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So You Want To Be A Rocket Scientist

Linda Soules

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So You Want To Be A Rocket Scientist

by Linda Soules

Genre: Children's Nonfiction

Key Takeaways

• Rocket science is a struggle against weight: because rockets need enormous amounts of propellant to reach orbital speed, engineers work to make every component lighter without sacrificing strength or safety.

• Rockets move by pushing hot exhaust backward, following Newton’s rule that every action has an equal and opposite reaction; carrying an oxidizer lets them burn fuel even in space.

• A rocket is a coordinated system of stages, tanks, engines, guidance systems, and protective structures, and each part must work reliably under extreme heat, cold, pressure, and vibration.

• Rocket science is collaborative and specialized. Propulsion, structural, guidance, flight-dynamics, materials, and test engineers work alongside technicians, welders, software developers, inspectors, and many others.

• Careful testing and learning from failure are central to the work. Simulations, static engine tests, telemetry, documentation, and safety reviews help teams find problems before they endanger a mission.

• Getting into orbit means continually falling around Earth while moving sideways fast enough to miss the ground; rockets tilt after liftoff to build horizontal speed, and Earth’s rotation provides an additional boost.

• Reusable boosters are changing spaceflight: landing and flying rockets again could reduce costs, while challenging engineers to inspect, refuel, and relaunch vehicles quickly and safely.

• Rocketry supports everyday life through GPS, communications, weather forecasting, agriculture, and wildfire monitoring, while also enabling space telescopes, planetary probes, and human exploration.

• Good rocket scientists need more than advanced math and physics. Precision, hands-on building experience, curiosity, imagination, teamwork, calm under pressure, and the courage to speak up are all essential.

• Engineering carries ethical responsibility: the history of Wernher von Braun and the V-2 reminds readers to consider who may benefit from a technology, who may be harmed, and how their work should be used.

Who Should Read This Book

This book is ideal for curious readers around ages 10–14 who wonder how rockets fly, enjoy building and testing things, or are beginning to explore engineering careers. Younger readers can share it with a parent or teacher, while older students can use its career descriptions, practical preparation tips, glossary, and recommended activities to plan next steps. Adults who read along will also find approachable explanations of orbital mechanics, launch operations, and space technology's everyday uses. Unlike a textbook focused mainly on equations or a career guide that lists duties and qualifications, this book combines accessible science with workplace stories, historical profiles, launch-day drama, practical experiments, and honest discussion of failure and ethics. Readers come away with both a picture of the excitement and a realistic understanding of the patience, teamwork, safety culture, and accountability that the work demands.

Chapter Summaries

What If You Were a Rocket Scientist?

The book opens with the excitement of helping build a machine that thunders from Earth carrying satellites, scientific instruments, or people. It immediately grounds that spectacle in a central engineering challenge: weight. A rocket must reach about 17,500 miles per hour to orbit, and since fuel itself is heavy, a vehicle needs fuel to lift its fuel. On a large rocket, roughly nine-tenths of the launch weight may be fuel and its oxidizer, leaving engineers to fight for every gram through lighter tanks, stronger materials, and more efficient engines. The basic principle is Newton's action-and-reaction law. A rocket expels hot gas at high speed and

moves in the opposite direction; even a released balloon demonstrates the idea. Rockets burn propellant—fuel plus an oxidizer such as liquid oxygen—so they can operate where there is no air. The book highlights the extremes involved: liquid oxygen is colder than Antarctica's coldest recorded day, while combustion inside an engine can reach around 6,000 degrees Fahrenheit. Engineers cool engine walls by routing cold propellant through small channels before it burns, while solid-propellant motors offer a simpler but less controllable alternative because they cannot be switched off once ignited.

Meet the Rocket

This section tours a rocket from nose to tail, explaining how its components work together. The fairing shields the payload during the trip through the atmosphere and then splits away; the payload is the satellite, telescope, supplies, or crew capsule that makes the mission worthwhile. Above the booster sit one or more upper stages, which take over after the lower section has done the hardest work and provide the final push toward orbit. The largest components are usually the fuel and oxidizer tanks, which keep the substances separate until they reach the engines. Pumps feed propellant into the engines, and bell-shaped nozzles direct the exhaust downward to produce thrust. Stages are discarded when their propellant runs out, reducing the weight the remaining rocket has to carry. Some modern boosters go further: after separating, they turn around, return to Earth, and land for possible reuse.

What a Rocket Scientist Actually Does

"Rocket scientist" is a broad nickname rather than one specific job, and most people in the field are aerospace engineers who specialize in particular systems. Propulsion engineers design engines, pumps, pipes, and nozzles; structures engineers create light but sturdy bodies and tanks; and guidance, navigation, and control engineers build the hardware and software that steer the vehicle. Flight-dynamics specialists calculate the trajectory, including when engines should fire, how long they should burn, and how the rocket must point to deliver its payload correctly. The work also involves chemists, materials scientists, and test engineers. Teams move from calculations and computer models to component tests, engine firings, and full-vehicle checks. They inspect and document bolts, welds, wires, and other parts so faults can be traced. Before launch, hardware may be shaken on large test tables or subjected to powerful sound. On launch day, teams at consoles monitor thousands of measurements and follow a countdown in which each group must report "go." Afterward, engineers examine flight data to identify successes and improvements for future missions.

Where They Work and the Tools of the Trade

Aerospace engineers work for NASA, private launch companies, manufacturers of engines and satellites, and space organizations around the world. The field includes office design work as well as remote engine-test sites and coastal launch facilities. Coastal locations allow rockets to travel over water, while some engineers work aboard ships that recover returning

boosters. The book notes that the worldwide pace of launches is increasing and that launch teams may learn from new flights every few days. Three essential tools support the work. Computer simulations let engineers model engine flow, launch vibration, and flight paths before spending money on hardware. Test stands hold engines or rockets in place during static fires, while sensors measure thrust, heat, and vibration. Telemetry sends measurements such as speed, altitude, temperature, and pressure back to engineers in real time and later serves as a detailed record of flight. Payloads are assembled in clean rooms, where filtered air and protective suits help prevent dust or stray hairs from damaging sensitive equipment.

The Best and Hardest Parts of the Job

Launch day is a defining reward for many engineers: after years of work, the engines ignite, the rocket rises, and the team sees its contribution become part of a real mission. Some launches use hundreds of thousands of gallons of water to absorb heat and sound. Engineers also take pride in the puzzles behind flight, such as steering in space by swiveling an engine or guiding a tall booster onto a ship at sea. NASA's Curiosity landing illustrates the suspense: because signals from Mars take longer to reach Earth than the landing sequence itself, the team had to wait to learn whether its "sky crane" had safely lowered the rover. The chapter balances those triumphs with the reality of setbacks. Engines can explode in tests, rockets can break apart on early flights, and a small mistake can destroy a mission—as when incompatible measurement units contributed to the loss of a Mars spacecraft in 1999. Launches may be scrubbed at the last minute because of weather or a questionable sensor reading, and budgets can delay missions or put jobs at risk. Engineers also face the growing problem of space debris and must plan for old stages and satellites to be safely removed from orbit. Failure is treated as evidence to investigate, not as a substitute for rigorous safety work.

Rocket Language, Orbital Physics, and Reusable Rockets

Readers learn the vocabulary of launch operations: "nominal" means performance is on plan, an "anomaly" is an unexpected event, "LOX" means liquid oxygen, and a "hold" pauses the countdown when someone sees a concern. "Max Q" is the point of greatest aerodynamic pressure, while "pogo" describes a dangerous bouncing vibration. The playful term "lithobraking" means stopping by hitting the ground—a joke, not a technique engineers recommend. The book demystifies orbit: a satellite is still falling toward Earth, but its sideways speed makes it continually miss the ground. Rockets therefore tilt after launch to build horizontal speed, often heading east to take advantage of Earth's rotation. Escape requires about 25,000 miles per hour, though planetary gravity assists can help probes travel farther. Another major shift is reusability. Boosters can land upright or be caught by launch-tower arms, then inspected and prepared to fly again. Reuse may make access to space cheaper, but it requires new solutions for dependable recovery and quick turnaround.

A Day in the Life and the People Behind a Launch

A fictional day follows a propulsion test engineer preparing a new engine for a 60-second firing. The team checks weather and safety procedures, loads super-cold liquid oxygen, and pauses the countdown to move an armadillo away from the test area. After the engine ignites, a temperature spike triggers an automatic shutdown at 42 seconds. Rather than treat the shortened test as wasted effort, the team studies the telemetry, finds that a valve opened slightly late, and plans a correction for the next attempt. The episode shows how predictions, safeguards, data, and iteration meet in hands-on engineering. No one builds a rocket alone. Technicians, machinists, and welders turn designs into hardware; software developers write critical code; inspectors examine parts; weather officers assess launch conditions; and range-safety staff and flight controllers protect missions. Even unusual specialties matter: NASA chemical specialist George Aldrich smelled materials before they flew, helping prevent unpleasant odors from making a spacecraft cabin uncomfortable. Engineers also work with customers who entrust years of scientific work to the launch team, and they share lessons across teams so one group's failure can help others avoid repeating it.

How Rockets Help People

The book connects launch vehicles to services people use every day. Navigation satellites help phones, ambulances, and aircraft determine their positions; communications satellites carry television, internet, and calls to remote communities and ships. Weather satellites track storms before they reach land, giving people more warning than was possible during disasters such as the 1900 Galveston hurricane. Satellites also help farmers monitor fields and firefighters track wildfires, including at night. Rockets also extend scientific knowledge. They have sent probes to every planet in the solar system, delivered rovers to Mars, and launched telescopes such as the James Webb Space Telescope. The book points out that space technology can return to everyday life: compact camera-chip technology developed for spacecraft helped make modern phone cameras possible, GPS depends on precise satellite clocks and corrections for relativity, and ear thermometers use sensors related to technology developed to measure celestial heat. Student-built satellites and the Artemis II lunar journey illustrate that space exploration can involve young people as well as professional teams.

The Qualities and Preparation of a Rocket Scientist

The author identifies precision, courage to test, calm under pressure, teamwork, and imagination as vital qualities. Engineers check calculations and ask others to check them because a decimal error or incorrectly tightened bolt can matter enormously. They deliberately test designs to their limits and use failures to understand where those limits are. The ability to pause, investigate, and speak up—including as the newest person on a team—is presented as a strength, not a disruption. Preparation begins with math, physics, and chemistry, but practical experience matters too. Building model rockets, taking things

apart, learning how parts are made, coding, and keeping a notebook of predictions and results all develop useful habits. Weather knowledge is important because wind, lightning, rain, and certain clouds can delay a launch; Apollo 12's lightning strikes helped prompt stricter rules about storm clouds. The book offers concrete next steps for young readers: try supervised rocket activities, change one variable at a time, enter a science fair, watch launches, pursue internships or student teams, and explore technician and apprenticeship routes as well as university degrees.

Famous Rocket Scientists and a Difficult History

Profiles show that rocket science has developed through people with varied backgrounds and routes into the field. Konstantin Tsiolkovsky taught himself through library study and developed the rocket equation. Robert Goddard launched the first liquid-fueled rocket in 1926 and persisted despite ridicule about rockets working in space. Hideo Itokawa advanced Japan's program through small, carefully measured Pencil rocket tests. Yvonne Brill overcame barriers to women in engineering and developed a satellite thruster, while Annie Easley moved from hand calculations to programming rocket systems at NASA. Ritu Karidhal helped guide India's Mars mission and later served as a lunar-mission director. The discussion of Wernher von Braun adds an essential ethical dimension. He led development of Nazi Germany's V-2 weapon, joined the Nazi Party and the SS, and oversaw work that relied on concentration-camp prisoners under terrible conditions; historians estimate that more people died building V-2s than were killed by them. After the war, the United States brought him and other engineers to America, where he later led work on the Saturn V. The book recognizes the technical legacy while refusing to separate it from the human cost, asking readers to consider who their work serves and whom it may harm.

Rocket Facts, Launch-Pad Secrets, and the Road Ahead

A collection of facts and behind-the-scenes stories makes the science memorable: early Chinese gunpowder rockets were "arrows of flying fire"; movie storytelling may have helped popularize countdowns; the Saturn V was taller than the Statue of Liberty; and scientists differ over where space begins. Launch-pad anecdotes include a woodpecker damaging shuttle-tank foam, a frog caught in a launch photograph, and the decision to leave the shuttle's fuel tank unpainted to save roughly 600 pounds. The book also explains that much of the white cloud at liftoff is steam from water used to protect the pad. The closing material turns curiosity into action. A simple balloon-and-straw activity demonstrates thrust and the effects of added weight, while the glossary defines terms such as payload, stage, trajectory, and telemetry. Readers are directed to books, NASA resources, rocketry clubs, Space Camp, student competitions, and museums. The author's closing message is that careful work can outlast its creators: engineers should record what they learn, improve designs one change at a time, and make it safe for anyone on a team to call a hold when something seems wrong. The rockets that will carry people farther are still being designed, and young readers can help

build them.

Notable Quotes

"For every action, there's an equal and opposite reaction."

"A satellite in orbit is falling toward Earth the whole time."

"Rocket scientists check every number, then ask a teammate to check it again."

"Being brilliant is not the same as being good. The best rocket scientists try to be both."

"Some of the most valuable words a person can learn to say are “I'm not sure this is right. Can we check?”"

"Whatever you end up building, the care you put into it today can travel farther than you ever will."

"Grab a pencil. Someone has to do the math."

Full Summary

So, you want to be a rocket scientist: to design machines that roar off launch pads, punch through the sky, and carry satellites, probes, and people into space. The work begins with a stubborn engineering problem: weight. A rocket must travel about 17,500 miles an hour to reach orbit, fast enough to cross the United States in less than ten minutes. Reaching that speed takes enormous quantities of propellant, but propellant is heavy, and lifting it requires still more propellant. It is like running a marathon while carrying all the snacks you’ll need, plus extra snacks to give you the energy to carry them. About nine-tenths of a large rocket’s liftoff weight is fuel and the oxygen needed to burn it. The spacecraft at the top is only a small fraction. Engineers therefore fight for every gram: lighter tanks, stronger metals, and more efficient engines can determine whether a rocket reaches space or falls short. Some early rockets had steel walls thinner than a dime and had to stay pressurized, like balloons, or collapse under their own weight.

The basic push comes from Newton’s rule that every action has an equal and opposite reaction. Throw a heavy ball forward while standing on roller skates, and you roll backward. A rocket does the same thing by blasting hot gas out of its engines, sending itself in the opposite direction. That push is called thrust. Even a balloon, released after being blown up, demonstrates the principle as it shoots around a room. Rockets burn propellant, a combination of fuel and oxidizer. Often the oxidizer is liquid oxygen, which allows fuel to burn even where there is no air, including space. Liquid oxygen boils at minus 297 degrees Fahrenheit, while burning propellant inside an engine can reach about 6,000 degrees. To stop

the engine from melting, engineers may route super-cold propellant through tiny channels in its walls before it burns, cooling the metal. Other rockets use solid propellant packed inside like powder in a giant firework; once ignited, a solid rocket cannot be turned off.

A rocket is largely a flying fuel tank, assembled as a system of parts that must work together. At the top, the fairing protects the payload—perhaps a satellite, telescope, supplies, or crew capsule—against the air during ascent. Once the rocket is above most of the atmosphere, the fairing splits open and falls away. Beneath the payload sits the second stage, which takes over high in the sky and provides the final push. The huge fuel and oxidizer tanks keep their contents separate until they meet inside the engines. Pumps force propellant into the engines, and bell-shaped nozzles direct the hot exhaust downward. At the bottom, the first stage, or booster, handles the hardest lifting. On some rockets it later turns around, extends landing legs, and touches down for another flight.

“Rocket scientist” may be used to mean genius, but the actual job depends less on genius than on patience, careful checking, and focused expertise. Most rocket scientists are aerospace engineers who specialize in a part of the vehicle. Propulsion engineers design the engines, pumps, pipes, and nozzles; structures engineers create the body and tanks, balancing low weight against the strength required to endure launch pressure and shaking. Guidance, navigation, and control engineers build the systems and software that steer the rocket and keep it from tumbling. Flight-dynamics engineers calculate its trajectory, deciding when engines should fire, how long they should burn, and where the rocket must point to deliver its cargo correctly. Other specialists develop propellants, invent heat-resistant materials, or test engines on the ground.

Large rockets often have several stages, each with its own tanks and engines. When a stage runs out of propellant, it drops away so the rocket no longer has to carry its empty weight. Designing and building the complete vehicle takes years. Engineers begin with calculations and computer models, then build and test individual parts, engines, and eventually the rocket as a whole. Every bolt, weld, and wire is inspected and recorded, allowing teams to trace which part was used and who checked it. A rocket may contain millions of parts, and components are shaken on giant tables or blasted with sound louder than a rock concert to test whether they can survive flight. At launch, engineers sit at computer consoles in a control room, follow a countdown of final checks, and monitor thousands of measurements. Each team must report “go” before the rocket can fly. Afterward, engineers study the flight data to learn what worked and what should change.

Aerospace engineers work at NASA, at private companies that build and launch rockets, and at businesses making engines, components, and satellites. In 2025, about 68,700 aerospace engineers worked in the United States; their median annual pay was about $135,000, and employment was expected to grow faster than average. Rocket work also takes place around

the world: Russia, China, India, Japan, New Zealand, and the European Space Agency's member countries launch rockets, while many more nations build satellites. The world recorded 324 orbital launch attempts in 2025, more than ever before. Most rocket scientists have at least a bachelor's degree in aerospace or mechanical engineering, physics, or a related subject; many earn a master's or PhD. Some military rocket jobs require a security clearance, and many positions call for years of hands-on experience.

Some of the work happens far from offices. Engine tests take place at remote sites in deserts and forests, where powerful test fires can be conducted without disturbing nearby communities. In 1929, one of Robert Goddard's Massachusetts launches was so loud that people thought an airplane had crashed and called for ambulances. Goddard later moved his work to New Mexico. Launch engineers work at coastal sites in Florida, Virginia, California, Texas, India, Japan, and elsewhere, where rockets can fly out over water and discarded stages can land in the ocean. Some engineers even work aboard ships that recover boosters at sea.

Before a rocket is built, engineers can fly it thousands of times inside a computer. Simulations model how hot gas flows through an engine, how the vehicle shakes at launch, and what path it might follow. Finding a design problem in a simulation is much cheaper and easier than finding it after construction. Ground tests then put hardware through real conditions. A test stand is a massive, reinforced structure that holds an engine or rocket in place during a static fire. Sensors can measure thrust, temperature, and vibration hundreds of times each second. Some stands are taller than a twenty-story building, and an engine may be fired dozens of times, each test pushing it harder.

During tests and launches, rockets transmit telemetry: measurements such as speed, altitude, temperature, and pressure. Engineers watch the readings on their consoles in real time, and a troubling measurement can stop the countdown before liftoff. After flight, the same stream of data becomes a detailed record of what the rocket experienced. Delicate payloads require a different kind of protection. A speck of dust or stray hair can damage a satellite, so teams assemble payloads in clean rooms, where filters remove almost all dust from the air. Workers enter in full-body suits, hoods, gloves, and booties, then seal the payload inside its protective fairing before it is attached to the rocket.

For many rocket scientists, the finest moment comes when years of work finally meet the sky. On some launch pads, enormous pipes release about 450,000 gallons of water a minute just before liftoff, soaking up heat and sound. At zero, the engines flare, and for a heartbeat the rocket holds still as they build power. Then it rises. A few seconds later, the roar arrives as a crackling sound felt in the chest. Engineers who have spent years perfecting one part of the vehicle hug, cheer, and sometimes cry with relief.

Watching a booster return can be just as thrilling. The first time a team sees a booster they designed drop out of the sky and settle gently onto its landing legs, it seems like a film running backward. Rockets offer puzzles that keep people fascinated for decades. To steer in space, where there is no air to push against, engineers swivel the engine, aiming its exhaust to turn the rocket. To land a booster taller than a twelve-story building on a ship rocking at sea, computers make tiny corrections many times a second, while the engine relights at exactly the right moment to slow the descent.

One of the most nerve-racking examples of rocket-powered precision came in 2012, when NASA's Jet Propulsion Laboratory waited for the Curiosity rover to land on Mars. The landing itself would take seven minutes, but radio signals needed almost fourteen minutes to travel from Mars to Earth. By the time the team heard what had happened, the spacecraft had already landed safely or crashed. The rover descended beneath a rocket-powered "sky crane," which hovered as it lowered Curiosity on ropes, then flew away. The wait became known as "seven minutes of terror." When the delayed signal finally confirmed success, the room erupted in cheers and hugs. Jars of peanuts were on desks: after six failed missions in a row in 1964, someone had passed peanuts around before the next one, which succeeded. The tradition stuck, and no one wants to be the person who forgets them.

The same work can also bring frustration, risk, and loss. Engines sometimes explode on test stands, and new rockets may break apart on early flights. Engineers might joke about a "rapid unscheduled disassembly," but a failure can erase years of effort in seconds. The team must investigate it piece by piece, finding what happened and what needs to change. Even a mistake in units can be devastating: in 1999, NASA lost a Mars-bound spacecraft because one team used American measurements while another used metric ones. The craft flew too close to Mars and was destroyed. Remembering that accidents in spaceflight have cost lives is one reason safety reviews are so strict.

Launch days can stretch through the night, only to end in a scrub when wind, lightning, or a suspicious sensor reading makes flying unsafe. Teams may have to start over the next day. Money adds another pressure: government budgets can change, delaying or canceling missions, while private companies must satisfy customers who expect costly rockets to work. Engineers also have to consider what happens after a mission. Old rocket stages and broken satellites can become space junk, so designers work to make stages and satellites fall back and burn up in the atmosphere when their jobs are done.

Launch control has its own vocabulary. "Nominal" means everything is proceeding as planned; "anomaly" is the restrained word for something unusual, whether minor or serious. "LOX," pronounced "locks," is liquid oxygen, the super-cold oxidizer. The countdown runs toward T-zero, the instant of liftoff; afterward, the clock uses T-plus. Anyone who spots trouble can call a "hold," stopping the countdown. "Max Q" is the point when air pressure pushes

hardest on a speeding rocket, so some vehicles throttle down before powering up again. “Pogo” describes a dangerous up-and-down bounce that engineers try to prevent. And “lithobraking”—slowing down by crashing into rock or ground—is a joke, not a flight plan.

Getting into orbit is another surprising idea: a satellite never escapes Earth’s gravity. It is continually falling toward the planet, but moves sideways so quickly that the curved ground falls away beneath it. At roughly 17,500 miles per hour, it keeps missing Earth and circles it about every ninety minutes. That is why astronauts aboard the International Space Station see around sixteen sunrises a day. Rockets do not simply shoot straight upward; soon after liftoff, they tip over and build horizontal speed. Most launch toward the east, taking advantage of Earth’s rotation. At Cape Canaveral, the ground is already moving about 915 miles per hour, giving a rocket an extra boost. To escape Earth altogether takes about 25,000 miles per hour. Farther out, spacecraft can use a gravity assist, passing close to a planet so its gravity flings them faster, like a slingshot.

For most of rocket history, boosters were used once and discarded. That began to change in 2015, when a booster flew to space and landed upright under its own power. By August 2026, one booster had flown thirty-seven times. In 2024, engineers tried an even more daring recovery: two huge arms on a launch tower, nicknamed “chopsticks,” caught a giant booster as it returned. Reuse could make spaceflight much cheaper, but it changes the engineering challenge. A booster must be inspected, refueled, and prepared for another launch safely, perhaps in only a few days. Bringing rockets home has become a major part of the work.

A test engineer’s day shows how progress is made in small, careful steps. At 5:30 in the morning, the engineer arrives at a Texas test site, checks the weather, and finds the stand lit by floodlights. The team briefing reviews the plan, safety rules, and reasons to stop. As technicians load propellant, white vapor pours from pipes carrying liquid oxygen. Then a radio call reports an armadillo near the stand. The countdown pauses while a crew member gently shoos it away, and the team laughs.

Before the test, every station reports “Go.” The new engine has run a hundred times in computer simulations, but this is its longest real firing yet: sixty seconds. From a concrete bunker, the engineer watches the countdown and the readings. The engine ignites, the ground shakes, and thrust is right on target—until, at forty-two seconds, a temperature reading spikes and the computer shuts it down. The engine is intact, but something became too hot. After the stand is safe, the team studies the data together. By evening, they find that a small valve opened a fraction of a second late, directing hot gas where it should not go. The flaw can be fixed; the team writes a plan to adjust the timing and test again the following week.

No one builds a rocket alone. Engineers rely on technicians, machinists, and welders who turn drawings into metal; a tank weld must be so precise that even a tiny flaw could cause a leak.

Software developers write code, inspectors examine parts, and weather officers track wind, clouds, and lightning. Range safety officers ensure a rocket stays on its planned path, while flight controllers take over when a spacecraft reaches space. Even a mission's less obvious needs matter. For decades, NASA chemical specialist George Aldrich smelled items before they flew—from glue and pens to spacesuit parts and stuffed toys—because astronauts cannot open a window if something stinks. He called himself a "nasalnaut."

Rocket teams also work with the scientists and other customers whose satellites, telescopes, or probes ride aboard. A scientist may spend ten years building a planetary spacecraft and then entrust it to a launch team for delivery to precisely the right orbit. Teams from different companies and countries share lessons from failures, so one group's hard-won discovery can help others avoid the same mistake. Around launch sites, families gather with the engineers, and beaches fill with cheering crowds; for many teams, launch day feels like a reunion.

The work matters far beyond launch day. Satellites help phones, ambulances, and airplanes find their way, and carry calls, television, and internet to ships and remote villages. They also watch storms form over the ocean. When a hurricane struck Galveston in 1900, people had little warning, and at least 6,000 died. Today, weather satellites can track a storm for days, giving families time to reach safety. Satellite images help farmers decide where fields need water and help firefighters follow wildfires, even through smoke at night.

Spacecraft also expand what we know. Probes have visited every planet in the solar system, and rovers have explored Mars. The James Webb Space Telescope reached orbit so precisely in 2021 that it had enough extra fuel to explore for about twice as long as planned; its images reveal galaxies whose light has traveled billions of years. Young people have already contributed: students from St. Thomas More Cathedral School built a satellite that entered orbit from the International Space Station in 2016. Rocket technology can even return to everyday life. NASA engineers seeking tiny, low-power cameras for spacecraft helped develop a camera chip now used in nearly every phone camera. GPS depends on precise satellite clocks, corrected for the tiny effects Einstein predicted, while the technology behind ear thermometers began with instruments for measuring the heat of distant stars and planets.

Doing this work well takes more than clever calculations. Precision matters because a misplaced decimal or incorrectly tightened bolt can determine whether a mission succeeds. Rocket scientists need the courage to test designs hard enough to expose their limits, and the calm to investigate an alarming reading instead of rushing. They also need imagination to picture machines that do not yet exist, and the humility to work as a team: no one knows every part of a rocket, so people must share knowledge, admit uncertainty, and speak up when something looks wrong.

Preparation can begin long before a job application. Building model rockets, taking things apart, fixing bikes, or learning how parts are machined and welded can teach an engineer

what is actually possible to build and repair. Math, physics, and chemistry explain trajectories, motion, and burning propellant; coding helps create simulations and guidance systems. Keeping a notebook of predictions, changes, and results is a simple way to practice the careful record-keeping engineers rely on. Student rocket teams, science fairs, launch broadcasts, and internships offer ways to test ideas and learn alongside others. Not every rocket worker needs a four-year degree: technicians and welders may train through community colleges or apprenticeships.

The history of rocketry includes people who followed very different paths. Konstantin Tsiolkovsky, left hard of hearing by scarlet fever as a child, taught himself from books in a Moscow library and later became a math teacher. In 1903 he published work explaining how rockets could travel into space. His rocket equation, relating a rocket's speed to its propellant and weight, is still taught today. Robert Goddard began dreaming about space at seventeen, after climbing a cherry tree to trim branches. In a snowy cabbage field in 1926, he launched the first liquid-fueled rocket: it flew for just two and a half seconds and rose 41 feet. A New York Times editorial had mocked his ideas, claiming rockets could not work without air to push against. Goddard understood that they push against their own exhaust; in 1969, the newspaper acknowledged its error as astronauts headed to the Moon.

Hideo Itokawa helped Japan enter the space age by starting with a rocket only 23 centimeters long. His team fired the Pencil rocket sideways through paper screens into a sandpit to measure its speed. Their work grew step by step until Japan launched its first satellite in 1970; an asteroid now bears Itokawa's name. Yvonne Brill, discouraged from studying engineering because she was a woman, instead excelled in math and chemistry. She developed a small satellite thruster using electricity to heat hydrazine, a design used since the 1980s, and received the National Medal of Technology and Innovation. Annie Easley, one of only four African American employees at her Cleveland research lab when hired in 1955, learned programming as electronic computers replaced human "computers." She wrote code for Centaur, a rocket stage using liquid hydrogen, earned a math degree while working, and spent 34 years at the lab that became part of NASA. Ritu Karidhal joined India's ISRO in 1997 and helped develop the autonomous systems that guided the Mars Orbiter Mission to Mars in 2014. She later directed India's 2019 Chandrayaan-2 Moon mission.

A celebrated engineer's achievements can also carry a painful history. Wernher von Braun led the German team that built the V-2 rocket for Nazi Germany during World War II. He joined the Nazi Party and the SS, and the weapon was built by concentration camp prisoners forced to work in terrible conditions. Historians estimate that about twice as many people died building V-2s as were killed by them. After the war, the United States brought von Braun and other engineers to America; he became a U.S. citizen and led the team that built the Saturn V. The V-2's history forces a question every engineer should ask: whom might this work help, and whom might it harm? Brilliance alone is not goodness.

Rocket history is full of surprises. Ancient Chinese defenders launched gunpowder-filled “arrows of flying fire” in 1232, an early version of the solid booster’s basic idea. A 1929 science-fiction film may have helped popularize counting backward before launch. The Saturn V stood taller than the Statue of Liberty, weighed about as much as 400 elephants, and produced a test roar measured at 204 decibels. There is even disagreement about where space begins: many scientists use the Kármán line, about 62 miles up, while NASA and the U.S. military award astronaut wings above 50 miles.

Launch pads have their own odd stories. The space shuttle’s fuel tank was painted white for its first two flights, but leaving it orange saved about 600 pounds. In 1995, a woodpecker mistook the tank’s foam for a tree, delaying launch about five weeks while workers repaired it and tried air horns and balloons with staring eyes. In 2013, a launch camera captured a frog flying beside a Virginia rocket. Much of the towering white cloud at liftoff is steam from water sprayed to absorb heat and sound. And after the first shuttle launch in 1981, a test director served beans and cornbread; the tradition grew into 60 gallons of beans for later launches.

The next generation can begin with a balloon and a straw, adding paper clips one at a time to see how extra weight changes the flight. The same habits scale up: change one thing, record what happens, and learn from the result. In the author’s view, the best teams also make it safe for anyone—even the newest person—to call a hold and say, “I’m not sure this is right. Can we check?” Rockets that will carry people to Mars are still being designed. A pencil, a notebook, and the willingness to check the numbers are good places to begin.

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