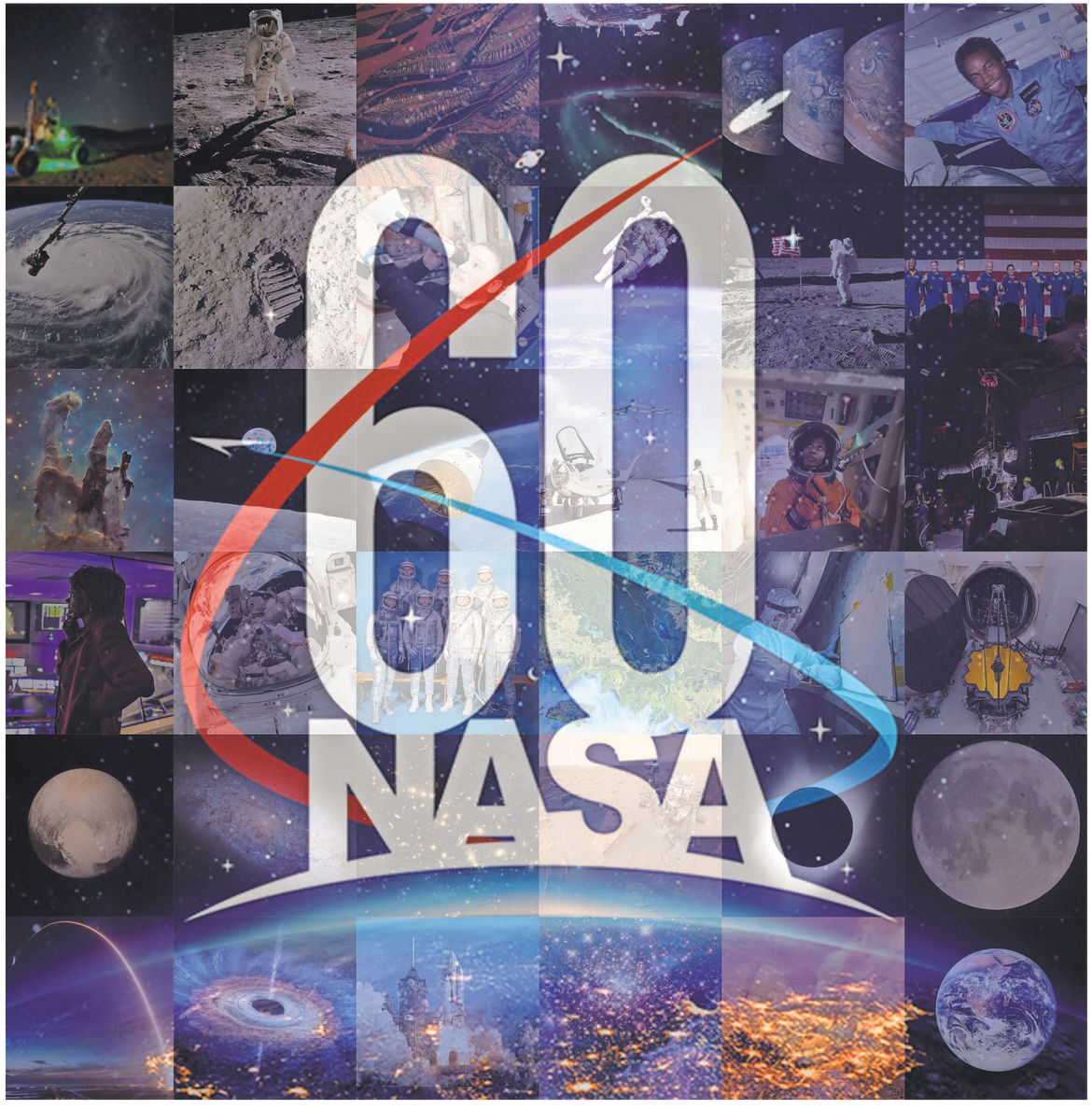

AT 60, IT'S 'NASA 2.0'

In an age when spaceflight has gone from magical to mundane and private companies are shooting for the stars, is the agency still relevant? Absolutely.

Matt Alderton Special to USA TODAY

At 60 years of age, the "good old days" loom large. Back then, things were easier — the best they'll ever be. But past is also prologue. If there were great days before, there can be great days still. And while the golden years may not be one's Golden Age, they're golden just the same. ▮ This is especially true for NASA, which celebrated its 60th birthday on Oct. 1.

On July 20, 1969, two American astronauts, Neil Armstrong and Buzz Aldrin, made the first footprints on the surface of the moon. It was the culmination of a decade of feverish effort driven by Cold War competition with the Soviet Union. At the start of that decade, Armstrong was a NASA test pilot, seen below with the X-15 rocket-powered plane.
LEFT, NASA; BELOW, NASA VIA AFP/GETTY IMAGES

The space agency's best days, history books suggest, were from 1961 until 1975, the period surrounding the Apollo program. Its peak: Apollo 11 making the first manned moon landing in 1969.

"For every American, this has to be the proudest day of our lives," President Richard Nixon told Apollo 11 astronauts Neil Armstrong and Buzz Aldrin from the White House. "For one priceless moment in the whole history of man, all the people on this Earth are truly one."

With good old days that good, the difference between *then* and *now* is stark. The NASA of today is not the NASA of 1969. Because there's no Cold War, space exploration is no longer an imperative. An American hasn't blasted off for space from U.S. soil since 2011, when NASA retired the space shuttle. And thanks to private companies led by billionaires, commercial spaceflight is coming soon to a galaxy near you.

Plus, spaceflight just isn't as sexy as it once was: Although 72% of Americans say it's essential for the United States to lead the world in space exploration, fewer than 20% think sending humans into deep space is a top priority, according to a 2018 Pew Research Center study.

"Space travel is so routine now that we no longer know the names of astronauts," says Matthew Hersch, assistant professor in the history of science at Har-

vard University and author of *Inventing the American Astronaut*. "It has become just another somewhat difficult and dangerous white-collar job."

Without the urgency, funding and public enthusiasm it once enjoyed, one has to wonder: Are NASA's best days behind it?

But the agency's ambitious goals — put humans back on the moon, then on Mars — suggest the opposite. If it can achieve them, the future might hold not only a new chapter for the civilian space program, but also a new Golden Age for American space enthusiasm.

From fear, greatness

To appreciate NASA's future, one must first understand its past.

"NASA was an act of a nation at war," says Robert Kurson, author of *Rocket Men: The Daring Odyssey of Apollo 8 and the Astronauts Who Made Man's First Journey to the Moon*. The United States and the Soviet Union engaged in the space race, he says, because each feared nuclear annihilation by the other. Each believed that the first nation to put humans on the moon would be the one whose technology and ideology were superior enough to win the Cold War. "When a country's back is against the wall, it is willing to invest huge money and huge intellectual capital to do things that were just yesterday believed to be impossible," Kurson says.

The Soviets made the first move in 1957 when they launched Sputnik, the first artificial satellite. NASA was born in 1958, and two years later it established the Apollo program. Within a decade, Americans were walking on the moon.

That NASA accomplished so much so quickly is thanks in large part to its youth, the naiveté of which allowed it to push boundaries in ways that more established bureaucracies never could.

These days, NASA is a lot older — and a lot more conservative. Grand achievements, therefore, feel fewer and farther between.

"NASA is still a great agency, but it's a mature agency," says W. Henry Lambright, a professor of political science and public administration at Syracuse University and author of *Why Mars: NASA and the Politics of Space Exploration*. "If you're a mature agency, just as if you're a mature person, it's much harder to do new things simply because you have so much baggage."

Astronaut Bruce McCandless II uses a jetpack-style maneuvering unit to fly free of the space shuttle Challenger in February 1984. It was the first time an astronaut had performed a spacewalk without being tethered to his spacecraft. McCandless flew about 320 feet from the shuttle before returning. The untethered spacewalk was a test of equipment to be used in a mission later that year to retrieve and repair a satellite. NASA

Peace is as much to blame as age. "Without believing that our very survival is at stake, it's very difficult to generate the kind of massive financial investment that's required to do what NASA did in the '60s," Kurson says.

Indeed, at its highest point — in 1966 — NASA's appropriations made up 4.4% of the federal budget. Today, they are less than 0.5% of it.

"Ever since Apollo, NASA has tried to re-create Apollo and failed because the conditions that made Apollo possible are no longer there," says John Logsdon, founder of George Washington University's Space Policy Institute and editor of *The Penguin Book of Outer Space Exploration: NASA and the Incredible Story of Human Spaceflight.* "As a result, I think we're at a point where NASA has to become NASA 2.0."

NASA 2.0 will be modular instead of monolithic, Logsdon predicts. "In order to remain relevant, NASA has to work in partnership with all the other countries that are now active in space," he says. "It must move away from thinking it's the only game in town."

Cosmic collaboration

Whereas space was once the exclusive domain of the United States and Russia, at least 29 countries now have space programs, according to NASA, which already collaborates with 14 other nations to manage the International Space Station (ISS). Given its resource constraints, NASA going forward will have to apply an ISS model more broadly in order to achieve its objectives.

"I just cannot see America doing the whole thing by itself anymore," Lambright says. "It's too expensive, too complicated, too risky — too everything. It's going to take a partnership."

Instead of a foreign nation's space agency, the most disruptive player could be private industry, led by the likes of SpaceX, Virgin Galactic and Blue Origin, whose billionaire founders have made it their personal mission to shake up space travel. SpaceX, for example, designs and manufactures reusable rockets with which to launch commercial spacecraft; helmed by Tesla founder Elon Musk, its ultimate goal is carrying human colonists to Mars. Blue Origin is pursuing the same mission under Amazon founder Jeff Bezos. Meanwhile, Richard Branson's Virgin Galactic plans to offer suborbital spaceflights to tourists.

These and other startups have things NASA lacks, not the least of which is money. NASA's budget may sound large — $20.7 billion in 2018 — but it's only a fraction of the global space economy, which the nonprofit Space Foundation valued at $383.5 billion in 2017. Relative to NASA, its wealth helps industry compete for talent, absorb risk and accelerate research and development, all of which give the private sector an edge in its pursuit of outer-space ambitions.

"The private sector is more nimble and more free to experiment," says Chris Impey, astronomy professor at the University of Arizona and author of *Beyond: Our Future in Space*. "The people in-

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volved are very rich and ... are very committed to the mission. So this isn't a fad; these companies are in it for the long haul."

Profiting from Partnership

While space startups might seem like an existential threat to NASA, observers say there's room in space for everyone.

"The idea that NASA is shutting down and turning its work over to the private sector is just a myth," Hersch says.

In fact, NASA has always worked closely with industry.

"From the very beginning, the agency was intended principally as a contracting agency that would take the tax dollars allocated to it and spend them on American contractors and subcontractors to produce design studies, space vehicles and launch services," says Hersch, who notes that NASA historically has spent more than 80% of its budget on industry contracts.

NASA doesn't *compete* with industry. Rather, it *creates* it.

"NASA is a catalyst of the American commercial space sector," says George Whitesides, Virgin Galactic's CEO and a former NASA chief of staff. "I don't think it would have been possible to do a company like Virgin Galactic without NASA because it pioneered the basic research of supersonic flight."

Through innovative contracting approaches, NASA likewise is a linchpin for companies like SpaceX and Orbital ATK (now Northrop Grumman Innovation Systems), whose private spacecraft replaced the space shuttle in 2012 and have been delivering cargo to the ISS ever since as part of NASA's Commercial Cargo Program.

The concept is simple: NASA provides seed funding to companies to help them develop rockets and capsules. Through a subsequent contract, it then hires those companies to resupply the ISS, releasing NASA from the risk and expense of owning and operating its own fleet.

Space shuttle Endeavour lifts off on an 11-day construction mission to the International Space Station in April 2001. Shuttles flew 133 successful missions from 1981 to 2011. Two shuttles were destroyed in accidents that killed 14. NASA

The program has been so successful that NASA is now developing a Commercial Crew Program that will use the same business model to transport astronauts to the ISS aboard commercial spacecraft from SpaceX and Boeing.

A 2017 analysis by the Kennedy Space Center found that its commercial programs cost NASA 37% to 39% of what it would have cost to continue the space shuttle program.

The approach doesn't just yield savings, however; it also yields capabilities. "The space shuttle had approximately 12,000 requirements that the private sector had to meet. With Commercial Crew it's about 280," says Phil McAlister, director of NASA's Commercial Spaceflight Division. "Establishing the requirements at a very high level and allowing companies to own the intellectual property and make decisions about how the spacecraft is going to operate has really opened up a lot of innovation."

NASA's Tipping Point program also takes advantage of public-private partnerships. Now in its third year, the program seeks proposals from companies with new space technology that's on the "tipping point" of commercialization. Acting much like a venture capitalist, NASA invests in promising companies, which use its funds and their own to carry products over the finish line for future use by both NASA and commercial entities. This year, NASA awarded $44 million to six private companies whose projects include a deep-space propulsion system, a navigation system that will help robots find the best spot to land on the moon and an advanced fuel system to support long-duration missions.

"We don't have the funding to do everything we'd like," says James Reuter, acting associate administrator of NASA's Space Technology Mission Directorate,

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Two hundred fifty miles above the Earth's surface, astronaut Mike Hopkins performs repairs on the International Space Station during a spacewalk in 2013. NASA

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which administers the Tipping Point program. "Being able to leverage industry heavily makes a huge difference and can have a force multiplier effect for us."

Optimism ahead

Clearly, the metamorphosis to "NASA 2.0" is already underway. And while setbacks are certain — last year, for example, SpaceX announced plans to develop a deep-space rocket that rivals NASA's forthcoming Space Launch System (SLS) both in cost and capability — so is success, supporters say.

"NASA's $18- to $19-billion-a-year budget may be small, but every year it rolls in like the tide," Impey says. "We don't know 10 years from now if SpaceX will still exist, or who the players in the private sector will be.

"First movers don't always persist, but NASA almost certainly will."

Of course, NASA doesn't just want to survive. It plans to thrive — and believes the new space economy will help it do so.

Take the Commercial Cargo and Crew Programs, for example. By outsourcing routine tasks to industry, NASA frees up valuable resources to put toward its most ambitious objectives: returning to the moon and putting astronauts on Mars.

"When something is available commercially, it's generally more cost-effective. Because we don't have to develop it ourselves, we can take the savings and apply it to our deep-space missions," McAlister says. "The solar system is a really big place, so there's always going to be the next hill — the next destination that no one has ever been to."

Exploration is the reason NASA gets up in the morning. "We can push the boundaries of discovery by pursuing missions that oftentimes don't have a return on investment for industry partners," Reuter says. NASA can invest in projects that take decades to execute while industry typically must focus on near-term projects and profits, he says. "We can take a longer-range view."

That's what has made it relevant for the last 60 years, NASA argues — and what will keep it relevant for the next 60.

"Since the retirement of the space shuttle, we've been in development working on things like Orion, SLS and Commercial Crew," McAlister says. "A lot of those capabilities are about to debut over the next one, two or three years. So things for NASA are about to get really exciting again."

Who knows: NASA's next Golden Age might literally be waiting just beyond the horizon.

"I'm very optimistic about the hunger of people in this country and around the world for space. I think we just have to make that next push," Kurson says. "Landing humans on the moon again, building populated bases on the moon and perhaps even getting to Mars is just the right prescription for rekindling that sense of wonder we seem to have lost."