgh, Pa. PPG also acquired the North American architectural paint business of Amsterdam-based AkzoNobel in 2013. The deal more than doubles the company's North American architectural coatings business. The new home for its North American Architectural Coatings business will be in Cranberry, Pa. In addition, the company is continuing to grow its research capabilities by expanding its lab for this business, in Harmar. This will add more than 300 new jobs to the Southwestern Pennsylvania region.

PPG Architectural Coatings Building in Cranberry, PA

Completion of these and other transactions has rapidly accelerated the company's portfolio transformation. Its portfolio is now 93 percent coatings and specialty

PPG spends approximately 3% of sales of R&D

materials. And yet, the company's focus on innovation remains constant. PPG has market leading technologies in several areas including aerospace sealants, tank coatings for marine applications, electrocoat primers for industrial and automotive, and several others. Its scientists focus on making things lighter, safer, stronger, more durable, quieter and more energy-efficient. And PPG scientists and engineers know how to do it on almost every type of consumer and industrial goods surface - from automobiles and airplanes to packaging, houses, buildings, bridges, factories and much more. In almost any room, for example, it is likely that PPG materials could be found in the paint on the walls, the windows of the building, the coatings on the furniture or fiberglass in the electronics. Nearly every passport contains PPG's protective coating, called Teslin.

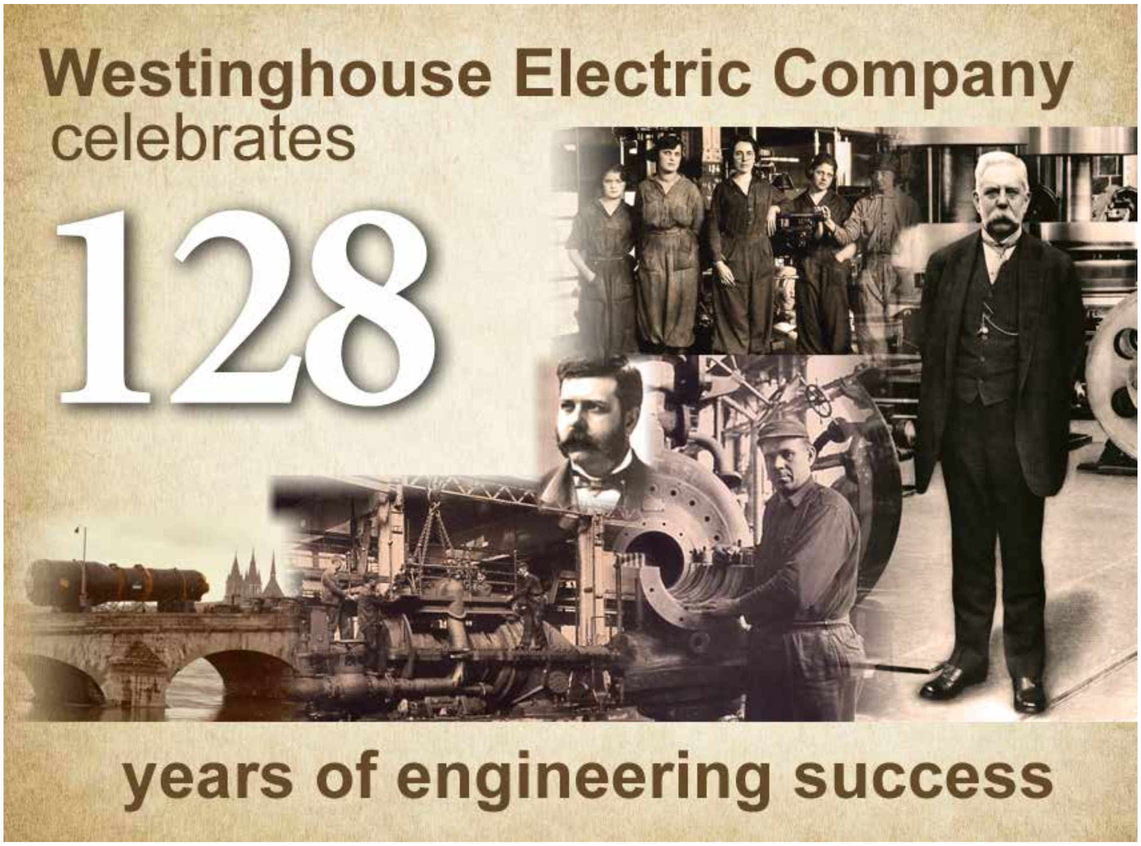
PPG has more than 5,000 material scientists, technicians, engineers, physicists and chemists, who are working on the next breakthroughs in product and application technology, around the world.

At the heart of its business is science. Today, PPG has more than 5,000 material scientists, technicians, engineers, physicists and chemists, who are working on the next breakthroughs in product and application technology, around the world. In Pittsburgh, there are about 600 STEM-related employees that work within its 800,000 square feet of combined lab space at three PPG R&D centers in the region. Many of these employees came from the University of Pittsburgh, Penn State University, Carnegie Mellon University, Duquesne University and the region's trade and technical schools.

Within PPG's R&D function in Pittsburgh alone, the company hires about 15 PhDs per year and another 15 with a bachelor of science or other technical degrees. Collectively, these colleagues create on average more than 80 new patents per year or about 1,000 in the last decade. This work has translated to about 60 new products per year that PPG believes gives it a sustainable competitive advantage in the market. New products are anticipated to generate $3 billion in sales within the next five years and generate approximately 80 patents. Research and development is a critical part of the company's innovation pipeline. Annually, it spends about three percent of sales on R&D. In 2013, this translated to about $500 million.

Every day, PPG scientists and engineers are working on the next big innovation. Some current examples in the pipeline include new state-of-the-art coatings for lithium-ion batteries; cure-on-demand coatings (paint that can dry quickly upon application, eliminating the need for large, expensive dryers found in today's in automotive shops); easy-to-clean coatings; OLED's – organic light emitting diodes used in next generation lighting; and new applications for its microporous Teslin substrate for use as a membrane for water filtration and purification.

These are applications that all have significant impacts on helping the company's customers save energy costs, be more efficient, and be successful. For PPG's new technologies to come to life – whether in the lab or in the digital space – the company relies on the work of talented, diverse scientists, technicians, engineers and IT personnel.



George Westinghouse spent hours of toil, trial and error, testing, application and adaptation. He worked hard and fast. He hired the brightest inventors and engineers of his time. And he did not stop until he could provide a complete, safe energy system that worked for practical industry and populace consumption. He repeated this pattern time and again, building a culture of continual improvement.

It is in this way that the Westinghouse Electric Company of today reflects the man who created it. Inventors and engineers who have followed Westinghouse's model continue to see solutions to problems and then develop them in increasingly concrete formulations until they are practical products that complete the tasks which sparked their births. We still grow from our roots of finding energy solutions. We are proud to look back over our history and find that the company stands firmly in our founder's footprints.

Westinghouse Electric Company was founded in downtown Pittsburgh in January 1886, at the dawn of the Age of Electricity. Although Thomas Edison's incandescent light bulb was a major breakthrough, it was Westinghouse's alternating current (AC) system, refined by Nikola Tesla, that transmitted electricity more efficiently over long distances. By March 1886, the two-month old company made its premiere imprint on history with the first U.S. demonstration of the AC system in Great Barrington, Mass. By November of that same year, the company had sold its first patented system and saw it begin operating at the first commercial AC generating station in Buffalo, N.Y.

The work of engineer and mathematical genius Tesla caught the attention of Westinghouse. Tesla's inventions included an induction motor and generators to create polyphase currents for alternating current devices. Westinghouse purchased all of Tesla's related patents and persuaded the intellectual inventor to join Westinghouse Electric.

In 1890, just four years after its founding, the company had installed more than 300 central power stations, with an employee population that rose from its initial 200 to more than 1,500. During these early years of the company, Westinghouse supported the development of engineering programs at universities and acted as a key employer of graduate engineers as the company grew – including the hiring of the country's first female electrical engineer, Bertha Lamme, in 1893.

While its successes mounted, there was fierce competition in the marketplace with the Edison Electric Company. Westinghouse pitted his company's alternating current (AC) technology against Edison's direct current (DC) system in a competition to win the lighting contract for the 1893 World's Columbian Exposition in Chicago, Ill. After years of costly research, Westinghouse won his chance. The real prize was not monetary but the 28 million witnesses for whom the company demonstrated its AC system in a dazzling display of lights and machinery and the ease with which it could be operated.

By 1894, the company introduced the first practical polyphase induction motors for simplicity in powering industrial machines. And the following year, it won a contract to build the 5,000 hp generators that set the standard for the first large system to supply electricity from one circuit to multiple end-users, and the first system to distribute electricity over a distance of 20 miles. The project proved an epoch in the progress of the electrical industry, sealing the fate of the Edison DC system.

"If someday it is said of me that with my work I have contributed something to civilization, something to the safety and happiness of human life, it will be sufficient"

– George Westinghouse (c. 1900)

Westinghouse Electric's developments became as prolific as its founder's. By 1914, the year that George Westinghouse died, the company had also brought AC power to locomotives, provided the first electric drive motors for main roll stands in steel mills and introduced the continuous filament tungsten lamp.

Notable engineering achievements continued in 1917 when Westinghouse Assistant Chief Engineer Frank Conrad built a wireless receiver and transmitter that broadcast music and announcements from his garage on the nation's first licensed radio station, 8XK. By 1920, Westinghouse launched its own station, KDKA – through which the company continues to advertise today – and in 1921 provided the first factory-made receivers for home use; 1923 brought the first international radio broadcast using short waves. Westinghouse was helping the world to connect at a more rapid pace than ever before.

Throughout the 1920s, an abundance of breakthrough technologies went to market. While in the 1930s the country was transitioning from boom to bust, Westinghouse more than tripled its research facilities and space, with innovations that helped grow the company.

For electricity generation, the dawning of a new age was again at hand. When Westinghouse decided to build the industry's first, and the world's largest, atom smasher to study nuclear physics in 1936 in Forest Hills, PA, it was another three years before the discovery of nuclear fission revealed the possibilities of nuclear power. Internal records reveal that Westinghouse chose to embark on this program of pure research with the faith that practical applications would follow. And that certainly has proven to be true.

Westinghouse brought in the Atomic Age with a $296 million program to enlarge its capacity 50 percent, and a significant portion of that growth contributed to the world's growing industrial base. For other feats, Westinghouse engineers were designing turbines to generate substantially more power at no increase in costs per kilowatt hour.

Most notably, though, was the leadership position the company was able to establish in nuclear power. With the development of zirconium cladding for nuclear fuel assemblies, the company opened a plant for continued work in the refinement of improved metal alloys and metallurgical techniques. The world saw nuclear propulsion put to action in 1955 with a Westinghouse S2W naval reactor for the first nuclear-powered submarine, the U.S.S. Nautilus, which was followed by more. Electrical production began in the world's first large-scale commercial nuclear power plant, built in Shippingport, Pa., in 1957; it was powered by a Westinghouse pressurized water reactor.

By 1972, Westinghouse had 83 nuclear power plants either on order, under construction or operating in the U.S. and around the world. The company was solidifying its position as the world leader in commercial nuclear technology. Its work landed expansive contracts to head U.S. nuclear engineering development laboratories and the nation's first large-scale demonstration breeder reactor. The company supplied 81 additional reactors through licensing agreements with global partners.

With perseverance during the 1970s, 1980s and 1990s, Westinghouse scientists and engineers continued to produce breakthrough ideas for nuclear power plants.

With the feedback and operating experience gained from utilities and its own concepts for the simplification and modularization of nuclear power plants that Westinghouse had begun in the 1980s, the company embarked on an innovative design approach involving the collaboration of engineers from 22 countries. The result was the Westinghouse AP600 nuclear power plant – a Generation III standardized design, featuring passive safety systems with a projected core damage frequency 200 times safer than that required by the U.S. Nuclear Regulatory Commission (NRC). It became the first Generation III nuclear power plant design to receive Design Certification from the U.S. NRC in 2000.

While it was strongly desired by industry, it had been designed to be cost-competitive with any other nuclear technology; but natural gas prices had remained much lower than forecasted – making it difficult for nuclear power to compete. As a result, Westinghouse engineers upscaled the design and set a new standard with the AP1000® reactor, which received Design Certification by the U.S. NRC in 2006 – to date the only Generation III+ nuclear power plant design to receive this designation.

By 2007, Westinghouse had sold the first AP1000 plants as part of landmark contracts to China. Shortly after, U.S. utilities began to contract for the new plant: Southern Nuclear for two units at its Vogtle site in Georgia, representing the first such contract in the U.S. since 1978; and the South Carolina Electric & Gas Company for two units at its V.C. Summer site in South Carolina. Today, there are eight AP1000 units under construction globally, with more planned.

This year, its 128th in operation, Westinghouse is still the pioneering nuclear technology company, thanks to our excellence in engineering. The company's values have not changed: safety, standardization, modularization, efficiency, innovation and a dedicated workforce determined to continue breaking ground to meet the needs of growing societies. Westinghouse has not forgotten its Pittsburgh heritage, nor its legacy of technological and engineering excellence. This is Westinghouse now, striving to reflect the dedication of its founder, George Westinghouse, who encompassed all of these in vision and action and whose legacy of engineering innovation still touches the lives of millions of people around the world today.

Provided by Westinghouse Electric Company

FROM PORK HOUSE TO PROJECT Z

An Early History of the Allegheny County Sanitary Authority

By Michael Anthony, ALCOSAN Historian

Prior to the 19th century, the narrow tract of land now occupied by the Allegheny County Sanitary Authority (ALCOSAN) was primarily known as a pass-through to points west. Centuries before industrialization, native Shawnee and Delaware tribes established a footpath from present-day Lawrenceville to the mouth of the Beaver River. Part of the "Great Trail" that linked New England to the Great Lakes, the path crossed the Allegheny River and traced the north shore of the Ohio, providing passage for, among others, a young George Washington, as colonial interests shifted west. By the 1800s, however, native paths were evolving into finished roadways, and William Davis' purchase of a flood plain three miles below the Point would bring a new identity to that same narrow tract.

Pork House

Davis, an Irish immigrant, purchased land extending from the river bank to the present site of Riverview Park and divided the bottoms of "Davisville" equally among his children. Hugh Davis, who was later first treasurer of Allegheny City, built a stone public house and whiskey still on his property, but it was the addition of William B. Holmes' Whirlpool Pork House that would earn the locale its new identity.

The coming of the Civil War in 1861 spurred massive industrialization in northern cities. Pork House expanded with the construction of the Ardesco Oil Refinery in 1862. Located along what is now Tracy Street in the vicinity of ALCOSAN's employee parking area, the Ardesco Refinery was the scene of a tremendous explosion on August 18, 1866. The blast, caused by the use of weak iron in a newly-installed refining still, resulted in the destruction of Ardesco's still house, receiving house, barreling and carpenter shops, 10,000 empty barrels, 1,000 barrels of crude and 1,500 barrels of refined oil.

On April 25, 1863, Henry W. Oliver, William J. Lewis and John Phillips entered into the manufacture of carriage bolts, nuts, washers and wagon thimble skeins under the name of Lewis, Oliver and Phillips. The company completed construction of the Excelsior Iron and Bolt Works at Birmingham (South Side) in 1864, and the lower mills of the Allegheny Works, located in the vicinity of what is now the ALCOSAN primary treatment facilities, in 1866. On August 6, 1880, the firm reorganized as Oliver Bros. and Phillips, and soon thereafter became one of the largest manufacturers of iron bar in the United States.

ESWP Member News

We are pleased to highlight the Corporate Member firms of the Engineers' Society of Western Pennsylvania (ESWP). With more than 75 firms represented, memberships are available at three levels: Gold, Silver and Bronze. Gold Member firms are entitled to 14 individual memberships, Silver, 9; and Bronze, 5 — annual dues are $2400, $1700, and $1000 respectively, and memberships can easily be assigned to members of your firm to allow for maximum particpation. For Government Agencies, Memberships are available at a 50% discount!

ESWP Corporate Member firms may add two more individuals in our "Under-35" age category at no additional cost. More information can be found at eswp.com. Please contact the ESWP Office (412-261-0710) for additional details.

Membership in ESWP comes with a long list of benefits! From our continuing education opportunities earning you Professional Development Hours (PDHs), to the business networking events in our fine dining city club, there is something for everyone in your organization. Also, ESWP is helping the next generation of engineers with student outreach programs, giving you the opportunity to participate in many rewarding programs.

ESWP Gold Corporate Member Firms

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gai consultants
transforming ideas into reality

i+icon USA
Infrastructure & Industrial Constructors USA

Baker

GATEWAY
On Call. On Time. On Target.

Orbital Engineering, Inc.

CDM Smith

HATCH™

DEI
DeSalvo Enterprises, Inc.

KVÆRNER™
KVAERNER NORTH AMERICAN CONSTRUCTION INC.

USS

ESWP Silver Corporate Member Firms

ASTORINO
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CEC
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KU Resources, Inc.

Lennon, Smith, Souleret Engineering, Inc.

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Aquatech

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Bayer MaterialScience

BRG Berkeley Research Group Construction Services

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Carnegie Mellon Engineering Carnegie Institute of Technology

CDR Maguire

Chester Engineers

Collective Efforts, LLC Civil and Environmental Engineers

CSD Carnegie Strategic Design Engineers LLC

dck worldwide

DANIELI Corporation

DiGioia Gray & Associates

DLA+ Architecture interior design

DQE Communications LLC

FIGG

Gannett Fleming

H.F. Lenz Company

Hatch Mott MacDonald

Hazen and Sawyer Environmental Engineers & Scientists

Highmark

Hill International

Hull

IKM

JNE Consulting

L.R. Kimball Architecture · Engineering · Communications Technology

Marcellus Shale Coalition

mascaro construction ... build with the best

MKA McTish, Kunkel & Associates

menard Ground Improvement Specialists

MOC, Inc.

ms consultants, inc. engineers, architects, planners

NGE Environmental & Geotechnical Engineering Solutions

Nicholson

Parsons Brinckerhoff

Paul C. Rizzo Associates, Inc. Consultants

Point Park University

RIG Consulting, Inc.

River Consulting

RDA

R. T. Patterson Co., Inc. Engineers & Consultants

SAI Consulting Engineers

Schnader Attorneys at Law

Sci-Tek Consultants, Inc.

SMS Siemag SMS group

SNC·Lavalin America

TeleTracking Workflow Automation for Healthcare.™

Turner Building the Future

University of Pittsburgh Swanson School of Engineering

URS

Veolia Water

Wade Trim

WC Wayne Crouse Inc. Contractors and Engineers www.waynecrouse.com

Wyatt Incorporated Interior Construction

Zell Engineers

Verner Station

James Verner also purchased land adjacent to the Pork House mills of Lewis, Oliver & Phillips in 1864 and organized the Pittsburgh Forge and Iron Company specializing in the manufacture of hammered car and locomotive axles. Verner also laid out a "company" town on the property, designing a street and housing plan for the predominantly foreign workforce. The area, including a nearby railroad station, became known as Verner Station and encompassed the entirety of ALCOSAN's treatment plant site.

Ninth Ward

Charles T. Schoen came to Pittsburgh in 1890, enlisting the assistance of Henry W. Oliver in establishing interest for his patented pressed steel railroad car design. Schoen established the Schoen Manufacturing Company on Cass Street, fabricating freight car parts from pressed steel as a substitute for more commonly used cast iron. On March 26, 1897, he was awarded a contract to build 600 pressed steel cars for the Pittsburgh, Bessemer and Lake Erie Railroad, filling the order in just nine months while completing a $500,000 plant expansion.

With demand exploding, Schoen purchased the Allegheny mills of Oliver Iron and Steel and later built an even larger facility in McKees Rocks. On January 12, 1899, Schoen merged with the Fox Pressed Steel Company and reincorporated as the Pressed Steel Car Company.

By the early 1920s, the Allegheny and McKees Rocks facilities were churning out 45,000 freight cars and more than 750 passenger cars annually. Demand for new rail cars soon ebbed, however, and by World War II, the company was facing the likelihood of failure. Wartime production of Sherman M-4 tanks served as a temporary lifeline, but by the mid-1950s the Pressed Steel plants were closed and the properties sold as warehouse space.

Devastation

The industrialization of this area played a common yet integral role in Pittsburgh's early rise as the world's workshop. By staging their industries along the region's rivers, men like Verner, Schoen, Carnegie and Frick ensured convenient access to coal and other materials necessary to keep their factories and profits in motion. Rivers were viewed not as natural resources, but as arteries to deliver natural resources. As a result, little concern was afforded when waterways, once teeming with life, became lifeless streams of disposal for those same factories.

n the 1920s, smoke billowing from factories blackened the mid-day sky and coated the city in 165.8 tons of particulate matter per square mile each month, equal to the weight of 100 cars. In mill areas, as much as 600 tons of soot and cinders rained on homes and businesses in a month's time. In addition, municipal and industrial waste, mine drainage, and other pollutants led to poor water quality and the spread of disease.

In 1907, Pittsburgh began sand filtration and chlorination of water supplies. At the same time, the city and hundreds of upstream communities continued to dump untreated sewage and industrial waste into the rivers. By the mid 1940s, less than 2 percent of the discharges into the Ohio River received any treatment at all, and the Monongahela, void of aquatic life, ran red with acid mine drainage, mill effluent, and other pollutants.

The election of Cornelius D. Scully as mayor in 1936 put a new emphasis on the environmental problems facing the City of Pittsburgh and the region. Scully was pressured by the newspapers to act in reversing the damage that years of industrial prosperity wreaked upon the condition of the city. He created the Commission for the Elimination of Smoke, opened new parks and concentrated on programs to provide the city with a cleaner water supply. With the coming of war in 1941, however, Scully was forced to put aside his campaign as the city's factories refitted to supply the war machine. The region produced 95 million tons of steel, 52 million shells and 11 million bombs to supply the Allied effort, but the pollution that resulted turned rivers into cesspools and the day sky into night.

Renaissance

As the war neared an end, civic leaders once again took up reversing years of environmental destruction in the region. Richard King Mellon, president of the Pittsburgh Regional Planning Association, generated support for a postwar planning committee to serve as a coordinating mechanism for regional transportation and environmental improvement efforts. The Allegheny Conference on Community Development was thus incorporated in 1944.

Forming a partnership with newly elected mayor David L. Lawrence, Mellon used the Allegheny Conference as a vehicle to promote what would be known as the Pittsburgh Renaissance, a "growth coalition" of capital, labor and politics. The immediate goals of this powerful partnership included smoke abatement, flood control, renewal of the Golden Triangle business district and the establishment of a regional sanitation district.

In May of 1945, two developments would move the County closer to addressing water quality issues:

- **Pennsylvania Municipal Authorities Act of 1945**
  Passed on May 2, the act provided for the incorporation

of bodies with power to acquire, hold, construct, improve, maintain and operate, own and lease property to be devoted to public uses and revenues. These uses included transportation, bridges, tunnels, airports, sewer systems and sewage treatment works.

- **Enforcement of PA Clean Streams Law of 1937**
  On May 17, Pennsylvania's Sanitary Water Board ordered 102 municipalities and 90 industries in Allegheny County to prepare preliminary plans and specifications for sewage treatment. The board further ordered cessation of sewage and industrial discharges by May 1947.

On March 5, 1946, the Allegheny County Commissioners adopted a resolution creating the Allegheny County Sanitary Authority with a plan to finance the Authority through bond issues.

Also in March, the Authority was granted office space on the fifth floor of the City-County Building and use of the city's testing laboratory on Centre Avenue. In a meeting before council on July 25, Chairman John F. Laboon estimated a 17-month period of planning and engineering before specifications for a sewage treatment system would be completed.

Decisions & Designs

By mid-year of 1946, the Authority began conducting underground audits and weir sampling to determine the extent of the region's sewage problems. Included in these audits were previously unknown mileage, capacities and conditions of the county's 102 municipal sewer systems. Thirty-five different sewer locations were chosen in preliminary sampling, which included the participation of 59 municipalities and 15 industrial sites.

Planning efforts continued through the first half of 1947, and by September 24, the Authority submitted to the Army Corps of Engineers a plan to lay interceptor sewers in the Youghiogheny, Monongahela, Allegheny and Ohio rivers.

The Authority completed preliminary sampling on November 1, 1947. In all, an average flow of 65 million gallons per day from a population of about 678,000 was measured, sampled and analyzed to determine the character of wastes emanating from municipal and industrial sewers.

On February 9, 1948, the Authority released the first of five reports recommending an $82 million single-plant treatment system for Pittsburgh and the surrounding communities. The report suggested the 48.1-acre Verner tract on the north side of the Ohio River, opposite McKees Rocks, as an appropriate location to site the treatment plant. The planned collection system included 91 miles of main interceptor sewers and 65 miles of branch interceptor sewers for immediate construction.

On March 1, 1948, consulting engineers Metcalf & Eddy approved the single-plant treatment plan, and on June 2, Mr. Laboon announced formal approval by the state Sanitary Water Board. This cleared the way for the Authority to prepare and issue contractual agreements to participating municipalities and industries.

In October, the County Board of Commissioners adopted a resolution extending the Authority's powers to include acquisition of water works.

On April 12, 1949, the Borough of Pitcairn became the first municipality to return a signed long-term contract for inclusion in the Authority's treatment plan. Only Mt. Lebanon, Ben Avon and Tarentum would follow. As a result of the disappointing return, the Authority negotiated an alternative with the city titled "Project Z" that dropped 63 communities and lowered the overall cost to $42 million.

By June of 1950, the Authority began preliminary core bores in the area of the treatment plant site. The bores indicated a variety of underground conditions including river silt, ash, coal screenings, sand and building foundations remaining from the Pork House and Verner days.

In September, the Authority completed construction of a pilot plant located under the Homestead High-Level Bridge. Built to emulate a fully designed facility and test selected treatment methods, the pilot plant cost $14,000 and had the capacity to treat up to 100,000 gallons of sewage per day.

Breaking Ground

Late in the Spring of 1951, attempts by the Authority to purchase the water systems of both the city and South Pittsburgh Water Company through the 1948 resolution of the county commissioners were officially terminated. The Authority proceeded with planning for construction of the treatment plant and collection system, hiring Celli-Flynn of McKeesport as consulting architects for all Authority buildings and Michael Baker, Jr. Inc. of Rochester to make soundings for eight interceptor river crossings.

In August of 1953, consulting engineers Metcalf & Eddy reported that plans and specifications for the treatment plant were complete.

The state Sanitary Water Board finally approved the Authority's plan for an $87 million treatment system and 63 miles of intercepting sewers on June 24, 1954, ordering the system to be constructed and operational by June 30, 1958. Following public hearings in November, a permit application was submitted for approval by the Corps of Engineers.

On February 15, 1955, the Authority received City of Pittsburgh Ordinance No. 40, expressing the city's desire to become a member of the Authority.

Beginning December 6, 1955, bids for the first construction contracts were received by the Authority. In all, $50 million worth of contract bids were opened through the month of December. In addition, all 343 property owners involved in required rights-of-way were contacted by year's end, with 26 properties expected to require condemnation proceedings.

On March 1, 1956, contractors began the first stages in the construction of the Authority's wastewater treatment system. Official groundbreaking ceremonies on April 4, 1956 began with a boat ride to the treatment plant site.

Construction

As groundbreaking ceremonies were being conducted, contractors from Dravo were beginning preparatory work for the construction of the main interceptor arteries. Workers began constructing concrete access shafts at 36th Street opposite Herr's Island and at Belmont Street just upstream of the West End Bridge. The work involved installing a cofferdam at the upstream end near Washington Boulevard, with tunnel boring progressing downstream.

On July 1, a strike by steelworkers delayed shipment of structural steel to the site by nearly a month. Additional stoppages during construction included:

- June 22-26, 1956 - dispute between cement finishers & carpenters over setting expansion material
- September 17-18, 1956 - plumbers refuse to lay pipe in trenches dug by heavy or building construction laborers
- June 3-9, 1957 - plumbers strike for increase in wage scale
- June 10, 1957 - ironworkers strike over Wayne Crouse, Inc. millwrights moving screw conveyors
- September 3-9, 1957 - dispute between carpenters and electricians
- January 15-21, 1958 - equipment operators strike over a discharged master mechanic
- May 29-July 22, 1958 - lathers strike for an increase in wage scale; Plasterers idle due to strike
- September 1-13, 1958 - slowdown by electricians, reason unknown
- April 5-15, 1959 - work stoppage of all trades, reason unknown

The accumulated delay resulting from labor strikes, slowdowns and boycotts during construction of the plant was more than 72 days.

In February of 1957, the Authority's Director and Chief Engineer John F. Laboon concluded that the dead weight of the main pump station as designed was insufficient to keep the entire structure from floating under the hydraulic pressure produced under certain operating conditions. Holes were drilled into the bottom rock of the excavation and heavy reinforcing bars were used to anchor the concrete floor of the pump station. The cost of the change was approximately $73,000.

In April. Dravo Corporation completed construction of the river wall at the plant site, the first contract to be completed under the Authority plan.

Surplus excavation materials from the treatment plant site were disposed of less than one mile away in the vicinity of Benton Avenue. Now the site of the John Merry athletic fields, the area was originally planned for the disposal of incinerator ash once the plant became operational.

Dedication

March 20, 1958, Authority employees voted unanimously to unionize, forming the Local 433 of the Utiltiy Workers Union of America (UWUA).

Speaking to a public hearing on May 14, 1958, regarding the discharge of wastes in the sewer system, Executive Director John F. Laboon stated that the Allegheny River would be a fishable water again within six months of the system going into operation.

Construction of the treatment facilities continued through the winter of 1958 and into the spring of 1959. On April 30, bulkheads were removed from individual outfall connections and the system was put into operation as a primary treatment plant.

An initial rate schedule went into effect on June 1, 1959. Based on water usage and billed quarterly, charges were $0.30 per 1,000 gallons (100,000 gallons or less), with a minimum charge of $2.50 per quarter and $0.50 per quarter for disposals.

Initial operational difficulties included the formation of football-sized grease balls in the sewers. It was estimated that by June of 1959, four to five tons of grease had been removed from the system and trucked to the City of Pittsburgh's incinerator before an engineered solution could be found. In addition, community complaints regarding odors emanating from the Authority's chimney became so prevalent that, by October, the Board of Directors ordered a general shutdown of the plant's four incinerators pending an engineering study.

Remnants of Hurricane Gracie forced the October 1, 1959, dedication of the wastewater treatment plant indoors.

On January 1, 1960, the Authority was nominated for the "Outstanding Civil Engineering Achievement Award" by the American Society of Civil Engineers. The recognition served as a fitting punctuation for the successful planning, design, construction and initial operation of ALCOSAN's collection and treatment system, and would set an indicative tone for the Authority's progression and expansion into the future.

The Discovery of the Marcellus Shale Play
An Operator's Experience

By:
Jeff Ventura[1], Ray Walker, Jr.[1], William Zagorski[2], Greg Davis[2], John Applegath[2], Matt Curry[2], Matt Pitzarella[2], Joe Frantz, Jr.[2], Don Robinson[2], Dennis Degner[1], Mike Middlebrook[1], Andrew Tullis[1]
[1]Range Resources Corporation - Ft Worth, TX
[2]Range Resources – Appalachia LLC Canonsburg, PA

The modern-day Marcellus Shale play, which is currently the largest producing natural gas field in the United States and is believed to be among the largest known fields in the world, was discovered and pioneered by Range Resources in 2004 in Washington County, Pennsylvania. Initially, vertical wells were drilled and completed to test the production potential of the formation and gather important information to assess the reservoir properties, including gas in place, recovery factors, and economics. Based on good test results, Range began an acreage acquisition program, with a focus on southwest Pennsylvania, specifically the wet gas window in Washington County, which has become the company's core operating area.

Horizontal wells and multi-stage fracturing were soon used to better develop the Marcellus and test its full potential. However, Range's initial attempts to fracture the reservoir in horizontal wells were unsuccessful due to the selected landing target. Over the course of two years and three more horizontal wells that used different landing targets and completions, Range discovered how to unlock the enormous potential in the Marcellus. Increased activity by numerous operators then began across parts of Pennsylvania as well as in West Virginia and Ohio.

Range Resources in 2003 – Pre Marcellus

In 2003 Range began a shift in corporate strategy from traditional, higher risk exploration to looking for large scale and repeatable resource plays. The Barnett Shale was then recognized as the first successful modern day shale play and industry was searching for the next shale play. The Marcellus opportunity presented itself in 2004, which through a combination of long term vision, opportunistic thinking, creativity and the ability to break conventional wisdom, provided Range with a path to success.

The exploration strategy in 2003 associated with those assets was more traditional at the time and focused on deeper higher risk plays, which were perceived to offer high return projects. Reviewing Range's exploration portfolio in 2003, then Chief Operating Officer and President and now Chief Executive Officer for the company Jeff Ventura's analysis of these projects was one of very high risk, high costs and limited repeatability. The exploration opportunities identified then included the Deep Woodbine in East Texas, the Norphlet play in Mississippi, various Offshore Gulf of Mexico prospects, and the Trenton Black River play in the Appalachian Basin in Pennsylvania and New York.

...those exploratory projects had chances of success of 10 to 20%, so they were fairly high risk.

All of those exploratory projects had chances of success of 10 to 20%, so they were fairly high risk. Looking at it another way, they posed an 80-90% chance of not discovering a field.

Ventura's view was while Range had a diverse inventory of high risk exploration opportunities, growth opportunities were limited. Even if these discoveries were successful, they would not be repeatable over large areas. One discovery didn't necessarily lead to the next. This would be a very tough way to build a company. Because Range then was a relatively small company these were expensive wells with very high risk for the company due to the individual well cost.

Ventura's vision and ultimately that of Range's top management and Board sought to pursue a different type of growth strategy. Rather than the traditional high risk exploration path, which historically tended to be even higher risk than considered within the company and a tough way to build scale, Range pursued an exploration strategy that offered the potential to be both large scale and repeatable. The exploration focus needed to be on resource plays.

The risk in a resource play wasn't the presence of hydrocarbons. The question in a lot of those types of plays at that time was their commerciality and the most effective use of technology. The challenge was made to the various divisions and exploration teams to focus on resource play types of opportunities and shift away from the deeper and non-repeatable exploration plays. One of the resource play ideas Range developed was the Marcellus Shale in Pennsylvania.

The Discovery of the Marcellus Shale

At the end of 2003 and early 2004, horizontal drilling in the Barnett Shale was taking off in a significant way. Particularly, new success was being made moving south from the original part of the Newark East field to the area just south of Fort Worth. Industry was recognizing that the Barnett's potential was quite real and it quickly became the largest proven gas field in the country, eventually ramping up to over 5 Bcf/d. The new exploration paradigm became: where could the next Barnett-type play/field be found? Operators were looking all over the country for new shale gas plays with the Barnett as the analogy in mind.

The initial genesis of the Marcellus play at Range started with Bill Zagorski, Range's senior Appalachian Basin exploration geologist and Vice President of Geology. In early 2004, Zagorski was in Houston reviewing a Neal Shale prospect in the Black Warrior Basin. While the Neal Shale play was interesting, he had the "eureka" moment there contemplating that the Appalachian Basin Marcellus Shale play was potentially a Barnett type of resource play. The two plays were compared in terms of geographic extent, depth, thermal maturity, thickness, pressure, reported gas shows, organic content, and other comparisons. His research strongly suggested that the Marcellus compared very favorably to the Barnett in many ways. In reviewing all of the old well reports for the numerous well penetrations of the Marcellus in Pennsylvania and nearby areas, it was amazing how many very strong gas shows were reported in the Marcellus, particularly in southwestern Pennsylvania. A number of phenomenal gas shows were identified in some old wells offsetting Range's Renz well area, some of them dating back to the 1940's or earlier. This initial research also suggested that the Marcellus might have significantly larger potential compared to the Barnett as it covered a much larger geographic area than the Barnett as shown in Figure 1.

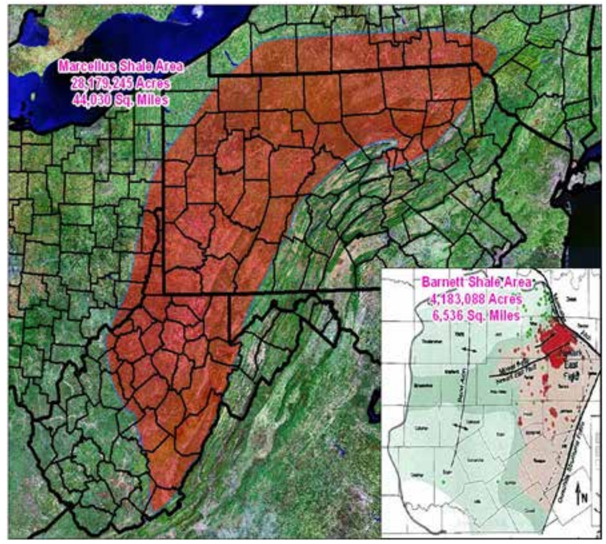

Figure 1: Original Range map comparing the extent of the Barnett to the Marcellus.

The idea of testing the Marcellus in southwestern Pennsylvania was first presented in a series of Range technical meetings in early 2004. It was a compelling idea. A large portion of the company and assets had its roots in the Appalachian Basin so Range already had a large presence in Ohio and Pennsylvania. Prior to the Marcellus idea, Range had acquired an acreage position in southwestern Pennsylvania targeting the deeper formations below the Marcellus such as the Oriskany sandstone, Lockport dolomite and the Trenton Black River intervals. The company had drilled an unsuccessful deep exploration well in Washington County, Pennsylvania in 2003 to test the Oriskany and Lockport on a seismic defined structure. This test was the Renz #1 well. That well, despite completion attempts on these targets, was unsuccessful at that point. Therefore, Range had an opportunity with a wellbore penetrating the Marcellus as well as a substantial contiguous acreage position. However, the well and location at the same time were being prepped for abandonment and surface reclamation.

While Ventura, Zagorski and a few others were excited about the Marcellus, many others within the company were more cautious and hesitant. The sentiment among some was fatigue associated with the Renz #1 because the company had already spent a lot of money on an unsuccessful well and had already begun reclamation. Another strong argument voiced against it was that the Marcellus was considered to be water sensitive. The concern then was that a big Barnett-style water treatment could lock up the formation. These opposing views were from very bright, sharp people with good experience in the Appalachian Basin. Although the deeper horizons were unsuccessful, the Marcellus now could be a real opportunity. The question and challenge for Range was to test or not.

Conventional wisdom was to not test the Marcellus. Some said it won't work; it's been tried before and was unsuccessful. There had been old reports where several operators had tried unsuccessfully earlier using various different treatments to unlock the Marcellus. The explorationists viewpoint countered that the Marcellus had great gas shows and it covers an area significantly larger than the Barnett, so we should try it using the same approach as in the Barnett Shale. Ultimately, all sides of the debate were heard and the team made the decision to move forward and put a big Barnett-style slick water completion on it. Thus begin the process of evaluating the play and acquiring additional acreage.

On October 20, 2004, the Marcellus interval in the Renz Unit #1 well in Washington County, Pennsylvania was hydraulically fractured using a slick water completion consisting of over 300,000 pounds of proppant and over one million gallons of water. After completion operations were finished, the well was flow tested on October 24, 2004 at an initial rate of 300 mcfpd. This rate was sufficient enough to favorably compare to Barnett vertical tests and marked the discovery for the modern Marcellus Shale play. Universal Well Services pumped the job consisting of a single stage with almost 1 million gallons of slickwater, 370,000 lbs of proppant, and pumped 65 bbls per minutes.

Early Vertical Tests and Lessons Learned

With the completion of the Renz well, Range learned a number of key lessons. One key lesson was that creativity with strong scientific basis tops conventional local wisdom. The company had a strong exploration minded argument on one side and on the other side, a strong operational experienced based argument against large scale testing based on long term experience in the basin and knowledge of earlier industry dealings with the Marcellus. Fortunately the right decision was made to test the new technological approaches gained in the Barnett Shale and apply them to the Marcellus in Washington County, Pennsylvania.

The key was that the team didn't overanalyze the completion design and cost. The completion treatment was not specifically designed for the Marcellus interval in the Renz #1, but essentially took the same job size and design for successful vertical Barnett wells. It was very early in the testing of the play and data was lacking. Had the company pumped a job designed for the Marcellus and its thickness compared to the Barnett, it could have been about 1/3 the size and then resulted in significantly lower gas rates and reserves.

In a marginal area like the Appalachian Basin was at that time, the typical practice might have been to pump a smaller job to keep the completion costs down. It is common with smaller companies to keep the financial risk down, keep the cost down, pump a small job and see the results. The poorer results, which likely would have resulted from a smaller completion, may have discouraged trying the same approach on future wells. The larger job was in essence an exploratory type idea at that point in time, so perhaps the lesson learned is to use a larger stimulation approach in exploration or delineation wells in resource plays. Range was a smaller company at that time and having that early success was crucial and was undoubtedly a key part in moving forward in the Marcellus.

Another interesting thing learned as a result of the extended shut-in period was that the Renz well came back at a significantly higher rate of 800 mcfpd compared to its initial gas rate of 300 mcfpd. This phenomenon is now recognized in other shale plays and is commonly termed "aging the well". The well produced condensate along with the high Btu gas establishing that we were in the wet gas window. It was quickly realized that wet gas could result in better economics compared to dry gas alone; however, significant infrastructure and processing capabilities would need to be built to capture this potential.

After the Renz Marcellus completion, Range drilled two additional delineation vertical wells to determine if the Renz results were repeatable. Both of these offset wells were completed with nearly identical or even a little larger fracture treatments than the Renz Unit. Comparable or better production results were observed in these follow up tests drilled in 2005. These served to further encourage and were also a key step in moving the play forward.

Early Horizontal Challenges

The next major challenge was to make the Marcellus work horizontally. It was really a key issue. While the vertical wells worked, the key to building Range was making the Marcellus a viable and successful horizontal play.

With the challenge of horizontal drilling, we again faced the conflicting mind sets between conventional thinking versus the desire to try new approaches and take the risk and make it work horizontally. Many thought that there was no way to make the Marcellus into a successful horizontal play. The concern was that major costs and expense would be incurred to drill horizontally. In addition, the Marcellus was believed to be water sensitive and/or that it would cave in while drilling. The final complicating factor was the lack of services, equipment, and infrastructure in the basin to perform multiple-stage, slickwater hydraulic fracture treatments. Others were content to move forward with a vertical drilling program. After all of the discussions and vetting, the decision was ultimately made to fully pursue testing the Marcellus as a horizontal target with all of the technical and financial risks that were included. That path initially was not an easy one.

In 2005 and 2006, Range drilled its first three horizontal wells in the Marcellus Shale. They were expensive and problematic. Additionally, there was no industry experience in drilling and completing horizontal wells in the Marcellus. Range was the first company attempting to drill horizontally in the play and to make matters worse, initial completion results and test rates weren't providing the multiple rates compared to the verticals. A major change in approach and analysis were needed to move the commercialization of the Marcellus into its next successful phase. That was going to require a major step up in commitment and focus from the company and the technical teams.

Key Lesson #2 – Focus by Opening a Dedicated Marcellus Division Office in Pittsburgh Pennsylvania

After much thought, the decision was made to open a Pittsburgh office whose staff and management's sole focus was on the Marcellus. The company split the operations from the existing conventional operation group in Hartville Ohio and dedicated a top technical team to focus solely on making the Marcellus horizontal play a success. This approach worked in the Barnett and the Fayetteville was in full swing as well.

In early January 2007, Range selected Ray Walker, a seasoned Texas veteran of the Barnett and other horizontal plays, to lead Range's Marcellus Shale efforts in Washington County, Pennsylvania and open a dedicated operational office. One of the daunting challenges Ray first faced in the Marcellus was that the Appalachian Basin lacked the equipment, technology, and expertise then needed to successfully drill and complete horizontal wells, particularly in the Marcellus. Another challenge was the need to evolve from a vertical play to a fully fledged horizontal play. In early 2007, Range had several successful vertical wells producing and three horizontal Marcellus wells with limited production capabilities. Total Marcellus production at that time was less than 1 mmcf/d.

The team remained focused that only a play like the Marcellus could propel the company forward in a significant way. The shallower horizons, even with good flow rates, never were going to position the company advantageously because they were just not repeatable on a large-scale basis.

By early 2007 the play had reached a critical point for Range. From 2004 to the spring of 2007, Range had invested about $150 million by acquiring acreage, drilling multiple vertical wells and a few horizontal wells, and they had purchased some equipment. To put that into perspective, in the spring of 2007, those first 3 horizontal wells were not commercial. In 2003 Range limited projects to approximately $3 million and the spring of 2007 Range had $150 million invested in the Marcellus and the play was still unproven. The company determined that $200 million was the maximum level of spend and had only 8 months remaining to crack the code and make the Marcellus work horizontally.

The team brainstormed on what to do moving forward including engineering, geology, geophysical, field operations, and others. Of the first 3 horizontal wells, one made 20 mcfpd, one made about 250 mcfpd, and one made about 600 mcfpd. These are poor results by any standard, plus they were expensive wells. The wells were also difficult to drill because of wellbore issues and on top of that they were very difficult to treat.

The technical teams examined every option like drilling longer laterals, pumping more stages, using more sand, pumping at a higher rate, using different perforating

HISTORY QUIZ

1. The first corporation to receive the Army-Navy 'E' for excellence for outstanding wartime production, on March 5 1942, was:
   a) ALCOA
   b) Westinghouse
   c) Koppers
   d) Dravo
2. The Flatiron Building in NYC was framed in steel fabricated by:
   a) Pittsburgh Bridge and Iron
   b) American Bridge
   c) Chicago Bridge and Iron
   d) Koppers
3. The world's first atom smasher/particle accelerator, built in Forest Hills by Westinghose in 1937 and retired in 1958, will, if the developer follows through, soon be:
   a) An education center
   b) The focus of rental properties
   c) A tourist attraction
   d) All of the above
4. The second President of Westinghouse Air Brake Company was:
   a) William L. Church
   b) Herman Westinghouse
   c) George Westinghouse II
   d) Donald Burnham
5. In 1881, this inventor unveiled his single-acting engine (the precursor to the modern steam turbine):
   a) Charles Steinmetz
   b) Nikolai Tesla
   c) Herman Westinghouse
   d) Walter Kerr

ANSWERS: 1d; 2b; 3d; 4b; 5c

charges, using a different methodology, and other ideas. The Geology Team showed everyone what is now known within Range as the famous 3 point correlation. The team examined the first 3 wells and plotted the peak gas rate versus the height landed above the Onondaga. The team indicated the correlation with an R2=0.98; every time they moved higher above the Onondaga, the results improved. The meeting outcome was to complete the next horizontals higher in the section. The Gulla #9H was drilled next and landed in a slightly higher target. The well was successfully treated in the summer of 2007 and results improved dramatically with a test rate of 3.2 mmcfpd. So with the Gulla #9H, Range finally had the breakthrough well it needed in the Marcellus play!

The lesson learned for the company was not to wait for more data and to look for correlations early. The choice to adjust the landing target was critical in cracking the code to making the Marcellus work as a horizontal play. Even today Range and other companies are still optimizing and doing things differently, including landing deeper in the section.

After cracking the code on the Gulla #9H, Range drilled and completed three more successful horizontal wells in a row. Range issued a press release on December 10, 2007 announcing the results of the successful Marcellus horizontal wells. Soon after in early 2008, Dr. Terry Engelder of Penn State University gave his estimate of Marcellus reserves, showing immense potential and just how big of a field it could be compared to other giant gas fields around the world. Soon afterward Range completed the 8th horizontal Marcellus well for a phenomenal test rate of 14 mmcfepd. This was far better than anything in the Barnett or Fayetteville plays. By April of 2008 the play was a featured story in The New York Times cover story, "There's Gas in Those Hills."

Another important lesson was the strong support through the steep initial learning curve by Range's financial team and the Board. One of Range's key strategic elements is its operating driven strategy, rather than a financial driven strategy. A company with a financial driven strategy may have imposed strict financial limits on the expenditures for plays like the Marcellus. Under this type of model, the company may have limited the investment or divided the capital among several different projects or business units. Under this type of investment guidance, Range may not have made it to the goal line with the Marcellus breakthroughs and the history of the play would have been different. Fortunately, the company had an operating driven strategy. Range's operational team was performing well, making progress, communicating with the financial team and the Board, who in turn continued to provide steadfast support. This dedication was critical to achieving the needed breakthroughs for the Marcellus play despite requiring nearly all of the initial $200 million allocated to unlock it.

Key Lesson #3 – Do the Right Thing

The risks and challenges associated with the Marcellus were not just limited to technical issues. Shortly after the horizontal drilling program was launched, the company recruited experienced personnel to drill and complete the horizontal wells and to evaluate the approach and identify challenges. The team decided that best engineering practices for the Marcellus play dictated a standard of operating that was above and beyond the current Pennsylvania regulations, which were designed for vertical drilling that had been conducted in the Appalachian Basin for many years. The best practices needed for horizontal Marcellus development on a large scale would cost about $200,000 more per well to do it right and would exceed the current regulated requirements.

The industry worked with state regulators to implement those practices across the state for safety and environmental reasons as horizontal well drilling increased. Pennsylvania regulators acted quickly and now Pennsylvania has adopted and modernized all of their regulations and today has some of the best regulations in the country.

By 2009, the key issues at that time, with the growth in the Marcellus from numerous operators across the state, were to recognize the potential environmental and social concerns. Ray Walker initiated the formation of the Marcellus Shale Coalition as a forum to collectively voice the industry position on what those best practices would be for the play. The Coalition continues to thrive with 33 Marcellus operators, 10 midstream members, and another 240 member service providers.

Significance of the Discovery

What is the significance of the discovery of the Marcellus and the shale revolution in general? The first of many points of significance is that the U.S. reserve life index has increased dramatically. In 1979, the gas reserve life index in the United States was roughly about 10 years or so. Today under a more conservative estimate, it is at least 100 years and some people have estimated over 200 years of reserve life index. The United States has gone from a country that was short of gas to where we're now the largest producing nation in the world.

The second significance is that because of the abundance of natural gas, U.S. prices are extraordinarily competitive. The price of natural gas in the United States today on a $/mcf basis is around $4.00. Today in Europe, the cost of gas is $12.00 - $13.00. In a lot of places around the world including Japan and China, the price for gas is about $15.00. Shale gas production volumes and U.S. natural gas prices put the United States in a very compet-

Well Pad Drill Site. Courtesy of Range Resources

The World's 10 Largest Natural Gas Fields.[1]

	Field Name	Country	Recoverable Reserves, Tcf
1	South Pars/North Dome	Iran and Qatar	1235
	MARCELLUS	USA	489 [2]
2	Urengoy	Russia	222
3	Yamburg	Russia	138
4	Hassi R'Mel	Algeria	123
5	Shtokman	Russia	110
6	South Iolotan-Osman	Turkmeni-stan	98
7	Zapolyarnoye	Russia	95
8	Hugoton	USA	81
9	Groningen	Netherlands	73
10	Bovenenko	Russia	70

Figure 4 – The world's 10 largest natural gas fields

[1] Rafael Sandres, Global Natural Gas Reserves - A Heuristic Viewpoint, March 2006
[2] Dr. Terry Engelder, Penn State University - from August 2009 issue of Forth Worth Oil & Gas Magazine

itive position globally.

The abundance and price of natural gas has led to the re-birth of American manufacturing. Energy prices are now so low that they offset the lower cost of labor overseas and with cheaper energy come cheaper feedstock.

Conclusion

From Range's perspective, the road to the commercialization of the Marcellus play and its emergence as a major world energy source was a long one with many challenges to overcome. In the initial phases of the play, the risks and challenges were more technically focused on geologic and engineering issues, as well as acreage acquisition and play delineation. Once the technical challenges were solved, the larger challenges proved to be broader encompassing numerous political, sociologic and community issues which needed addressed. Many people, from the initial pioneers, to the various teams of consultants and specialists, continue to improve the Marcellus play. It is an outstanding achievement for a company like Range, and our entire industry, to have transformed this opportunity from its initial beginnings into national prominence as the largest gas play in the United States and one of the largest in the world in just a few years. However, the story really has just begun. There will be wells drilled for many decades and they will inevitably involve many challenges, both seen and unforeseen, to be tackled in the future.

Editor's Note:
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