HOW DESIGNERS, ARCHITECTS, AND ENGINEERS ARE CHANGING OUR WORLD

IMAGINE DESIGN CREATE

EDITED BY TOM WUJEC

THE X PRIZE

This carefully crafted system for encouraging design has brought innovation to space travel and automotive efficiency—with more to come.

SOME TIME IN LATE 2011, AT A NEWLY ERECTED SPACEPORT IN LAS CRUCES, NEW MEXICO, six passengers and two pilots will board a sixty-foot-long rocketplane called *SpaceShipTwo*. A much larger, four-engine carrier craft will haul the smaller vessel halfway up into the stratosphere, to fifty-two thousand feet. Here, *SpaceShipTwo* will release itself from the underbelly of its mother ship, ignite a hybrid engine that burns a potent cocktail of synthetic rubber and nitrous oxide, and accelerate to twenty-five hundred miles per hour. It will hurl itself to an altitude of seventy miles, where for six glorious minutes its passengers will experience zero gravity, floating weightless in the cabin as they skirt the boundary of outer space. And then *SpaceShipTwo* will begin a silent free fall until, at an altitude of eighty thousand feet, its tapered wings will pivot horizontally and glide its passengers and crew gently back to terra firma.

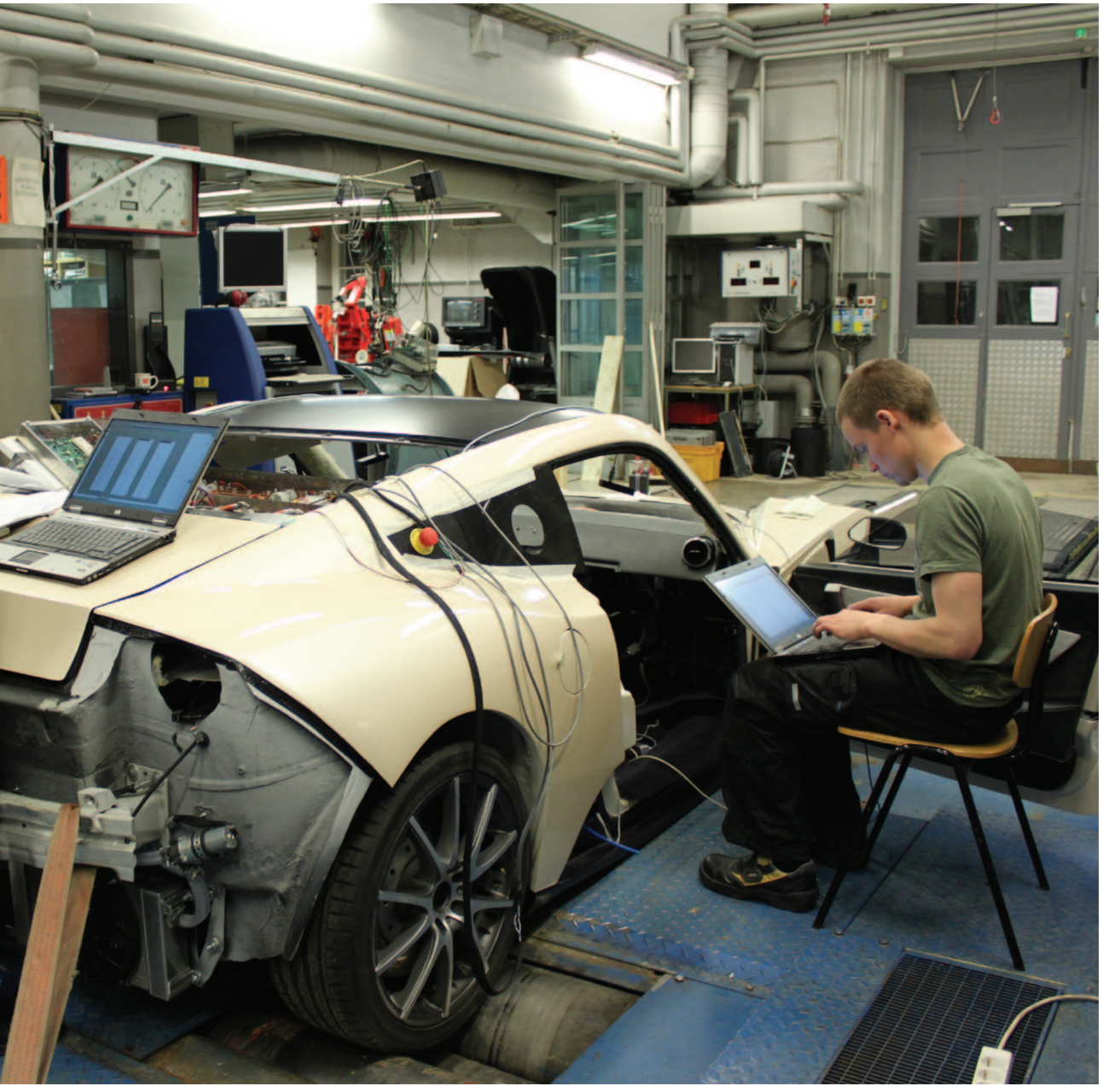
Space-industry old-timers long scoffed at the feasibility of safely ferrying well-heeled tourists to suborbital altitudes in a reusable spacecraft. Some claimed it was technologically impossible, others bemoaned its prohibitive cost, and many regarded it as just plain silly. But as Peter Diamandis loves to tell naysayers, "The day before something is truly a breakthrough, it's a crazy idea." Diamandis is the Brooklyn-born forty-nine-year-old founder and chairman of the X Prize Foundation, a nonprofit institute that establishes lucrative incentive prizes to spur groundbreaking innovation.

SpaceShipTwo and its carrier craft, *WhiteKnightTwo*, owned by billionaire entrepreneur Richard Branson, are anomalies of aviation. Their designs depart radically from the paradigm of conventional aerospace engineering. Both vessels are offspring of the first X Prize: In 1996, Diamandis offered $10 million to any privately funded group that could send a manned vehicle into space twice in two weeks.

The Ansari X Prize was the first test of the X Prize as a system for encouraging design. The prizes—there are now four, with more under development—are Diamandis's strategy to alter the course of design and engineering, and to do it with carefully crafted, highly visible competitions. The prizes are intended to thrust research and design in a direction they wouldn't ordinarily go. Diamandis succeeded unequivocally with the first X Prize. For decades, aerospace innovation had languished amid a handful of government agencies, where the pace of development was glacial. Today, many credit the Ansari X Prize with single-handedly hatching what is now a flourishing commercial space industry. "Humans have a tendency to be stuck in the way they think," Diamandis says. "We talk about change, but people really don't want change. This is where the X Prize has potential value, because the best way to cause people to change is through a very bold, big, dramatic demonstration that flips a switch in their mind."

Some twenty-six teams stepped up to compete for the Ansari X Prize. The lure of fame and $10 million—and the chance to reinvent an industry—spawned a dazzling fleet of one-of-a-kind spaceships. Not since the moon landings had there been such a flurry of fresh ideas for

Each X Prize is designed to encourage a wide variety of solutions. The Progressive Automotive X Prize led to a riot of different styles of car, each a unique response to the demands of the prize.



THE GENIUS OF THE X PRIZE IS THAT THE SYSTEM IS DESIGNED TO PRODUCE A WIDE RANGE OF ENTRANTS AND SOLUTIONS. "HUMANS ARE GENETICALLY ENGINEERED TO COMPETE," SAYS DIAMANDIS.

Finland's RaceAbout electric vehicle (left) took second place in the competition to reach 100 mpg. The X Prize is the creation of Peter Diamandis (right), who regards it as an efficient and important method for creating breakthroughs.

space travel. The X Prize attracted plenty of garage loonies, compulsive inventors, engineering prodigies, serial entrepreneurs, and lofty dreamers. And that was just fine with Diamandis. "You don't want to turn away those pesky bicycle mechanics from Dayton, Ohio," he says. It was precisely this amalgam of eccentricity, practicality, and drive that he hoped would finally pry the floundering space industry from the prosaic claws of big government.

"In large corporations, you worry because of the embarrassment and what it could do to your stock price," says Diamandis. "But true breakthroughs often come from sequestered labs at small companies, where the failures won't cause public harm." The X Prize, he believes, "allows for crazy ideas to come into existence—real breakthroughs that require high levels of risk and great risk of failure. Incentive prizes are a mechanism to get people to take that level of risk and try those crazy ideas."

At the moment, there is a $10 million X Prize offered to the first team of scientists that can sequence an entire human genome in ten days or less. Send a robot to the moon, get it to roam at least 1,640 feet (500 meters) from its landing site while it beams data to Earth, and you'll win the $30 million Lunar X Prize. Up for grabs in 2010 was a $10 million purse for building a production-capable automobile (either electric or hybrid) that got the energy equivalent of 100 miles per gallon. And there are X Prizes in development to address the need for clean energy to end our dependence on fossil fuels, eliminate poverty, cure cancer, and heal dying coral reefs.

DIAMANDIS CONTENDS THAT THE ELABORATE AND SOMETIMES DRACONIAN RULES ESTABLISHED FOR X PRIZES ARE ESSENTIAL TO MEET HIS ULTIMATE GOAL: CULTIVATING DISRUPTIVE TECHNOLOGIES.

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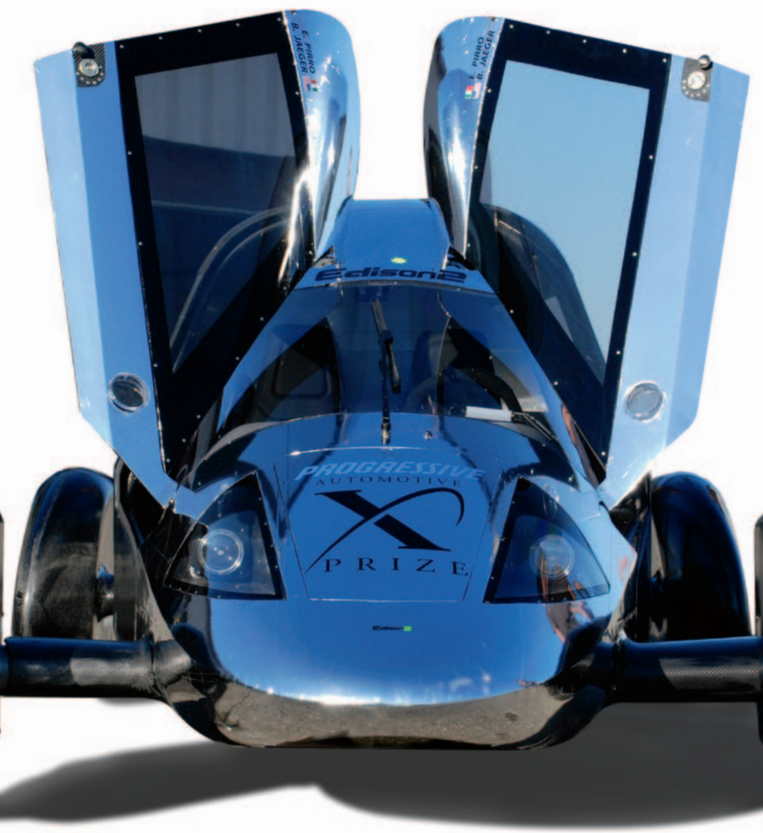
While the X Prizes seem tailor-made for a media-saturated, reality-show-friendly time, Diamandis notes that this kind of system for spurring design has a long history. In 1714, the British government established the Longitude Prize, one of the earliest incentive awards. It sought a technique to determine a ship's longitude while under sail. Today's marine chronometer is based on the invention of the English carpenter who won the £20,000 prize—the equivalent amount today is in the range of an X Prize. Trying to figure out how to feed his far-flung troops, Napoleon sponsored a prize to devise a way to preserve food. You can thank the winner for that twelve-year-old can of Chef Boyardee ravioli in your pantry.

It was the Orteig Prize that most inspired Diamandis. In 1919, New York hotelier Raymond Orteig offered $25,000 to the first pilot who could make a nonstop flight between New York and Paris. Eight years later, Charles Lindbergh completed the 33.5-hour crossing in the *Spirit of St. Louis* and as a result jumpstarted the modern aviation industry.



The Edison2 team's Very Light Car (below) won the Mainstream Class, achieving 100 mpg with a vehicle that weighed just 830 pounds. It was powered by ethanol and gasoline, and could carry four passengers. The Progressive Insurance Automotive X Prize finals (following pages) featured fourteen very different cars on the racetrack.

Diamandis earned a master's degree in aerospace engineering and for a long time dreamed of becoming an astronaut. But he didn't pursue either field. Instead, he fashioned himself into the world's leading cheerleader for private space travel. Diamandis knew that his chances of blasting into orbit on the space shuttle were slim. His ticket to the final frontier would be onboard some yet-to-be-conceived private spacecraft. Using the Orteig Prize as a model, Diamandis scrounged for cash and eventually managed to cobble together $10 million, with a hefty chunk coming from telecom entrepreneur Anouseh Ansari. He renamed the challenge the Ansari X Prize, and the competition quickly blossomed into a global race to the cosmos—or the edge of our atmosphere, to start. The genius of the X Prize is that the system is designed to produce a wide range of entrants and solutions. "Humans are genetically engineered to compete," says Diamandis. "We have it in our genes, in our ethos." The result is invariably a fertile and diverse field of players working within very particular limits and rules.

Diamandis has a clear framework for designing an X Prize. It has to offer a real incentive, typically $10 million or more. "That gives people an excuse to dream big, assemble teams, and raise capital," he says. Often competitors will pour up to forty times more cash into their efforts than they stand to gain from winning the prize. The aim is "to bring forward dozens of different designs and consequently a new industry rather than a single solution backed by venture capitalists."

An X Prize must focus on an area where there is a market failure—such as in the aerospace and automotive industries. The Prize's goal must be clear and measurable: 100 miles per gallon, or flying to an altitude of 100 kilometers twice in two weeks. The goal has to be achievable in three to eight years. Too short is too easy; too long and no one cares anymore. Finally, Diamandis says, "it must be a competition that the public gets excited about, and one that creates heroes."

On October 4, 2004, aerospace pioneer Burt Rutan, leading a team backed by Microsoft cofounder Paul Allen, won the Ansari X Prize. "On that day, two things happened that were significant," recounts Diamandis. "One was that Richard Branson committed a quarter of a billion dollars to develop *SpaceShipOne* into *SpaceShipTwo* and launch Virgin Galactic. That was critical, because rather than just having the prize result in a museum piece hanging in the Smithsonian, it launched an industry, which was our objective goal. The other thing that

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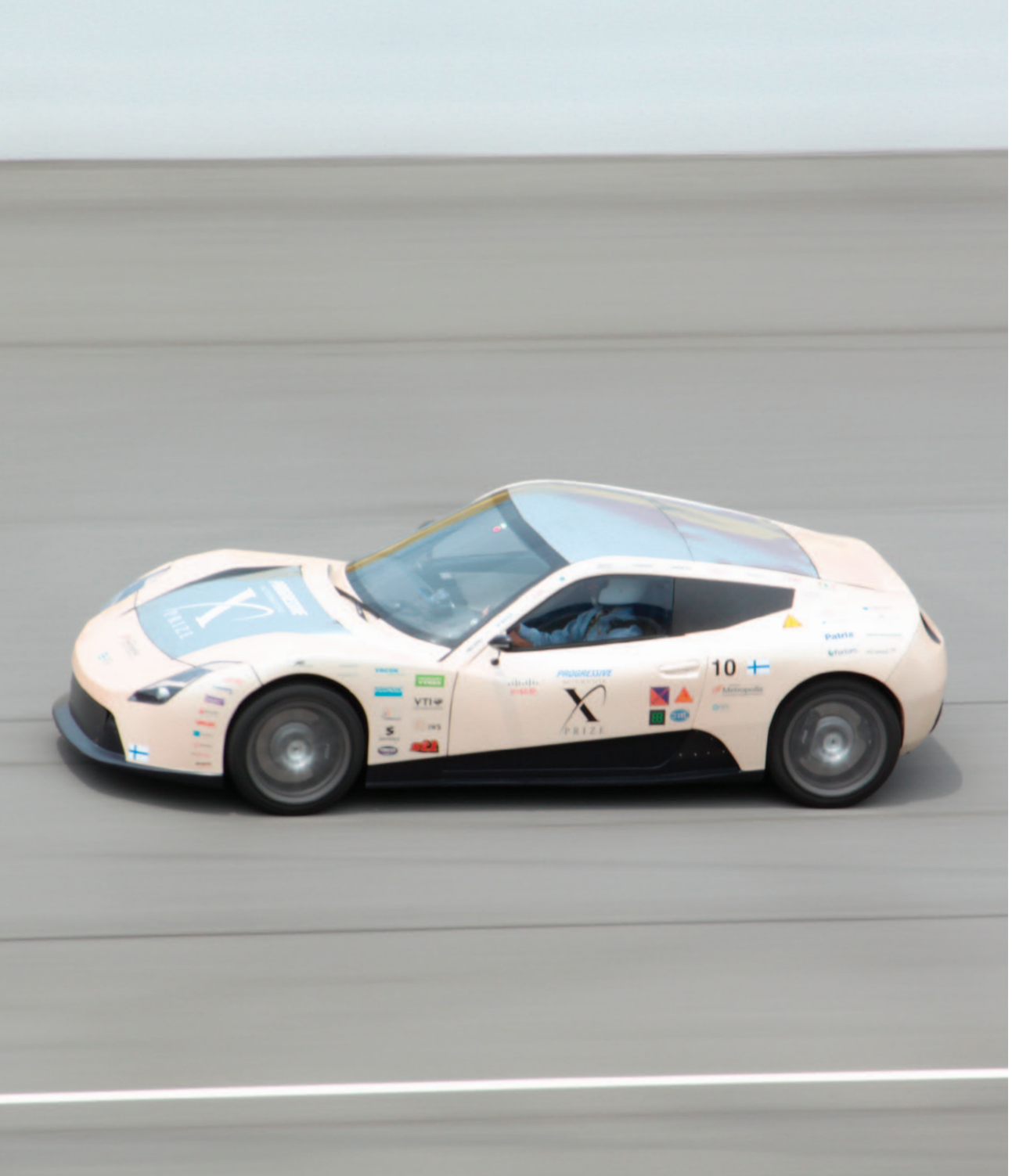

One of Diamandis's requirements for an X Prize is that it attract a lot of attention. The combination of cars, racetracks, high technology, and prize money helped keep the Progressive Insurance Automotive X Prize in the headlines for many months.

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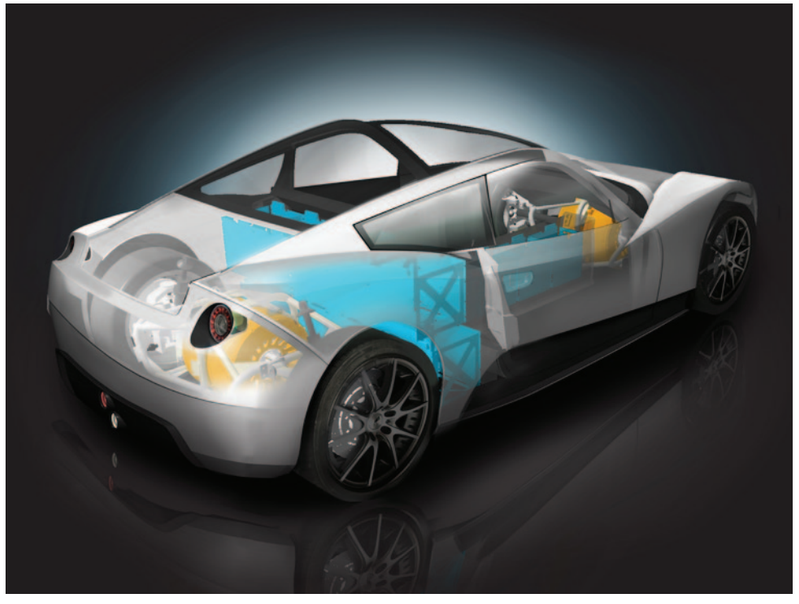
happened is Northrop Grumman purchased Scaled Composites, the company that had built *SpaceShipOne*."

Next up was the Progressive Insurance Automotive X Prize, announced in April 2007. The auto-prize rulebook numbered a whopping 137 pages. "The people who wrote it did a good job of ensuring something new would appear," says Ron Mathis, chief of design for the Edison2 team, one of the seven finalists. "The requirements were really at the very edge of what was possible."

The performance parameters led competitors to scrap everything they knew about cars. "You had to start from scratch," continues Mathis. "There was no way to stretch a normal production car to achieve that sort of efficiency. I deliberately decided not to be very organized about our design process, because if it were too formalized we'd lose originality and spontaneity." Gary Starr, whose ZAP team designed a three-wheeled vehicle, says, "The rules helped create something that was low-cost and affordable, that people would actually want to buy and feel safe in." They also forced teams to think on the fly. "We had to do things quick, rather than spending time testing and analyzing," says Sami Routsalainen, who led a team from Finland. "There were literally innovation and design changes happening on the track."

Diamandis contends that the elaborate and sometimes draconian rules established for X Prizes are essential to meet his ultimate goal: cultivating disruptive technologies that challenge conventional wisdom and smash entrenched archetypes. "For me, good design is being clear about the boundary conditions, clear about where you are heading, even when you're not sure about the realm of possibility. But because we're interested in the realm of breakthroughs, we're very careful to not overconstrain the problem." He cites the Ansari X Prize as a benchmark. "None of the detail was specified, to keep the options for experimenting wide open. As a result, we had literally



Another stated aim of the X Prize is that the technology developed for competition be adapted for the market. The Finnish RaceAbout team shared that goal, developing a powertrain made primarily from Finnish technology.

twenty-six different designs tackling the problem. It was extraordinarily fulfilling to see this sort of Darwinian evolution taking place. We wanted to set up a structure that would allow for really exciting, surprising, and unexpected solutions with unexpected benefits."

Diamandis has said of the X Prize approach: "One of the precepts that I'm learning is, fail often and fail early, until you make it happen right." Of the twenty-four teams that initially enlisted for the Automotive X Prize, all but seven had been eliminated by the final stage of the competition. The high knockout rate is typical—a challenge's stringent rules ensure what Diamandis calls the "proper balance of audacity and achievability."

In 2009, Diamandis set forth his convictions in a self-published paper. "The prize rules should define a problem to be solved, not a specific solution to be implemented," he wrote. "An incentive prize can support a wide variety of approaches/solutions to come into existence to address a challenge, thereby creating an entire industry." Market research and consulting firm McKinsey & Company recently sought to quantify whether incentive awards like the X Prize make a meaningful impact on advancing innovation. They cite a study from Harvard and the Norwegian School of Economics and Business Administration that examined prizes offered between 1839 and 1939. Winners, it turned out, had a far better chance of getting their inventions patented, and even the losers applied in record numbers to protect their creations.

The Orteig Prize had similar repercussions: Within eighteen months of Lindbergh's flight, the number of airline passengers soared from 6,000 to 180,000. The population of pilots tripled, and there were four times as many airplanes buzzing the

The Edison2 team took an unconventional approach, entering four different cars, each with varying bodywork and characteristics but using the same drivetrain.

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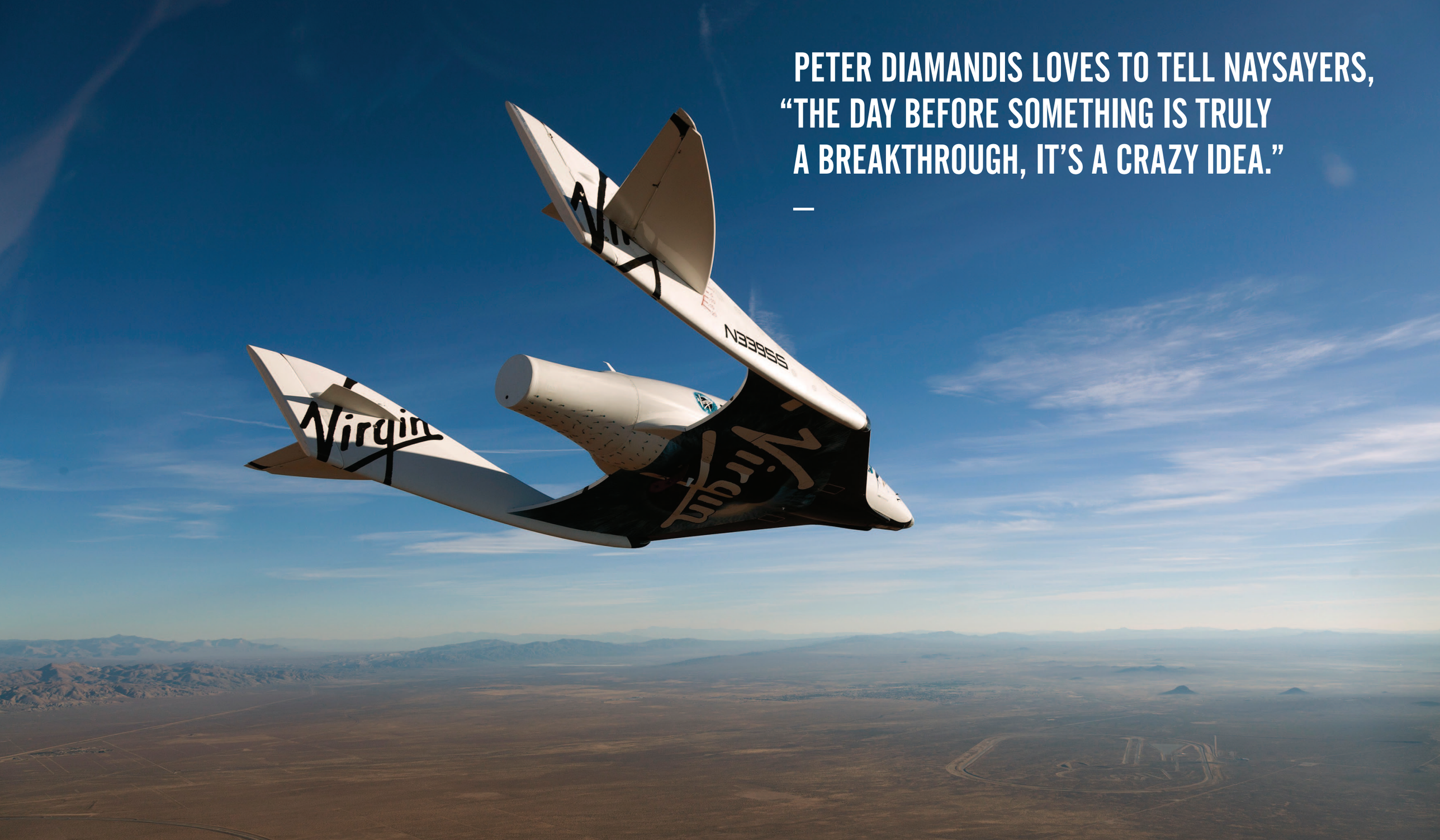

PETER DIAMANDIS LOVES TO TELL NAYSAYERS, “THE DAY BEFORE SOMETHING IS TRULY A BREAKTHROUGH, IT’S A CRAZY IDEA.”

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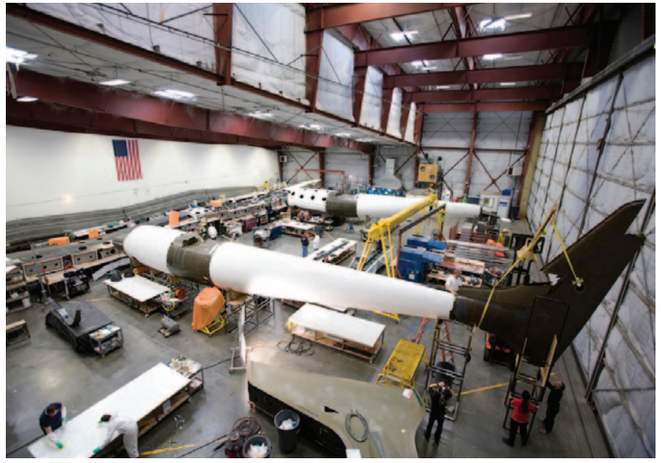
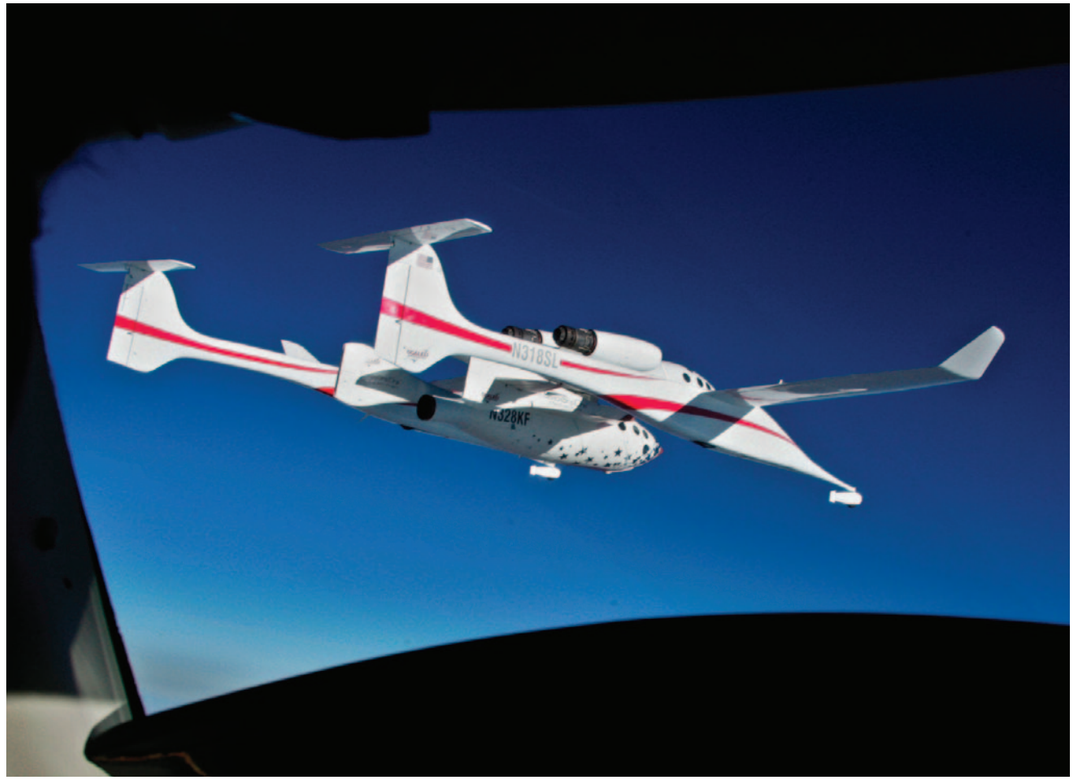
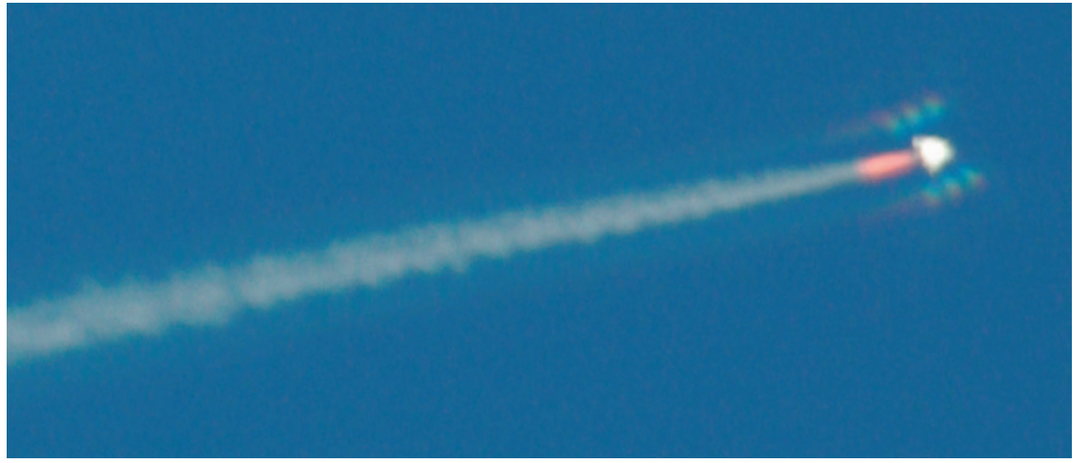
skyways of the United States as there had been before. Soon after *SpaceShipOne* made its historic suborbital flights, and Branson spun off the technology into Virgin Galactic, private spaceflight companies with names like Armadillo, Blue Origin, Rocketplane, and SpaceX, among dozens of others, gathered momentum, kindling further investment and attracting new talent. Diamandis explains, "We insist that the competition's design has a back-end business model, meaning that when the prize is won, the teams are able to take their technology to market." Of the Auto X Prize, Mathis says, "if the intent was to introduce new solutions and fresh thinking to the world of car design, the organizers succeeded hands down. They recognized the possibility for small groups of people to do uncommon things—and created an arena to make that happen. They should be commended for it, and we should thank them."

For his part, Diamandis is confident that the X Prize will continue to evolve in sync with advancing technology—artificial intelligence, robotics, nanotech, biotech—enabling the awards to take on increasingly ambitious feats. He points out that "creating the future is all very hard, and you will likely have multiple failures along the way." Even so, Diamandis is "excited about the future of design. It's all about the ultimate personalization, where the design tools fade from perception and empower us to turn our whimsy into reality. All of us will have what might be considered godlike powers to create, to manifest our dreams in a way that is magical." A





The Ansari X Prize, the first such competition, awarded $10 million for a vehicle (right) that could enter low-space orbit three times. The winning entrant has become Virgin Galactic's *SpaceShipTwo* (preceding pages).



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