

A Bold Plan to Go Where Men Have Gone Before

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EL SEGUNDO, Calif.



Monica Almeida/The New York Times
Elon Musk, who made his millions by building and selling PayPal, aims to build and launch rockets to take people and other payloads into orbit and to the moon.

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ASK Elon Musk what he wants to do with his life — after having amassed a \$300 million fortune from the Internet — and the answer is surprising. At 34, he says he is too young to retire. Philanthropy is a bit staid. Starting another Web-based venture is hardly a challenge, not for a man who bought the idea for PayPal, built it up and then sold it to [eBay](#) for \$1.5 billion.

In seeking a new direction in life that would be as ambitious as his dreams, Mr. Musk has picked a doozy: cheap and reliable access to space.

Making money from space is a road that several other

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self-made millionaires have traveled, from a Texas banker named Andrew Beal to one of [Microsoft's](#) co-founders, Paul G. Allen. There have been enough of them to warrant a mocking nickname: "trillionaires." And so far their efforts have either ended in failure or have been just ventures in "space tourism" that brought test pilots to the fringe of space.

Mr. Musk wants more, and he has put \$100 million of his fortune on the line to try to get it. His goal is to make a business out of inexpensively launching satellites into orbit. Inexpensive, of course, is a relative term, in a business where launchings of private commercial weather, telecommunications and other payloads start at \$30 million and go up to \$85 million or more.

Through his company, Space Explorations Technology, or SpaceX, Mr. Musk wants to send things to space for one-third of the going rate or less — even bringing down the price to \$7 million for small payloads to low Earth orbit — with a series of simple rockets of his own design. His goal is to build a [Volkswagen](#) of the cosmos, a bare-bones and dirt-cheap rocket that will go into space and return, to be used again and again. Commercial launchings currently cost \$5,000 to \$10,000 per pound of payload; Mr. Musk says his simple rockets could do it for \$1,000 a pound.

His first rocket, the Falcon 1, is a two-stage, liquid fuel design that is scheduled to lift off on Wednesday from a United States Army facility on Omelek Island in the Kwajalein Atoll, part of the Marshall Islands. On board will be a 43-pound satellite, the FalconSAT-2, which was designed by Air Force Academy cadets to study the ionosphere.

THE launching has been postponed twice for technical reasons, but if it succeeds, it will move SpaceX closer to filling some of the \$200 million in firm launching orders already placed by the Pentagon, foreign governments and private companies.

Less clear is whether a success will also silence the many skeptics who have seen wealthy space dreamers fail in the past.

"This is an enormously difficult business to make money in," said John E. Pike, a space policy analyst at GlobalSecurity.Org, a nonprofit group in Alexandria, Va., that analyzes national security issues. "The best way to

make a small fortune in space is to start out with a large one. New rocket science has a high mortality rate, and we don't know what he's got his hands on until he's flown it a half-dozen times."

Part dreamer and part realist, Mr. Musk says he was drawn to the project not only because he has long been fascinated by space — he has a degree in physics from the University of Pennsylvania — but also because he sees a market opportunity in America's declining share of the world's satellite-launching business.

In the commercial market, the United States' two big rocket giants, Lockheed Martin and [Boeing](#), have been priced out by lower-cost competitors from Russia, Ukraine and France. Lockheed's Atlas 5 had only one commercial order in 2005, compared with 22 in 1998. Boeing has withdrawn its Delta 4 rocket from the commercial market and relies exclusively on business from the United States government.

At stake is a market that was worth \$4 billion last year, when governments and businesses paid for 55 launchings, according to the Federal Aviation Administration. Of those, 18 were commercial, with a value of \$1 billion.

American companies compete for commercial orders only by teaming with foreign partners — often former cold-war foes. Lockheed has teamed up with Khrunichev State Research of Russia to form International Launch Services, which mainly uses Russia's Proton rockets. Boeing has joined with several nations to form a consortium called the Sea Launch; it uses the Ukrainian Zenit 3SL to put up commercial payloads.

Mr. Musk says he wants to develop an all-American option that will be price-competitive and break the duopoly of Lockheed and Boeing on contracts with the federal government. Ultimately, he wants to send people into space, to the moon and beyond.

"We have to do something dramatic to reduce the cost of getting to space," said Mr. Musk in an interview in his cubicle at SpaceX's offices here. "If we can get the cost low, we can extend life to another planet.

"I want to help make humanity a space-faring civilization," he said with disarming — or alarming — candor.

SpaceX's first effort, the Falcon 1, will not put anyone on the moon. It is designed to send small satellites — typically communications and scientific payloads weighing less than 1,000 pounds — into low orbit, which is up to 300 miles above the Earth. The two-stage Falcon 1 is designed to be mostly recyclable, with part of it falling into the ocean to be picked up and used again.

The Falcon 1 will charge \$6.9 million a launching. It is intended to go head to head with the Pegasus rocket made by the [Orbital Sciences Corporation](#) of Dulles, Va., which charges \$25 million to \$30 million for the same launching, as well as rockets from such newcomers as India and Israel.

Next up are the Falcon 5, the same rocket with five engines, and the Falcon 9, with nine engines. The Falcon 9 would bring SpaceX into direct competition with Boeing's Delta 4 and Lockheed's Atlas 5 in the so-called heavy-lift market, in which the United States government is the main customer. A Falcon 5 plans to launch 8,000-pound payloads for \$18 million, a third of the price of competitors. The Falcon 9, which will put 10 tons of payload as far as 22,000 miles into the sky, will cost \$27 million per launching. The same launching by Lockheed or Boeing would be about \$70 million to \$80 million.

Expecting that it can compete in this market, SpaceX has sued Boeing and Lockheed in federal court in California, seeking to prevent them from combining their rocket units in a joint venture called the United Launch Alliance, which would have a lock on \$32 billion in Air Force launchings through 2011.

"SpaceX has the potential of saving the U.S. government \$1 billion a year," Mr. Musk said. "We are opposed to creating an entrenched monopoly with no realistic means for anyone to compete."

A native of Pretoria, South Africa, Mr. Musk moved by himself at age 17 to Canada, where he briefly attended Queens University in Kingston, Ontario. He later transferred to the University of Pennsylvania, where he received two undergraduate degrees — one in theoretical physics and the other in business from the Wharton School. He enrolled in the graduate physics program at Stanford in 1995 but dropped out within days to become an Internet entrepreneur.

His first big hit was Zip2, a Web-based ad company that

he sold in 1999 for \$307 million. (The [New York Times](#) Company was an investor in Zip2.) He moved on to another Web venture, involving electronic payments over the Internet — even though, as skeptics noted, he lacked experience in banking. That business ultimately became PayPal, which eBay bought for \$1.5 billion in 2002.

By the time Mr. Musk was 30, he had amassed \$300 million and was pondering his future.

His first thoughts were of philanthropy — and of space. He came up with the idea of "Mars Oasis," an effort to send a small greenhouse to Mars to gather scientific information and create excitement about space travel — or so Mr. Musk thought. His idea was quickly derailed by the extraordinary cost of getting to space, but that led him to wonder why technology had not brought down the cost of space exploration or led to more of it. And that led him to found SpaceX in 2002.

Every day since then, Mr. Musk has driven to a gritty industrial zone, where he puts in long days at SpaceX. Still, he allows himself a few perks of the newly rich: a big house in Los Angeles, a \$1 million McLaren F1 sports car, and a Dassault Falcon 900 business jet, which he sometimes uses to ferry his staff to the Marshall Islands.

In some ways, SpaceX is a throwback to his dot-com days. Many of the 160 employees, including former engineers from Boeing and other aerospace companies, are on a first-name basis with him. One building houses a Ping-Pong table; another has a Segway. All employees — who call themselves "SpaceExers" — have received stock options that could make them millionaires someday. In one spot, a blue tarp covers a small piece of a rocket that Mr. Musk casually described as a "top secret" project and joked about putting a sign on it saying so. Indeed, it was a part for a launching scheduled by the Pentagon, which already has \$100 million of SpaceX business lined up. He has another \$100 million in launchings from the government of Malaysia, the Swedish Space Corporation and several American companies, including Bigelow Aerospace, which is planning to build a private space station.

The Falcon 1 flight this week is for the Air Force and the Defense Advanced Research Projects Agency, the Pentagon's research and development arm. "DARPA is excited about the launch," said Steven Walker, the

DARPA manager for the Falcon program. "A successful launch demonstration will change the way we do space launch in this country."

WHAT sets SpaceX apart from other rocket makers is that the boldness of its ambition is matched by the modesty of its design. To meet his goal of a cheap and reliable rocket, Mr. Musk is producing a basic design, with fewer opportunities for systems to fail — even if it means some technical compromises with performance. "SpaceX is optimizing for simplicity rather than performance, and that's what sets it apart from the others," said Jeffrey Foust, an analyst at the Futron Corporation, an aerospace consulting firm. "When you have a limited number of things that could fail, you can increase a rocket's reliability."

Where most other rockets have multiple stages and multiple engines, the Falcon will have just two stages, each with one engine. Most of SpaceX's stages are designed to be reusable. Although fishing small used rockets out of a vast ocean can be difficult, Mr. Musk says that it is cheaper than building a new one every time.

"Throwing away multimillion-dollar rocket stages every flight," he said, "makes no more sense than chucking away a 747 after every flight."

Instead of buying engines from established suppliers, Mr. Musk has designed his own and built them in-house. The bigger first-stage engine, called the Merlin, is a model of 1960's technology, a simple "pintle" engine that has only one fuel injector rather than the costly showerhead of injectors used in most rockets.

"The Merlin is much more analogous to a truck engine than a sports car engine, which is how all other engines are designed," he said. "Instead of designing it to the bleeding edge of performance and drawing out every last ounce of thrust, we designed Merlin to be easy to build, easy to fix and robust. It can take a beating and still keep going."

AS such remarks make clear, economy is everything at SpaceX. While Boeing and Lockheed typically have more than 200 people in their mission control launching centers, SpaceX will have 23, in part because all the Falcon's manufacturing is done in the factory and nothing is left to be assembled at the launching pad. SpaceX plans some launchings for Vandenberg Air Force Base near Lompoc,

Calif., where it will move its mission control, which is now housed in a truck in SpaceX's parking lot.

SpaceX also has a 300-acre test site in McGregor, Tex., that it bought from Mr. Beal, the Texas banker, after he abandoned his private space-launching effort. He closed his company, Beal Aerospace, in 2000, complaining that Boeing, Lockheed and NASA had a lock on launchings and that small entrepreneurs could not compete against these government-subsidized ventures.

Mr. Beal and others have said that the biggest problems for space entrepreneurs are more political than technical. For Mr. Musk, wealth provides some protection — a point that even critics like Mr. Pike of GlobalSecurity.Org concede. "He's got the advantage of deep pockets," Mr. Pike said.

For the moment, Mr. Musk is bankrolling SpaceX alone. But if he can launch Falcon 1, he anticipates getting venture capital money along with more commercial orders.

"There is concern that the United States is losing its competitive edge in commercial space launches," said Mr. Foust, the Futron analyst. "If SpaceX can provide low-cost launches that are reliable, it could turn the tide. He's certainly got the mind-set, the team and the money."

Most other "trillionaire" ventures revolve around space tourism and suborbital trips, which are less challenging and costly.

Mr. Allen, the billionaire co-founder of Microsoft, provided \$25 million to help bankroll SpaceShipOne, which was designed by the aeronautical engineer Burt Rutan and won the \$10 million Ansari X Prize in October 2004 for being the first private manned spacecraft to reach suborbital space twice. Mr. Rutan is now designing a bigger version for Virgin Galactic, the space tourism venture of Sir [Richard Branson](#), who founded Virgin Atlantic Airways.

The engines on Mr. Rutan's SpaceShipOne came from [SpaceDev](#), founded by Jim Benson, a computer engineer who had started two software companies. SpaceDev plans to put satellites on Falcon 1 and is developing the "Dream Chaser" to pursue suborbital space tourism.

Jeff Bezos, founder of [Amazon.com](#), has started Blue

Origin to develop a three-person suborbital rocket. And John Carmack, developer of the Doom and Quake computer games, has founded Armadillo Aerospace near Dallas and has already put in \$1 million to build a suborbital craft.

Space tourism presents no threat to Boeing or Lockheed, but Mr. Musk could. The two companies are quick to dismiss him. "Launching into space is an extremely challenging and complex business," said Dan Beck, a Boeing spokesman, adding: "For SpaceX to be considered a potential competitor they need to have a launch."

Tom Jurkowsky, a spokesman for Lockheed, had a similar view. "SpaceX needs to prove themselves," he said, "and thus far they have been unable to demonstrate that they are a competitor."

Still, some cheer on Mr. Musk.

"I'm particularly happy to see it happen," said Robert Sackheim, chief propulsion engineer at NASA's Marshall Space Flight Center and an early consultant to Mr. Musk. "Their engine design is less than perfect, but it is good enough. I think he is doing all the right things. This can be an incredibly important advance to the country."

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