William F. O’Neil could not have had any idea what the future held for the company that he started on September 29, 1915, in Akron, Ohio. He simply wanted to make tires and tire repair products for trucks, and a few years later, for automobiles. It didn’t take long for him to start innovating.

A year after its founding, O’Neil’s General Tire & Rubber Company introduced a revolutionary, oversize tire that increased comfort and reduced fuel consumption for trucks. As a result, the company became a major truck tire manufacturer. The soft, oversize tire concept was so well received that General Tire came out with a similar product for cars in 1931.

These innovations and others in tire manufacturing were not enough for O’Neil, though. In the 1930s, he began diversifying by investing in some local radio stations, later moving into AM, FM and TV station ownership. In 1944, General Tire bought controlling interest in a rocket design and production company, Aerojet Engineering Corporation, and later fully acquired the company. Over the next several decades, the company grew to include a movie production company, an airline company, soft drink bottling franchises and more.

By 1984, General Tire evolved into a holding company, named GenCorp Inc., which exited the tire business completely three years later. Now focused mainly on high-technology design and production in the defense and space industries, the company changed its name again to Aerojet Rocketdyne Holdings, Inc. in 2015.

Today, the company remains laser focused on pushing the boundaries of the dynamic space and defense frontier – but never too busy to give a respectful nod to its diverse and eclectic heritage.

December 5, 2014 Liftoff of a Delta IV Heavy rocket on the Exploration Flight Test-1 (EFT-1) mission, with NASA’s Orion Spacecraft, was powered by three Aerojet Rocketdyne RS-68 LOX/Hydrogen engines. Each engine produced more than 17 million horsepower.

Credit: Lockheed Martin and United Launch Alliance
Today, the Aerojet Rocketdyne Holdings, Inc. company consists of two major subsidiaries. The main focus is its Aerojet Rocketdyne subsidiary, a leader in designing and building a wide variety of rocket engines and other propulsion systems for spacecraft, satellites and military missiles. Aerojet Rocketdyne also develops advanced technology power systems for use on Earth or in space. This company operates 14 facilities in 10 states and the District of Columbia. In fiscal year 2014, its net sales amounted to $1.6 billion.

One of its products, an iridium/rhenium High-Performance Apogee Thruster, has inserted 100 geosynchronous satellites into orbit. Another product still in development, the AR1 rocket engine, is intended to replace the Russian-built RD-180 engines that currently power the United States’ Atlas V launch vehicle. Throughout its history, the Aerojet Rocketdyne team has delivered nearly two million tactical missile motors and warheads to the U.S. military and allies. Pushing the envelope of technology development in 2014, Aerojet Rocketdyne successfully designed, built and tested a rocket engine made completely of components manufactured via 3-D printing. This process reduced the manufacturing cost of the liquid rocket engine by 65 percent. These are only a few examples of the company’s design expertise and large-scale manufacturing capabilities.

European Space Propulsion, a subsidiary of Aerojet Rocketdyne, was established in 2012 in Belfast, Northern Ireland, and provides the European space community with Aerojet Rocketdyne products and services for in-space propulsion.

Easton Development Company, the second subsidiary of Aerojet Rocketdyne Holdings, has a very different mission. Its focus is on planning and developing mixed-use communities on more than 6,000 acres of land owned by Aerojet Rocketdyne Holdings. The land, located a few miles east of Sacramento, California, is an excess portion of a large parcel purchased in the 1950s for the headquarters and manufacturing facilities of the rocket engine company. Easton’s goal is a master planned community with a broad range of housing, office, industrial, educational, retail and recreational areas. Developing the land includes restoring areas disturbed by gold mining a century ago. Other goals are conserving woodlands and other wildlife habitats, and creating a network of trails and an interpretive nature center.

The company’s core values are honesty, safety, respect for others, quality and accountability. A value statement on the corporate website reads: “Ultimately, our values help to remind us that how we do business is every bit as important as the business itself.” Aerojet Rocketdyne Holdings and its subsidiaries employ nearly 5,000 people who operate under these tenets.
The Patriot Advanced Capability-3 Missile Segment Enhancement (PAC-3 MSE) program is an air-defense, guided missile system with long-range, medium- to high-altitude, all-weather capabilities designed to destroy tactical ballistic missiles, cruise missiles and advanced aircraft. Built by Lockheed Martin, the missile is powered by a rocket motor designed and built by Aerojet Rocketdyne.

Powered by Aerojet Rocketdyne’s RS-68 and RL10 main and upper-stage engines, a United Launch Alliance Delta IV Heavy rocket launched NASA’s Orion spacecraft on its maiden voyage during the EFT-1 mission on December 5, 2014.

As a member of the Orion team since 2006, Aerojet Rocketdyne provides propulsion for nearly every component of the spacecraft.

Aerojet Rocketdyne has provided propulsion for all of NASA’s Mars orbiter and lander missions since 1975 and provides the power source for Curiosity. As of 2015, the rover is conducting science experiments and exploring the Red Planet thanks to Aerojet Rocketdyne’s Multi-Mission Radiisotope Thermoelectric Generator (MMRTG).

This highly anticipated, mixed-use master plan community in Northern California will soon become a reality. It encompasses approximately 6,000 acres in Eastern Sacramento County.
The year 1915 was a challenging time to start a business, particularly in tires. More than 380 American companies were making tires at that time. However, the market was growing rapidly. That year, the number of passenger cars in the United States doubled to two million. Roads were rough and tires were vulnerable, so most cars carried at least two spares.

Initially, the General Tire company manufactured tire repair materials. Within a year, however, it introduced its first new tire. The General Jumbo was a revolutionary, oversize, pneumatic tire usable as an aftermarket replacement on Ford Model T trucks. Until that time, trucks were too heavy to use existing pneumatic tires, so they drove on solid rubber tires that caused uncomfortable vibrations, required strongly reinforced chassis and damaged roads. The General Jumbo was a popular solution.

A year-and-a-half after the company opened, the United States entered World War I.
The war caused a rubber shortage that made it difficult for manufacturers to meet the demand for new tires. With the end of the war in 1918, the shortage eased and demand increased. Demand slackened again in 1920-21 because of an economic recession. During these difficult times, General Tire fared better than many of its competitors for two reasons. Rather than supplying automobile and truck manufacturers, it concentrated on the secondary market for high-quality tires. It also ran an innovative marketing campaign appealing directly to consumers by placing ads in publications such as the Saturday Evening Post, on roadside billboards and toward the end of the decade, on popular radio programs including the Jack Benny Program.

Later in the 1920s, General Tire introduced an innovative tire for automobiles. The General Balloon Jumbo had an elliptical profile rather than a smaller circular one, and it was inflated to only 12 pounds of pressure. These features produced a more comfortable ride and greater durability. The company also developed a blowout-proof tire called the Dual Balloon, and an increased-traction, long-wearing tire called the Squeegee, among others. Such tires were more expensive than the competitors, but General Tire advertised them with slogans such as, “They cost more because they’re worth more” and “The complete confidence you feel riding on Generals is worth many times the little extra it costs.”

Besides the tire designs, General Tire introduced related innovations, including rubber flaps for truck tires. They initiated the process of retreading truck tires. They originated the notion of trading in used tires for a new set of Generals. In fact, the Balloon Jumbo tires required larger wheels, an additional investment that encouraged customers to continue buying from General Tire.
By the time the Great Depression hit in 1929, General Tire was operating 14 retail stores in addition to its tire production operation. Even though it was not a supplier of original equipment to any vehicle manufacturer, it claimed 1.8 percent of the tire market. The declining economy drove some tire producers out of business, but General Tire was able to expand its business by buying two struggling companies. By 1933, General Tire’s market share had grown to 2.7 percent.

Although the company was surviving the difficult economy, its leadership decided to seek greater financial security through diversification. It began investing in Ohio radio stations that carried its advertising. This was the start of a major sideline business in the entertainment industry (see the American Lifestyle section).

In 1934, General Tire developed an innovative “drum method” for manufacturing truck tires that was substantially less costly and 50 percent faster than existing methods. Around this time, the company also expanded its product line to include airplane tires. By 1938, it was running print ads touting the tires’ “quality construction and expert workmanship” as evidenced by the fact that both the U.S. Army and Navy used them on their aircraft.

The company’s core operation gained additional stability in 1934 when International Harvester added General Tire to its list of approved suppliers of original equipment. Within the next three years, all major truck manufacturers did the same.
World War II brought a new era of diversification to the General Tire & Rubber Company. In some cases, new lines of production were dictated by military needs. The company built a new factory in Mississippi to produce munitions, and built 500-pound bombs in Indiana. In another factory, workers produced rubber pontoons that could be lashed together to form floating bridges for heavy equipment or used individually to carry up to 20 military men. Elsewhere, it manufactured gas masks, barrage balloons, decoy landing craft, life preservers and raincoats. And despite rubber shortages, General Tire built an additional tire production facility in Texas to meet the government's needs.

General Tire chemists revolutionized rubber production by developing a process for more effectively blending carbon black reinforcing filler into batches of natural or synthetic rubber. They also developed a process for modifying inferior types of natural rubber to make them usable in tire manufacturing.

The most dramatic diversification, however, was General Tire's acquisition of Aerojet Engineering Corporation in 1945. Aerojet was an outgrowth of the rocket development activities of Dr. Theodore von Kármán and five colleagues at the California Institute of Technology. Since 1938, they had been working under a U.S. Army contract to develop jet-assisted takeoff (JATO) rockets for aircraft. The group formally incorporated Aerojet in 1942 and began producing thousands of JATO units for military planes. That technology halved the distance needed for airplanes to take off, either from short runways or aircraft carrier decks.
➢ Aerojet engineers also were working on solid-fuel rocket design. Their association with General Tire & Rubber began when they asked for help developing rubber binders for the solid fuel. In 1947, Aerojet’s first Aerobee rocket was launched at White Sands Proving Ground in New Mexico. The suborbital Aerobee became the first American-developed rocket to reach space. For nearly 40 years, more than a 1,000 of them were launched for atmospheric and cosmic radiation research, making it the world’s longest continuous rocket program.

➢ In the period of economic prosperity that followed World War II, both General Tire and its Aerojet subsidiary flourished. General Tire became an approved supplier of original equipment for major passenger car manufacturers. The company built a plant in Texas to produce synthetic rubber, and purchased controlling interest in an iron and steel manufacturing company. General Tire also established an industrial products division and began manufacturing plastic and metal parts for aircraft and electric appliances. Aerojet built a plant in Sacramento, California to produce liquid-fuel and solid-fuel propulsion systems for various military missiles.

Engineers of Aerojet Engineering Corporation pose proudly with the new solid propellant JATO in 1944

Standing left to right: Norton B. Moore, Adolph L. Antonio, Brooks Morris, Bernhardt L. Dorman, Martin Summerfield and Robert Young. Kneeling left to right: Maurice J. Zucrow and Clyde Miller.

The First Aerobee rocket flew to a height of 37 miles at White Sands Proving Ground.

1943 Rocket Test Firing
Dynamic engineer, Roy Queen, observes the test firing of the 25AL1000 rocket at Aerojet-General in Pasadena, California.
Automobiles are an essential component of the American lifestyle and General Tire contributed to keeping them on the road. General Tire developed the Gen-Tac adhesive for bonding polyester tire cords to rubber - a blowout-resistant Nygen cord for tubeless tires. It also created new machinery for building radial tires. In 1981, General Tire became the fifth largest tire maker in the U.S.

In the decades after World War II, however, the General Tire & Rubber Company virtually outgrew its name by contributing to many aspects of the American lifestyle. Perhaps the most dramatic example was its participation in the entertainment industry. The investment in Ohio radio stations during the 1930s was just the beginning. In 1942, it expanded its holdings in the broadcast business by buying the Yankee Network, a Boston-based company that owned six radio stations and had 22 affiliate stations.

The Yankee Network purchase included a Boston television station license, and in 1948, General Tire’s first TV station, WNAC-TV, began broadcasting. After purchasing three leading radio stations in California, General Tire bought a second television station, KHJ-TV in Los Angeles, in 1951. The following year, it acquired AM, FM and TV stations in New York. General Tire now called its broadcast division General Teleradio. In 1954, it entered the Memphis, Tennessee market when it purchased a television station and a radio station. That same year, the Memphis radio station was the first to broadcast a recording by local singer, Elvis Presley.

During the next few years, General Teleradio continued to acquire radio and television stations. In order to gain access to a large number of famous movies for TV broadcast, General Tire bought a major film studio, RKO Radio Pictures, in 1955. General Teleradio retained the rights to broadcast RKO’s 750 feature films in areas served by its television stations, but it also sold broadcast rights to independent stations in other areas. After making a few movies at the RKO studio, General Tire sold the studio facilities and backlot in 1957, but retained rights to broadcast films in the large collection it had acquired. The broadcast division was renamed RKO General, Inc. in 1959, and was a wholly-owned entertainment subsidiary.

The following year, after 45 years with General Tire, company founder William O’Neil died. The business remained a family affair, led by his sons: Jerry O’Neil headed the tire business from Akron; John O’Neil served as General Tire’s chief financial officer in Washington, D.C.; and Thomas O’Neil headed the RKO subsidiary in New York. Like their father, they were never reluctant to innovate and the company continued to undertake new endeavors.

One new venture was the institution of subscription television viewing in Hartford, Connecticut. Working with Zenith Electronics, RKO General provided a system for subscribers to view commercial-free, first-run movies, as well as live sports and performance events.

In 1948, General Tire’s first TV station, WNAC-TV, began broadcasting.
General Tire’s Aerojet subsidiary also contributed to satisfying the American appetite for entertainment and business activity. In 1962, a Thor-Delta rocket, using an Aerojet liquid-fuel rocket as its second-stage propulsion, launched Telstar 1. Telstar 1 was the first satellite to relay television pictures, telephone calls and fax images. It even provided the first live transatlantic television transmission, which included: pictures of the Statue of Liberty and the Eiffel Tower; a short segment of a baseball game between the Philadelphia Phillies and the Chicago Cubs; and an address by U.S. President John F. Kennedy. A year later, a similar launch vehicle sent the satellite’s twin, Telstar 2, into orbit.

RKO General’s radio and television station holdings continued to grow. In 1979, the company formed the RKO Radio Network, which became the first commercial radio network to deliver content exclusively by satellite.

In addition to its radio and television broadcasting and movie syndication activities, RKO General served as a holding company for other noncore businesses owned by General Tire. At various times, those included 11 Pepsi bottling franchises, 10 hotels, a billboard company, two marine-towing companies, a helicopter service and the controlling interest in the original Frontier Airlines.

During the 1990s era, the Penn Racquet Sports unit of GenCorp Polymer Products was the leading manufacturer of tennis balls and racquetballs in the world, with major market positions in the U.S. and Europe. Other polymer products included latex, adhesives and coatings, and residential and commercial wallcovering products, as well as fabricated plastics.

Throughout its history, General Tire & Rubber Company endured several downturns in tire manufacturing resources. World War I, the Korean War and World War II restricted rubber availability. The 1974 oil embargo and the subsequent Corporate Average Fuel Economy (CAFE) standards resulted in a sales decline for American automobiles, for which General Tire supplied parts, and an increase in foreign auto sales. During those periods, the company’s unrelated subsidiaries helped sustain it. For example, in 1979, the RKO General subsidiary accounted for 43 percent of General Tire’s profits. For the first quarter of 1982, RKO General’s $6 million profit saved the parent company from experiencing a $3.8 million loss. Diversification paid off.
While the tire business and the RKO General subsidiary were contributing to the American lifestyle, its Aerojet division was playing an important role in national security. During the Cold War that followed World War II, Aerojet developed and produced a variety of defensive and deterrent weapons. During more heated conflicts in Korea, Vietnam, Afghanistan and Iraq, it provided sophisticated offensive weapons as well.

General Tire’s acquisition of the Aerojet Engineering Corporation came about because of the JATO technology Aerojet developed during World War II. Hugh O’Neil, a son of General Tire founder William O’Neil, had died in an amphibious airplane crash that might not have happened if the plane had been equipped with JATO. As a result, General Tire invested in Aerojet in 1944. The following year, after William O’Neil realized the similarities between rocket and rubber chemistries, General Tire increased its investment in Aerojet and acquired a controlling interest.

After World War II, Aerojet continued to develop solid rocket propulsion systems beyond the JATO and Aerobee sounding rockets, many of them for military missiles. One prominent example is the motor that propelled the Homing All the Way Killer (HAWK) missile. Development began in 1959 on the HAWK, which became the U.S. Army’s first mobile, medium-range, guided anti-aircraft missile. Variations of the surface-to-air HAWK missile have been used by U.S. and allied military forces since 1959. Throughout this time, Aerojet has been the sole supplier of HAWK rocket motors.

Beginning in 1958, Aerojet developed the MK 46 torpedo for the U.S. Navy, delivering 20 demonstration units in 1960. The company eventually delivered more than 5,500 MK 46 torpedoes starting in 1963. Within the company’s Undersea Systems Division, several other undersea vehicles, mini submarines, swimmer delivery vehicles, and under water propulsion systems were developed and delivered between 1951 and 1993.
Minuteman was another notable defensive missile deployed during the Cold War. It was the first U.S. solid-fuel, intercontinental ballistic missile (ICBM). Armed with up to three nuclear warheads, each missile was housed in a hardened, underground silo from which it could be launched. Minuteman missiles were powered by a three-stage solid-propellant motor stack. Aerojet supplied the second and third stage motors. Development began in September 1958, and by October 1962, the first 10 Minuteman missiles were installed and ready for use. In the following five years, a total of 1,000 Minuteman missiles were poised in silos at various sites in the U.S. Since then, the missile has gone through several design revisions. Several hundred of the newest versions are currently deployed.

Yet another noteworthy missile of the Cold War era was Polaris. It was the first submarine-launched ballistic missile developed in the U.S. Variations of Polaris missiles were equipped with single or multiple nuclear warheads. Polaris missiles were also an important element in the United Kingdom's defensive arsenal in the 1970s and 1980s. Aerojet-General built the first stage solid rocket motors for the Polaris A1, A2 and A3, as well as the British A3R program. Atlantic Research Propulsion, which was acquired by GenCorp in 2003, designed and delivered all the post boost propulsion for the Navy’s Polaris, Trident and Trident II missile programs, as well as the Minuteman III ICBM systems.

The Titan I rocket was developed during the Cold War era, with the first Titan I launch in 1959. Aerojet provided both the first and second stage liquid-propellant engines, and many of the third stage engines, for the Titan family of rockets. The program spanned more than five decades, providing propulsion systems for not only military missiles, but also surveillance and communication satellites and space probes. The final Titan IV heavy lift vehicle was successfully launched from Vandenberg Air Force Base, California in 2005 with a top-secret National Reconnaissance Office satellite payload.

1 Minuteman Missile
Aerojet supplied the second and third-stage motors, Atlantic Research Corporation designed and delivered all the post boost propulsion using a Rocketdyne engine for the Minuteman III ICBM systems.

2 Polaris Missile
Aerojet-General built the first stage solid rocket motors for the Polaris A1, A2 and A3, as well as the British A3R program.

3 Titan I Launch
The first U.S. multi-stage ICBM, Titan I, lights up the skies over Cape Canaveral, Florida on Feb. 6, 1959. Aerojet supplied the first- and second-stage liquid rocket engines for the entire Titan launcher family.
Beginning in 1960, the U.S. Air Force placed satellites into orbit for early warning of hostile missile flights. Infrared sensors made by Aerojet’s Electronic Systems Division enabled these Defense Support Program (DSP) satellites to detect heat from missiles. Many of the satellites were launched with Titan IIIC rockets that used liquid-fuel Aerojet engines for all three stages.

During the 1970s and 1980s, the U.S. was involved in numerous military conflicts, most notably in Vietnam and the Middle East. Aerojet’s Ordnance division developed and produced several important munitions types. For example, by the mid-1980s, it delivered more than 23,000 Combined Effects Munitions cluster bombs and 23 million rounds of 30mm ammunition for GAU-8/A Avenger rotary cannons. In the early 1990s, DSP satellites using Aerojet infrared sensors effectively detected hostile missile launches during the Persian Gulf War. Aerojet also supplied large quantities of munitions for that conflict. In particular, its rocket motors propelled missiles launched by Multiple Launch Rocket System vehicles. These highly effective weapons earned the nickname “steel rain” during that conflict. The company continues to produce all of these and other munitions, along with depleted uranium for military ordnance.

The THAAD Divert and Attitude Control System (DACS) is a high-precision, lightweight-propulsion system that capitalizes on new technologies. The THAAD interceptor plays an integral role in the Missile Defense Agency’s Ballistic Missile Defense System, providing a transportable, rapidly deployable ground-based capability to intercept and destroy short-to-medium range ballistic missile targets in the final phases of flight. Aerojet Rocketdyne supplies both the booster motor technology that powers the interceptor, as well as the DACS.

The mission of Aerojet Rocketdyne’s THAAD weapon system is to defend against short and medium-range ballistic missiles at significant distances from the intended target and at high altitudes. THAAD is the only terminal system designed to intercept ballistic missiles both inside and outside the Earth’s atmosphere and has rapid mobility to defend anywhere in the world within hours.

Terminal High Altitude Area Defense (THAAD)

A Man-Portable Air-Defense System (MANPADS) used by the U.S. military and by 29 other countries, is manufactured by Raytheon Missile Systems with more than 70,000 missiles produced, each with a launch motor and flight motor. Stinger was the first Atlantic Research Corporation rocket motor to go into combat. The Mujahadin successfully utilized this critical weapon against the Soviet Union in Afghanistan.

The Army Tactical Missile System (ATACMS) fired its first combat mission against an Iraqi surface-to-air site on Jan. 26, 1991 to successfully suppress the enemy air defense system just prior to the beginning of ground combat actions.

Multiple Launch Rocket System (MLRS) Nearly 10,000 MLRS rockets were fired during the 100-hour ground operations of Operation Desert Storm with such devastating effect that the Iraqi soldiers called them “steel rain”. 

Terminal High Altitude Area Defense (THAAD)
In addition to military uses, rockets and satellites are used for the peaceful exploration of space. Both Aerojet and Pratt & Whitney Rocketdyne, a company acquired in 2013, have been significant contributors to space programs. In fact, when the newly established National Aeronautics and Space Administration (NASA) awarded its first contract for a civilian launch vehicle in 1959, both companies were selected to provide propulsion systems. The vehicle, called Thor-Delta, used a Rocketdyne liquid-fuel engine for the first stage and an Aerojet liquid-fuel engine for the second stage. In the early 1960s, Thor-Delta rockets launched a dozen satellites, including Echo 1, an inflatable, metalized balloon that reflected transmissions, and the Telstar communication satellites that actively relayed signals with a transponder.

A Rocketdyne Redstone first-stage engine helped launch America’s first satellite, Explorer 1, in January 1958. Six weeks later, an Aerojet AJ10-118 second-stage engine helped launch the United States’ second satellite, Vanguard I, which was the world’s first solar-powered satellite.

Aerojet and Rocketdyne played important roles in manned space programs. A Rocketdyne A-7 engine powered the single-stage Mercury-Redstone 3 rocket, which propelled the first American astronauts into Earth orbit for NASA’s first human spaceflight program – Project Mercury, from 1962 to 1963.

In the subsequent Gemini program, two astronauts performed maneuvers and extravehicular activities (spacewalks) in Earth orbit. The Gemini launch vehicle, the Titan II, used a first-stage LR-87 liquid-propellant engine and a second-stage LR-91 liquid-propellant engine, both developed and produced by Aerojet. Titan II vehicles launched 10 manned Gemini missions in 1965 and 1966. Rocketdyne developed and supplied thrusters that controlled the Gemini spacecraft’s movements in orbit.
Between 1969 and 1972, NASA’s manned missions to the moon also depended on Aerojet and Rocketdyne technology. The Saturn V launch vehicle used Rocketdyne engines for all three stages: five F-1 engines for the first stage; five J-2 engines for the second stage; and one J-2 engine for the third stage. Aerojet developed and supplied the main engine for the Apollo-combined service and command modules, in which one astronaut flew in lunar orbit while the other two descended to the surface of the moon in the lunar module. The ascent engine of the lunar module used an injector developed by Rocketdyne to return it to lunar orbit, where it docked with the combined service and command modules for the trip back to Earth. Attitude control was accomplished using 32 R-4 100 lbf bipropellant engines aboard the service and lunar modules.

America’s longest manned space program used space shuttles, first as self-contained orbiting laboratories, then for satellite deployment and recovery, and later as a transport vehicle for astronauts and supplies to construct and service the International Space Station (ISS). Between 1981 and 2011, space shuttles flew 135 missions. Each space shuttle used a cluster of three Rocketdyne Space Shuttle Main Engines (SSMEs), or RS-25, for its main propulsion system. Orbital maneuvering system engines, developed by Aerojet, inserted the shuttle into orbit allowing it to maneuver in orbit, while also providing braking power for deorbiting.

Kaiser Marquardt bipropellant technology, drawing its heritage from Apollo, was used for the 38 primary and six vernier thrusters aboard the Shuttle, while seven Rocket Research monopropellant hydrazine gas generators powered the auxiliary power units.

The moon is the farthest distance that human beings have traveled from Earth, but unmanned spacecraft have ventured much farther. Here, too, Aerojet and Pratt & Whitney Rocketdyne have each made substantial contributions and continue to do so as a single company. This is well illustrated by the numerous orbiters and landers that NASA has sent to our neighboring planet, Mars.

Launched in May 1971, Mariner 9 became the first spacecraft to orbit another planet when it began revolving around Mars six months later. Rocketdyne MA-5 engines launched it from Earth to begin its voyage. Two Pratt & Whitney RL10 engines powered the Centaur-D upper stage, and a Rocketdyne RS-21 engine provided propulsion for the spacecraft and orbital insertion. The mission gave humans their first clear view of Mars, with more than 7,300 images being transmitted during its year in orbit.
Mars has long captured the imagination of people around the world, so it is not surprising that so many missions have been sent to study it. For every probe NASA has sent to Mars since 1975, Aerojet and Pratt & Whitney Rocketdyne have provided mission-critical propulsion systems for launch and cruise, as well as soft landings for spacecraft reaching the planet’s surface. This includes:

- Viking 1 and 2 landers launched in 1975
- Mars Pathfinder base station and rover launched in 1996
- Mars Global Surveyor orbiter also launched in 1996
- Mars Odyssey orbiter launched in 2001
- Spirit and Opportunity rovers launched in 2003
- Mars Reconnaissance orbiter launched in 2005
- Phoenix Mars Lander launched in 2007
- Mars Science Laboratory and Curiosity rovers launched in 2011
- Mars Atmosphere and Volatile EvolutioN (MAVEN) mission orbiter launched in 2013
- Mars InSight Lander to be launched in 2016

NASA’s Mars Science Laboratory was powered and controlled by eight Aerojet MR-111C 1.0 lbf thrusters, eight MR-107U 68 lbf thrusters and eight MR-80B thrusters with variable thrust from 8 to 800 lbf. In addition to the thrusters on the spacecraft, Mars Science Laboratory was launched by an Atlas V powered by Aerojet AJ-60A Solid Rocket Boosters and a Pratt & Whitney Rocketdyne RL10 Centaur upper-stage engine. Power for the Curiosity rover is provided by an Aerojet Rocketdyne Multi-Mission Radioisotope Thermoelectric Generator (MMRTG).
Another interplanetary mission using Aerojet and Pratt & Whitney Rocketdyne technology flew in the opposite direction, toward Mercury, the planet closest to the sun. An unmanned spacecraft named MErcury Surface, Space ENvironment, GeOchemistry and Ranging (MESSENGER) became Mercury’s first satellite in 2011. Aerojet engineers designed, built and installed a propulsion system capable of slowing the spacecraft enough to be pulled into orbit despite the opposing gravitational pull of the sun. During its four-year orbiting life, MESSENGER mapped 100 percent of Mercury’s surface and transmitted nearly 100,000 images back to Earth.

Aerojet Rocketdyne products have helped set spaceflight distance records as well, propelling spacecraft out of our solar system. Voyager 1 and Voyager 2, launched on different trajectories two weeks apart in 1977, have both traveled far beyond Pluto. Voyager 1 officially left the solar system in 2012, and Voyager 2 will do so sometime around 2016. Both are still transmitting information back to Earth and are expected to continue doing so until at least 2025.

Voyager 2 flew by Jupiter, Saturn, Uranus and Neptune and sent back information about each. That left Pluto as the only planet (now designated a “dwarf planet”) yet to be explored. Aerojet Rocketdyne helped accomplish that as well, with the New Horizons space probe’s flyby of Pluto in July 2015. The company supplied five solid-fuel AJ-60A boosters for the launch, eight solid-propellant retro rockets to separate the Atlas core vehicle from the Centaur upper stage, an RL10 upper-stage engine, 12 monopropellant thrusters on the Centaur upper stage, and the propulsion system for the New Horizons spacecraft itself. The probe’s onboard thrusters successfully performed a critical 93-second, course-correction burn on March 10, 2015, nine years and two months after launch, at a distance of three billion miles from Earth. New Horizons collected volumes of images and other data as it flew past Pluto, coming within about 6,000 miles of its surface on July 14, 2015. It’s expected to take 16 months to transmit all of the visual and scientific data back to Earth. New Horizons continues to gather additional data about the Kuiper Belt, the area beyond Neptune, and regions beyond.
1915 • General Tire & Rubber Company is founded.

1916 • First tire bearing the General Tire name is manufactured and through an innovative marketing approach begins running full-page advertisements.

1920s • General Balloon Jumbo tires revolutionize the tire market.

1929 • General Tire now is operating 14 retail stores with 1.8% of the tire market.

1930s • General Tire begins investing in local radio stations.

1931 • General Tire becomes leader in industry and purchases Yale Tire and Rubber.

1933 • General Tire commands 2.7% of tire market share.

1942 • General Tire purchases Yankee Network, a Boston-based chain of radio stations.

1945 • General Tire switches part of its production to defense needs with the purchase of Aerojet Engineering Corporation.
• General Tire acquires Pennsylvania Rubber (eventually Penn Sports) and 45% of Mansfield Tire and Rubber Company.

1947 • First complete Aerobee rocket launched by Aerojet Engineering.

1948 • First on air radio broadcast.

1951 • Aerojet establishes an Underwater Engine Division to focus on torpedo propulsion development, evolving to provide complete systems.
• Aerojet breaks ground in Sacramento, California and moves its solid rocket motor production from Azusa to Sacramento.

1953 • Aerojet Engineering Corporation is renamed as Aerojet-General Corporation.

1955 • General Tire purchases RKO from Howard Hughes for $25 million.
• Aerojet-General receives Titan ICBM engine development contract.

1956 • General Tire opens synthetic rubber plant in Texas.
• Purchases controlling interest in A.M. Byers, manufacturers of steel and iron.

1958 • RKO General sells movie business to Desilu.
• Aerojet-General receives the first Minuteman solid rocket propulsion system development contract.
• Time Magazine calls Aerojet-General the “General Motors of the U.S. Rocketry.”

1960 • Medium-range surface-to-air HAWK missile (with Aerojet solid rocket motor) enters service.
• First Titan I flight (with both stages).

1961 • First Minuteman flight. Aerojet-General makes the second stage of the Minuteman-I missile.

1962 • General Tire is a Fortune 25 company with international operations in Mexico, Africa and Czechoslovakia, among other countries.

1963 • Dr. von Kármán is selected as first recipient of National Medal of Science.
• Aerojet begins production of the MK 46 torpedo, delivering 5,500 units to the U.S. Navy by 1967.

1964 • General Tire acquires controlling interest in Frontier Airlines.

1965 • General Tire acquires first hotel.
• RKO General acquires soft drink bottling business, Pepsi Bottlers.

1966 • Rocket Research captures first monopropellant hydrazine production program for Titan Transtage.

1969 • July 20, 1969 Neil Armstrong takes his first steps on the moon.
• Apollo 11 launch and moon landing uses Aerojet engines.
While I would like to note that great employees make a successful company, there was an entrepreneurial spirit that permeated throughout the company that most likely was inherited from the founders. These qualities and characteristics contributed to the company’s success for many years.

James Marien
President GenCorp Polymer Products 1988 - 1993

COMPANY TIMELINE

1972 • Atlantic Research Corporation begins development on the Stinger rocket motors.

1974 • National tire business declines due to oil embargo.

1975 • Titan III successfully boosts the first U.S. spacecraft (Viking 1) to Mars.
• Atlantic Research Corporation commences full-scale activity on the U.S. Navy Tomahawk cruise missile booster.

1976 • General Tire maintains 17% market share of truck tires.
• Viking 1 and Viking 2 land on the Martian surface powered by Rocket Research spacecraft and lander engines.

1977 • Voyager 1 and Voyager 2 launches are powered by Aerojet and Pratt & Whitney launch engines.
• Voyager 1 and 2 remain operational to this day using Aerojet Rocketdyne thrusters.

1978 • Aerojet is awarded contract to develop stage II of the Peacekeeper missile.

1979 • RKO is responsible for 43% of General Tire’s profits.

1980 • General Tire’s tire sales approach $1.5 billion.
• Atlantic Research Corporation and Vought Corporation (later Lockheed Martin) are awarded the MLRS production contract and greatly expand the Camden, Arkansas facility to accommodate the largest solid rocket motor production program in the company’s history.

1981 • General Tire becomes 5th largest U.S. tire maker.

1982 • General Tire & Rubber Company plant in Akron, Ohio closes.


1984 • General Tire & Rubber creates a parent holding company called GenCorp Inc. for its various businesses.
The main subsidiaries were: General Tire, Broadcaster RKO General involved in motion picture and video production, and Diversitech General, a manufacturer of tennis balls and polymer products including automotive soundproofing and home wallpapers, and defense contractor, Aerojet. Through its RKO General subsidiary, the company also held stakes in: Frontier Airlines, RKO bottlers, which operated Pepsi-Cola distributorships, and several resorts and hotels, including the Westward Look resort in Tucson, Arizona.

1985 • GenCorp sells satellite radio and Frontier Airlines.

1987 • GenCorp sells tire and bottling businesses to focus on high technology and high growth aerospace, automotive business.
• Undergoes large-scale restructuring to ward off hostile takeover attempt by General Acquisition, Inc.

1988 • Sales at Aerojet reach a high of $1 billion.

1989 • GenCorp sells all RKO broadcasting companies.

1990 • GenCorp Automotive becomes the leading supplier of vehicle sealing systems for vehicles.

1992 • Terminal High Altitude Area Defense (THAAD) development begins.

1993 • GenCorp Automotive supplies components to 98% of North American car platforms.

1994 • First flight of an Aerojet arcjet thruster on the Telstar 4 satellite ushers in the age of application for electric propulsion.

1999 • GenCorp spins off Decorative and Building Products & Performance Chemicals to Omnova Solutions.

2000 • The ISS electrical power system is the largest power system ever flown in space and provides 100 kW of continuous power to the space station.
• The first U.S. photovoltaic arrays are installed in December 2000.

2002 • GenCorp acquires General Dynamics Space Propulsion Systems (Rocket Research and Kaiser Marquardt).
• Aerojet conducts successful qualification tests of a full-scale 67-foot Atlas V solid rocket motor.

2003 • GenCorp acquires Atlantic Research Corporation’s propulsion business.

“Under Chairman Tom O’Neil, we were blessed with a gung ho group of talented people operating within a disciplined system wherein all departments cooperated and contributed to the excellent sales success we were achieving.”

Jim Marino
President of RKO Radio 1976 - 1980

“While I would like to note that great employees make a successful company, there was an entrepreneurial spirit that permeated throughout the company that most likely was inherited from the founders. These qualities and characteristics contributed to the company’s success for many years.”

James Marien
President GenCorp Polymer Products 1988 - 1993
**2004**
- GenCorp’s new Easton project transforms 1,400 acres to benefit the Northern California region with an innovative community plan.
- A robust ground-testing program of the THAAD weapon system is conducted.

**2005**
- The Titan rocket, a workhorse space lifter for 50 years, makes its final flight with Aerojet first and second-stage liquid rocket engines.
- Flight testing of the THAAD weapon system begins and has been 100% successful.
- GenCorp sells Aerojet Fine Chemicals to American Pacific Corporation.

**2006**
- Aerojet solid and liquid propulsion powers New Horizons to the planet Pluto on an Atlas V – the fastest spacecraft ever launched carries an Aerojet-built propulsion system.
- Achieves target intercept with THAAD Flight Test 3 on July 12, 2006.

**2008**
- Aerojet technologies lead to historic Mars Phoenix landing. This first successful pulse mode modulated descent used Aerojet thrusters.

**2009**
- GenCorp announces formation of Easton Development Company, LLC.
- Aerojet, Solar Power, Inc. and Sacramento Municipal Utility District (SMUD) dedicate 3.6 megawatt solar system and announce a 2.4 megawatt expansion at Aerojet’s Sacramento site (at six megawatts, one of the largest in the U.S.).
- The last set of photovoltaic arrays were installed on the ISS in March 2009.
- Aerojet Rocketdyne either designed, built or integrated the following hardware on the ISS: Solar arrays, array sequential shunt units, battery charge/discharge units, power converters, remote power controllers, thermal pump and flow controllers, and plasma contactors.

**2010**
- Delta launch vehicle’s 50th anniversary.
- NASA’s Orion Pad Abort-1 historic flight test successful with Aerojet’s technology.
- Aerojet Hall thruster used to rescue stranded Advanced Extremely High Frequency satellite.
- X-51A unmanned demonstrator aircraft sets air-breathing hypersonic flight record with Pratt & Whitney Rocketdyne scramjet engine operating at Mach 5 for 140 seconds.

**2011**
- Aerojet is awarded contract to complete Throttling Divert and Attitude Control System (TDACS) development for the Standard Missile-3 (SM-3) Block IIA missile.
- Maiden flight of Aerojet SM-3 Block IB TDACS demonstrates extreme envelope capability.

**2012**
- Aerojet marks 70 years serving the warfighter and powering exploration.
- Aerojet and Daice mark 50 years of partnership.

**2013**
- GenCorp acquires Pratt & Whitney Rocketdyne.
- Aerojet-General Corporation and Pratt & Whitney Rocketdyne combine to form Aerojet Rocketdyne, Inc.
- Aerojet Rocketdyne creates the Rocket Shop Defense Advanced Programs Business Unit to leverage the new company’s intellectual resources and focus on future growth through innovation.
- The X-51A WaveRider beats its own air-breathing hypersonic flight record with the Pratt & Whitney Rocketdyne scramjet engine operating at Mach 5.1 for 210 seconds.

**2014**
- NASA’s Orion spacecraft opens a new era of space exploration during its first test flight aboard a Delta IV Heavy rocket powered by three Aerojet Rocketdyne RS-68 main engines and an RL10 upper-stage engine. Aerojet Rocketdyne also provided a variety of thrusters and pressurant tanks on both the launch vehicle and spacecraft.

**2015**
- GenCorp Inc. changes its name to Aerojet Rocketdyne Holdings, Inc. and begins trading on the New York Stock Exchange and Chicago Stock Exchange under its new name with the trading symbol AJRD.
- Easton completes closing of 703 acre land sale in Northern California.
- SM-3 Block IIA TDACS successfully passes Design Verification hot fire test in advance of full qualification program.
➢ The fascinating field of space exploration will continue to be propelled by Aerojet Rocketdyne. After decades of diversified interests, Aerojet Rocketdyne Holdings is focused on propulsion, power and real estate.

➢ Aerojet Rocketdyne’s scramjet propulsion technology set records for air-breathing hypersonic flights. The X-51A WaveRider, an unmanned scramjet demonstration aircraft, completed its first powered hypersonic flight in 2010 at Mach 5. In 2013, the X-51A completed a flight of more than six minutes and reached speeds of Mach 5.1 under sustained scramjet power for 210 seconds. The company is currently developing a wide range of hypersonic propulsion system technologies applicable to aircraft and missiles, including high speed weapons, hypersonic cruise vehicles with rapid global reach for reconnaissance and strike missions, and concepts that will provide enhanced access to space.

➢ The shift in company organization can be traced back to 1982. General Tire & Rubber Company was a huge operation with 32,000 employees. It operated 27 manufacturing facilities in the U.S. and had 12 foreign manufacturing affiliates in 10 other countries. Besides Aerojet-General and RKO General, it was involved in 11 major businesses producing 15,000 products, including tires, latex, reinforced plastics, industrial rubber products, wall coverings, athletic products, coated fabrics, diversified plastics, building products and plastic films, synthetic rubber and PVC resins.

➢ At the same time, the company’s key leaders, the three sons of founder William O’Neil, were approaching retirement. Those and other factors led to a major restructuring. In 1984, the company was renamed as GenCorp Inc. and restructured as a holding company with four subsidiaries: Aerojet-General Corporation, RKO General, General Tire, and Diversitech General. In 1987, GenCorp’s focus was refined to include only aerospace and industrial products. Over the next decade, all of its businesses, except for Vehicle Sealing (the last remaining vestige of Diversitech General) were sold or spun off. In 2001, the focus was fine-tuned again to concentrate on diversified propulsion systems, and GenCorp sold its Electronics Systems business.

➢ While this may seem like a dramatic narrowing of market possibilities, GenCorp still offered a variety of products to the defense and aerospace industries. Furthermore, it expanded those capabilities in 2002 when it acquired General Dynamics’ Space Propulsion and Fire Suppression (originally Rocket Research Corporation). That company had developed small thrusters for in-space propulsion of satellites and launch vehicles including the Space Shuttle, Atlas and Delta. The following year, GenCorp acquired the propulsion business of Atlantic Research Corporation, a developer and manufacturer of solid rocket propulsion systems and auxiliary rocket motors for both space exploration and defense. The company’s product line expanded even further in 2013 when it acquired Pratt & Whitney Rocketdyne.

➢ One notable change was yet to come. In 2015, GenCorp evolved further as its name changed to Aerojet Rocketdyne Holdings, Inc., to better reflect its core mission of providing propulsion and energetics to its space, missile defense, strategic, tactical missile and armaments customers throughout domestic and international markets.
Orion Spacecraft
A successful unmanned test flight of the Orion vehicle was conducted in December 2014.

Delta IV Heavy Boosters,
each powered by an Aerojet Rocketdyne RS-68 engine, arrive at Port Canaveral in support of NASA’s EFT-1 with the Orion spacecraft.

U.S. Navy’s SM-3
Aerojet Rocketdyne employees are continuing to build new technologies based on the 100% successful SM-3 Block IB propulsion systems.

➢ Of Aerojet Rocketdyne Holdings’ two subsidiaries, Aerojet Rocketdyne is the largest, providing innovative products for defense and space customers around the world. It is an industry leader in the development and manufacture of aerospace propulsion systems, precision tactical weapons systems and armament systems, including warhead and munitions applications. It offers both solid- and liquid-fuel propulsion systems and is the industry leader in tactical solid propulsion. Specific areas of expertise include defense, space and launch systems, additive manufacturing, specialty metals, modeling and simulation, power and energy solutions, and research and development.

➢ The other subsidiary, Easton Development Company, is planning and developing mixed-use residential and commercial communities in the Sacramento, California metropolitan area.

➢ The defense and space markets offer great potential for Aerojet Rocketdyne. For example, the company is working on qualification of the SM-3 Block IIA derivative of the SM-3 Block IB TDACS, a hit-to-kill missile defense interceptor which provides intercept capability against both intermediate-range and intercontinental ballistic missile threats. The SM-3 Block IB TDACS is in full production and has demonstrated 100 percent mission success across both ship and land launches. Additionally, development work is being done on composite case bomb bodies for the BLU-129 and Focused Lethality Munition (FLM) programs to replace traditional “iron bombs,” providing low collateral damage options for the warfighter.

➢ On the space exploration front, NASA is developing the Orion spacecraft that will carry astronauts beyond low Earth orbit. Aerojet Rocketdyne is providing propulsion for almost every component of Orion, including the reusable vehicle itself, its expendable service module and its launch abort-system. A successful unmanned test flight of the Orion vehicle was conducted in December 2014. Aerojet Rocketdyne also will supply propulsion systems for the Space Launch System, which is under development by NASA and will launch the Orion missions. Engine testing is underway and the first unmanned flight is scheduled for 2018.

➢ Aerojet Rocketdyne is developing a launch abort and orbital maneuvering system for Boeing’s CST-100 reusable commercial crew vehicle, one of two vehicles being developed under NASA contracts for carrying astronauts and supplies to the ISS. The innovative “pusher” abort system propels the crew module away from the launch vehicle. Rather than being jettisoned after a successful launch, the pusher system stays with the crew module, and its propellant can be used for other mission activities. Aerojet Rocketdyne is also furnishing propulsion for the crew and service modules.

These are only a few examples of new projects currently being developed. As for what novel projects may arise in the next few years, well, the sky is no longer the limit.