

UP

**RICHARD BRANSON'S SPACE LINE IS
FLIGHT-TESTING FOR A 2014 VIRGIN
GALACTIC LAUNCH. AFTER THAT: MARS**

**BY ADAM HIGGINBOTHAM
PHOTOGRAPHY: CHRIS CRISMAN**



S

OMETIMES it almost seems to disappear into the desert. Conceived as a conjuring trick of architecture and topography, the Virgin Galactic Gateway to Space rises in a sinuous curve from the harsh New Mexico dust, its steel surfaces weathered into a red-brown mirage on the horizon; at twilight, the silhouette of the world's first purpose-built commercial spaceport melts slowly into the ridgeline of the San Andres mountains, 30 kilometres away.

The route that the package-tour astronauts of tomorrow will take through the building has been meticulously devised by the architects of Foster + Partners to foreshadow the journey they will make into space: a concrete ramp ascends gently towards the centre of the building - a narrow, hooded cleft that even in the blinding southwestern sunshine forms a small rectangle of perfect darkness. A magnetic tag worn by each passenger triggers heavy steel doors that will open into a narrow and dimly lit passageway, the walls curving out towards another blackened doorway, and a catwalk with views of the 4,300-square-metre hangar four storeys below, housing the fleet of spacecraft in which they will travel.

And then, the finale: the last set of doors swings open into the astronaut lounge, a vast, open space filled with natural light from an elliptical wall of windows, offering a panorama of the three-kilometre-long spaceport runway, and the sky beyond. The effect is just as the architects intended: although the building is not yet complete, when a group of prospective space tourists was brought to it, they found the experience so overwhelming they were moved to tears.

Yet there remains a great deal at stake out here in the desert. There are now nine locations in the United States designated

as spaceports, but the New Mexico complex - Spaceport America - is the only one built from scratch and designed to accommodate a regular passenger service. It was raised from nothing on an isolated plain 50km from the nearest town. Creating it has not been cheap: to date it has cost almost a quarter

of a billion dollars (£155 million); engineers have paved 16 kilometres of road simply to connect the site to the outside world; the bill for the runway alone will eventually be \$37m. And, although the building at its centre bears Virgin Galactic's name and was designed to the company's requirements, it

has been paid for by the state of New Mexico, whose citizens voted for a sales tax designed to finance its construction.

On a cold November morning, Christine Anderson, the former US Air Force official now charged with bringing Spaceport America to life, stands on a wind-whipped



SPACEPORT AMERICA
(ABOVE) THE FUTURISTIC BUILDING THAT WILL HOUSE VIRGIN GALACTIC, IN NEW MEXICO

MOON FLIGHTS
(LEFT) IN 1968, THE FOUNDER OF PAN AM, JUAN TRIPPE, BEGAN SELLING THE PROMISE OF FLIGHTS TO THE MOON. TICKETS WOULD BE \$14,000 AND 98,000 SIGNED UP, EXPECTING TO TRAVEL BY 2000

access road near the Gateway to Space. "This is the beginning of the commercial passenger space-line industry," she says. Anderson's crews are on target to complete their work by the end of 2013; Virgin Galactic plans a regular service - launching daily flights into space - for the start of 2014. Anderson is optimistic about the future: daily suborbital passenger flights will be followed by point-to-point intercontinental travel that will traverse the globe in the time it takes to watch an in-flight movie; trips out of the Earth's atmosphere will become as commonplace as taking a bus. "I hope," Richard Branson says later, "it's the beginning of a whole new era in space travel."

But before any of that can happen, Virgin Galactic will have to build a rocket that flies.



fact that space tourism had become possible - yet only for those who were absurdly wealthy - brought him to a more profound realisation. "What I regretted more was that neither Russia nor America was really that interested in enabling the millions of people who would love to go to space to have the opportunity to do so." Afterwards, he began canvassing people about the idea. "I said, 'If you had the chance to go to space, and were pretty sure it would be a return ticket - and you could afford it - how many of you would go?' And 95 per cent of people would stick their hands up."

In 1995, following a conversation with Buzz Aldrin, Branson began seriously exploring the potential for democratising space travel. But when his head of special

projects, Will Whitehorn, attempted to register the Virgin identity for use by a space-line at Companies House in London, he discovered someone had beaten him to it. Branson had quietly trademarked the brand for use in space more than a decade earlier.

Wearing black pilot's overalls bearing a winged design and a patch embroidered with his name, Sir Richard Branson emerges from a hangar on the outskirts of Mojave Air and Spaceport in California. Above him, the building has been recently painted with the Virgin Galactic eye logo. As he crosses the concrete apron of the hangar, he carries under his arm a cardboard cutout of the six-seat Virgin spacecraft, known as *SpaceShipTwo*. Today is a lightning-quick corporate meet-and-greet

at Mojave, a cluster of dun-coloured corrugated steel buildings scattered along a concrete airstrip in the desert a few kilometres from Edwards Air Force Base.

He is here to mark Virgin's final acquisition of its dedicated spacecraft-manufacturing arm, The Spaceship Company (corporate motto: "We Build Spaceships"). The newly painted building behind him is the Final Assembly Integration and Test Hangar - or, in the best acronym-friendly traditions of spaceflight, "Faith" - where the company's fleet of new vehicles will be put together. Gathered around Branson on the Tarmac to have their picture taken are 200 staff from Virgin Galactic,

The Spaceship Company and a scattering of engineers from experimental-aircraft manufacturers Scaled Composites. They're the ones who have spent much of the last ten years building the prototype of the world's first spaceliner, in another giant shed on the other side of Mojave airport known as Building 75.

Branson and Scaled Composites' notably eccentric founder, Burt Rutan, go back a long way. Rutan made his reputation

GEORGE WHITESIDES
VIRGIN GALACTIC'S CEO (BELOW) IS ALSO A FORMER CHIEF OF STAFF AT NASA. BEFORE JOINING THE COMPANY, WHITESIDES HAD BEEN ONE OF THE EARLY TICKET BUYERS FOR A TRIP INTO SPACE

PHOTOGRAPHY (ROTARY ROCKET): CORBIS

PASSENGER space travel has been a staple of sci-fi for almost as long as there have been commercial airlines - the prefiguring of a frictionless future never more perfectly visualised than in the opening scenes of Stanley Kubrick's *2001: A Space Odyssey*, where a white-turbaned Pan Am stewardess dispenses snacks in zero G, en route to an orbiting Hilton hotel. And by the time Kubrick's film was released in 1968, the real Pan American - corporate pioneers who had flown the first transatlantic and trans-Pacific commercial services - had already opened a waiting list for trips to the Moon. They estimated the service would begin no later than 2000, and began issuing numbered membership cards for their First Moon Flights club. It was part corporate optimism, born of a confidence in the technology of the high frontier, and part publicity stunt. Galvanised by the Moon landing the following year, 98,000 people worldwide eventually signed up; one tried to guarantee his seat by sending a deposit cheque for \$1 million (£620,000).

But the euphoria of Apollo 11 didn't last long. Nasa slashed its lunar-exploration programme, and in 1971 a similarly cash-strapped Pan Am closed the waiting list; when the airline finally went bankrupt in 1991, the First Moon Flights club became a mocking footnote to the company's obituary, a bellwether of fatal corporate hubris.

Now 62, his blond mane steadily becoming a jaundiced white, Richard Branson still remembers sitting in his parents' living room, watching Armstrong and Aldrin walk on the Moon. He had turned 19 just a few days earlier, and was one of the generation of starry-eyed Aquarians who felt cheated by the future when their dreams of space travel for all

ROTARY ROCKET
DESIGNED TO FLY VERTICALLY INTO SPACE AND BACK, USING ROTOR-TIP PEROXIDE JETS, THE ROTON ATMOSPHERIC TEST VEHICLE WAS BUILT IN THE MOJAVE DESERT IN 1999. THEN THE MOST PROMISING CONCEPT, IT WAS A REUSABLE 18-METRE CRAFT. BRANSON CONSIDERED IT FOR COMMERCIAL SPACE TRAVEL BUT THE COMPANY WENT BUST SHORTLY AFTERWARDS

fizzled away. "I definitely thought that one day soon we'd all be doing it," he says. And yet, he says, he could still have made a pleasure trip into orbit in the late 80s, before anyone else on Earth.

By then, Branson was already one of the world's richest men, proprietor of his own airline, and exploring a popular sideline in daredevil brand-building - transatlantic powerboat rides, record-breaking balloon trips - when he took a call from the USSR's ambassador in London. Mikhail Gorbachev, the ambassador explained, had a proposition for him: how would he like to become the first tourist in space? It would require 18 months' training at Star City outside Moscow, and came with a significant catch: "It would cost \$50m or something," Branson says. The price was a problem. "I just felt that to spend that sort of money going to space, people just might feel it was a bit of a waste. We did quite a lot of charitable work in Africa and so on, and I just felt that the amount of money - although I might have been able to afford it - was just a little bit... gross."

So Branson declined; later, he regretted it. "I think maybe I should have said yes," he says. "I could probably have justified it from a marketing point of view." And the



by selling plans for unconventional-looking aeroplanes with gimmicky names – the VariEZ, the Long-EZ – that DIY-minded pilots could build from foam and fibreglass in their garages. But in 1986 he became better known as the designer of the Rutan Model 76 Voyager, the first aircraft to fly non-stop around the world on a single tank of fuel. When Branson began building equipment for his series of trans-oceanic balloon flights, beginning with an Atlantic crossing by hot-air balloon in 1987, he came out to Mojave for advice. “Burt is a genius when it comes to things such as pressurised capsules,” he says.

While his record-breaking balloon exploits continued, Branson’s search for a viable vehicle to take the Virgin name into space grew more earnest, and he and Will Whitehorn began travelling the world to look at potential spacecraft. The launch of the X Prize in 1996 (WIRED 10.09) – which offered ten million dollars (£6.2m) to the first team to put a reusable vehicle capable of carrying passengers, twice, over the threshold of space – sparked an explosion in the number of private companies hawking technologies they claimed could be the future of space tourism. Branson and Whitehorn would eventually look at 50 concepts. “Most of them were father-and-son businesses. So few were trying it in a serious way,” Branson says. “But you never quite knew.”

In 1999, he returned to the Mojave desert to see Rotary Rocket’s Roton concept, the most promising scheme yet. Funded by investors including the novelist Tom Clancy, who had hoped that the project would “put Nasa out of business”, the Roton was a reusable 18-metre rocket with helicopter blades, designed to fly vertically into space and back, using rotor-tip peroxide jets. Built under contract by Scaled Composites, the prototype Roton was exceptionally light, but almost impossible to control and, even at a maximum height of 20 metres, flew as if dangled from a thread by an impatient giant. Branson thought about it, but not for very long: “It looked quite perilous,” he says.

And in the meantime, Burt Rutan had secretly begun developing plans for his own spaceship.



THE FINAL VIEW
THE LAST EARTHBOUND SIGHT FOR PASSENGERS WILL BE THE THREE-KILOMETRE SPACEPORT RUNWAY THAT EXTENDS FROM THE ASTRONAUT LOUNGE OUT INTO THE NEW MEXICO DESERT

FLYING human beings safely into space is not easy, and getting them back is harder still. The goal of the X Prize was to reach suborbital space – which begins at the Karman Line, around 100km above sea level. This is far less costly, in both energy and money, than reaching Earth orbit.

Rutan’s inspiration was more elegant, and reached back to technology born before Nasa existed, with the X series rocket planes in which US Air Force test pilots first broke the sound barrier, and later tested the boundaries of space. These reached their zenith with the X-15. Lifted to a height

of 13.6 km, shackled beneath the belly of a B-52 bomber, the dart-shaped aircraft saved 50 per cent of the fuel it would otherwise have needed, before being released to begin a rocket-powered flight to the edge of space. It then glided back to Earth. But the X-15 also required a computer guidance system. Rutan wanted his rocket ship to be flown entirely by stick and rudder. His solution was the “feather” system, by which his vehicle’s wings could fold up hydraulically in flight, so at re-entry it would fall – slowly and with great stability – like a giant and very expensive shuttlecock.

With more than \$20m of funding from Microsoft cofounder Paul Allen, Rutan embarked on a programme to build and test *SpaceShipOne*, and the mothership designed to carry it to launch altitude, *WhiteKnightOne*. Rutan used a hybrid design, in which a tank of nitrous oxide was

used to burn through a hollow cylinder of solid rubber, hurling *SpaceShipOne* into space in under two minutes.

In November 2003, Alex Tai, a Virgin Atlantic captain flying the London-Los Angeles route, was in Mojave. Tai had heard from adventurer Steve Fossett that Rutan had something exciting in Building 75 (at the time Fossett, Rutan and Branson were collaborating on the Virgin Atlantic GlobalFlyer, which Fossett would fly non-stop around the world in 2005). When Rutan revealed the nearly complete *SpaceShipOne*, Tai called Will Whitehorn, who reached Branson. “Fuck GlobalFlyer,” Whitehorn told his boss, “they’re building a spaceship.”

A few months later, Branson flew in to have dinner with Paul Allen and Rutan, at the engineer’s pyramidal house outside Mojave. “I was frothing with excitement,” Branson says. “This was a dream come true

– and I knew that if anybody could pull it off, it would be Burt. I was determined that when it went into space it had the Virgin brand on it, and if it was successful, then we would take it on to the next stage.”

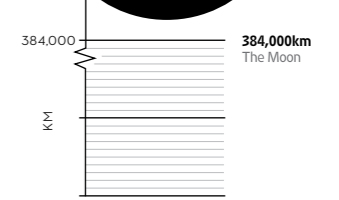
Rutan and Allen, who had no interest in running a passenger spaceline and planned simply to put the spacecraft in the Smithsonian Air and Space Museum once it had achieved its objective, agreed to license the technology to Virgin. According to Branson, there was no competition: “Bizarrely,” he says, “I think we were the only people who put our hands up.”

On June 21, 2004, 64-year-old test pilot Mike Melvill flew *SpaceShipOne* over the Karman Line for the first time. Seven months later, when Rutan’s rocketplane made the two flights within a fortnight necessary to win the X Prize, the Virgin Galactic logo was on its twin tails.

TWO days before the first X Prize-qualifying flight, at a press conference, Branson announced his intention to launch a passenger service into space, just as soon as he had a vehicle in which to do it. Tickets would be going on sale shortly, with the full fare payable immediately as a deposit. Although fully refundable, this required each potential passenger to put down \$200,000 in advance. Branson said flights could begin as soon as 2007.

The new company’s first full-time employee was Stephen Attenborough, a former City investment manager who organised a team of five to put the foundations of the company in place. Working from spare desks they had found at the Virgin Group’s corporate headquarters in Notting Hill, the team set up a rudimentary website – a logo, some footage of the X Prize-winning *SpaceShipOne* flight, and an application form – to take reservation enquiries. When it went live, Attenborough sat back to see what would happen.

“Although we expected to get a lot of hits,” he says, “we were far less sure about whether we would find people to do what we asked. We were saying, ‘Look: we don’t know how long this project’s going to last, we don’t know when the product’s going to be delivered; we don’t know what it’s going to look like; we don’t really know much about what it’s going to be like for you on board; we don’t whether you’re



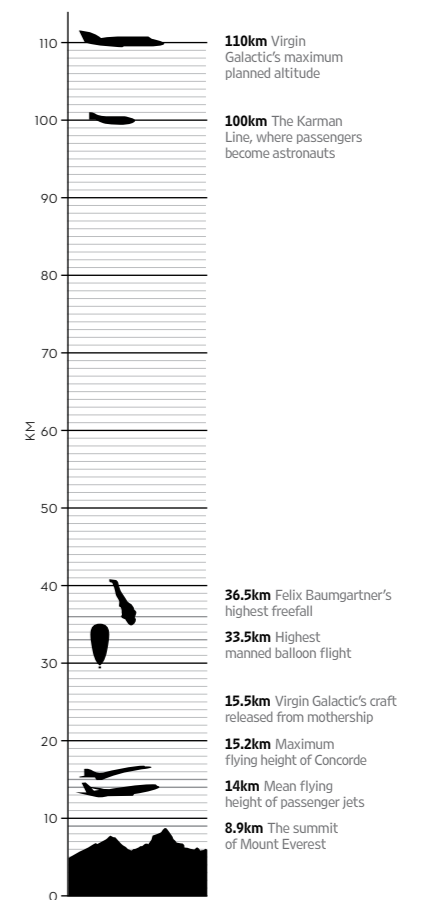
going to be eligible to fly, because we don’t understand too much about the fitness requirements... but if you want to join, we need \$200,000 up front.”

The site crashed under the weight of responses. “There was a deluge,” says Attenborough. He began receiving cheques from all over the world, and people came to Notting Hill in person to deliver deposits.

Early applicants were – necessarily – very wealthy, and most were keen to make sure they were at the head of the queue to go into space. Seats on the first Virgin Galactic trips were reserved for the earliest buyers, their number capped at 100, known as the Founders. This private club of high-rolling adventurers would have privileged access to the programme as it developed and, when the time came, their names would enter into a draw to decide who would fly first.

HEIGHT OF AMBITION

VIRGIN GALACTIC WILL TRAVEL 110KM UP – 10KM INTO SPACE. THE MOON IS ANOTHER 384,000KM AWAY, WHICH IS, TO SCALE, APPROXIMATELY 350 TIMES THE HEIGHT OF THIS CHART





N348MS



VIRGIN GALACTIC

N348MS

VIRGIN GALACTIC





SCALED
ELEMENTS



BACK in Mojave, the Scaled Composites team began work on turning an experimental three-seat rocket ship, which had only ever carried a single experienced test pilot and 180kg of undemanding ballast, into a vehicle that could meet the requirements of the Virgin customer experience. No one had ever done anything remotely like this before, and Matt Stinemetze, the engineer who became the project manager overseeing the new programme, recalls that initial discussions were very general indeed. "Just a lot of rough order-of-magnitude guesswork," he says. Why not build a big rocket? A small one? One that would carry 11 passengers? Fifteen? Twenty? They also considered building several more *SpaceShipOnes*, to send passengers into space two at a time. But the prototype was a crude research aircraft, built to prove simply that it was possible to get into space cheaply, and it suffered from several potential "single point failures". "If one bolt falls off and you die," Stinemetze explains, "that's a single point of failure. There were things that you probably would've done differently if you're going to carry Angelina [Jolie]."

Stinemetze - who has a shaved head, and when we first meet is wearing a single earring and a "I went so fast my hair blew off" T-shirt - joined Scaled immediately after graduating in aeronautical engineering in 1998. A licensed pilot, whenever he refers to the needs of Virgin Galactic's paying passengers in describing the design process, he has a habit of using the names of the vehicle's most well-known celebrity ticket-holders as a sardonic shorthand. "You don't want to take Angelina and tumble her around leaving the atmosphere," he'll say. "Is Angelina really going to shimmy down a rope ladder when some emergency happens?"

The team soon realised that the commercial needs of Virgin Galactic and the expectations of its ticket holders necessitated the design of an entirely new vehicle. It would have to carry enough passengers to bring the individual seat price down relatively quickly, but not so many that they would be competing with one another for the best view. From London, Stephen Attenborough canvassed his early customers on what they would like. "They wanted to get out of their seats in zero gravity, and they put very high priority on seeing Earth from space," he says. Neither of these things was easy in the cramped cabin of *SpaceShipOne*.

So the new vehicle would be designed to take two pilots and six passengers. And it would have large windows; a lot of them. Rutan dispatched Stinemetze and the design team to Los Angeles to take a dozen parabolic zero-G flights in a specially converted Boeing 727, so that they could



P. X X X
WHITEKNIGHTTWO, THE MOTHERSHIP LAUNCH CRAFT, IN SCALED COMPOSITES' BUILDING 75 IN THE MOJAVE DESERT



P. X X X
THE TWIN-ENGINE TURBOPROP JET IS DESIGNED TO CARRY SPACESHIP TWO - HUNG IN THE CRADLE VISIBLE BETWEEN ITS WINGS - TO LAUNCH ALTITUDE



P. X X X
SPACESHIP TWO AFTER THE INSTALLATION OF THE NEW ALUMINIUM-LINED OXIDISER TANK, THE CENTRE OF THE NEWLY CONFIGURED PROPULSION SYSTEM



P. X X X
THE NEW SYSTEM BECAME NECESSARY AFTER THE FATAL ACCIDENT THAT KILLED THREE SCALED COMPOSITES TECHNICIANS IN 2007

better understand how to design a cabin for use in space. The rest of the technology - the rocket motor, the feather - could be scaled up from the prototype. In the summer of 2005, Attenborough began banking \$10m worth of deposit cheques.

In September the following year, at the US WIRED NextFest in New York City, Branson unveiled a full-size mock-up of *SpaceShipTwo*: a glossy white tube with a delta wing, reclining seats sculpted into soft curves and a total of 12 portholes for passengers. The ceremony was attended by Buzz Aldrin and Alan Watts, a Virgin Atlantic passenger from Watford who had saved enough

frequent-flyer miles to buy a ticket for space. Branson announced passenger flights would launch from New Mexico in 2009.

When complete, *SpaceShipTwo* will be almost three times the size of its experimental predecessor - with a cabin 2.28 metres in diameter and 3.6 metres long, half the size of that in a small business jet. But riding in it will be little different from the ride that Mike Melvill took when he became the first private pilot in space. After a take-off tethered beneath the mothership - *WhiteKnightTwo*, a twin-fuselage turbojet with a 42-metre wingspan - the ascent to launch altitude will be the longest

single part of the journey, taking more than an hour to reach 15km. During this time, with nothing to do but wait for the moment of release, the pilots of *SpaceShipTwo* will talk to the passengers over wireless headsets, and reassure the anxious. "There's no drinks service, no newspapers," says Dave Mackay, the former RAF test pilot and Virgin Atlantic captain who will be in the cockpit for Galactic's first flights.

Once released from the mothership, the spaceship drops away to a safe distance, where the pilot ignites the rocket motor, using two cockpit switches. The first arms the system; the second opens a ball valve,



SUBJECT TO DELAYS
RICHARD BRANSON HAD HOPED TO OFFER GALACTIC TRAVEL TO COMMERCIAL PASSENGERS BY 2007 BUT NOW PROMISES FLIGHTS IN SPACESHIP TWO BY EARLY 2014

releasing a fine mist of liquid nitrogen dioxide into the throat of the engine, and fires a failsafe ring of three electrical igniters. With an unthrottled shriek, the rocketplane shudders to full thrust within a tenth of a second, its nose pointed straight up to where the air thins towards the edge of space. The acceleration is hard to imagine: at the instant of ignition, the passengers are thrown back into their seats with the full force of 3Gs; Melvill says it feels like being hurled against a brick wall. It's 12 seconds to the sound barrier, 30 to Mach 2; within a minute, the spacecraft is travelling at 4,800kph. "You'll feel all the effects of what an astronaut goes through going to orbit," says Steve Isakowitz, Galactic's chief technical officer, an aerospace engineer and former administrator at Nasa. "The noise, the vibration, the acceleration, are almost the same as if you were sitting there in the Space Shuttle trying to go up to orbit."

In those few seconds, the sky beyond the cockpit window tumbles through the spectrum of blues from the rich azure of southern California to navy, indigo and then - abruptly - it turns black. "Not grey, black," Melvill says. "As black as black paint."

At around 80 seconds, the pilot cuts the engine, and the rocketplane immediately enters zero gravity. The passengers have now become astronauts. Releasing their seatbelts, they float around the cabin, and gaze at the view: 1,600km from horizon to horizon, the curvature of the Earth subtle but clear, the fine blue line of the atmosphere

easily visible against the blackness of space. On-board cameras will capture every second of the experience, according to Virgin Galactic's Mark Butler, who is leading the company's preparations to open Spaceport America in the New Mexico desert: "It will be the most photographed event of their lives," he says.

It will also be one of the shortest. At the top of a parabolic arc, the rocket-plane will spend only four minutes in space before it then begins to fall back down to Earth. The pilot positions the "feather" for re-entry, and the six passengers will fold their seats flat to enable them to cope with the 4-5Gs of acceleration that they'll encounter when returning to Earth's atmosphere. After a 15-minute glide, they will be back on the desert runway from which they had taken off.

The trip sounds fabulous. Exciting, but familiar enough in outline - the anticipation, the plunge, the rush of adrenalin, the aftermath - to seem routine, like an extravagantly costly rollercoaster ride, perhaps, or a very long bungee jump. And Virgin Galactic justifiably boasts of its experience in passenger transport, its excellent safety record over almost 30 years of flying people around the world. But rocketplanes are not airliners, and going into space is not like flying across the Atlantic.

Although it's regarded as a tested prototype for passenger travel, *SpaceShipOne* made a total of only six powered flights before being hung in the Smithsonian; on two of those occasions Mike Melvill experienced failures he thought would kill him. The engineers of Scaled Composites have designed *SpaceShipTwo* to be as simple as possible, and are pursuing an incremental testing programme to gradually expand its capabilities. "It has all the refinements and lessons learned from *SpaceShipOne*," says Matt Stinemetze. "It's a much, much better aeroplane in every respect." The idea, he says, is to make it into an aeroplane that flies like a rocket, not the other way around. But it remains an experimental technology. Something could still go wrong.

MIKE MELVILL was sitting in his office in Building 75 when he heard the bang from out beyond the aeroplane graveyard. At first, he thought little of it: Mojave lies in a supersonic flight corridor, and he was used to sonic booms echoing in the sky overhead. But when he went outside on to the flight line, just after lunchtime one

afternoon in July 2007, he saw the cloud of dust off to the east, and knew something bad had happened. A few minutes later, Chuck Coleman, a structural engineer who had gone out to the Scaled rocket-test site earlier that afternoon, staggered into Melvill's office. Long shards of carbon fibre protruded from his body, like arrows. "You need to get some help out there," he said. He was in shock. "He didn't even know he had those things in him," Melvill says.

Although it took place on the rocket-trial range, out among the bunkers at the end of the runway originally used for ammunition storage when Mojave was a Marine base, the test that day didn't involve rocketry or explosives. The propulsion engineers from Scaled were

VIRGIN'S FIRST
DAVE MACKAY (RIGHT), A FORMER RAF TEST PILOT AND VIRGIN ATLANTIC CAPTAIN WHO WILL ALMOST CERTAINLY BE IN THE COCKPIT FOR VIRGIN GALACTIC'S INAUGURAL FLIGHTS

experimenting with a new valve on the oxidiser tank for *SpaceShipTwo*, a two-metre sphere of carbon fibre designed to hold 5,500kg of liquid nitrous oxide under 800 atmospheres of pressure. The test was simply to open the valve, and let the NO₂ escape: a "cold flow" test that Scaled engineers had done before.

Seventeen men were present; before the test began, six retired to a control post more than 100 metres away, protected by banked earth and a shipping container, from where they could watch the test on closed-circuit TV. The rest of the team remained behind and watched the tank from behind a chainlink fence, less than ten metres away, as the valve was opened. Seconds later, a sudden reaction caused the bottom of the tank to rupture with such explosive force that the decompressing gas blew 15 centimetres of concrete off the pad beneath the test stand, scattering fragments of rock and carbon fibre in a lethal arc. Two men were killed instantly; a third died in hospital of his injuries; three others were hospitalised for weeks. After several years away, propulsion engineer Charles May had only just returned to work at Scaled that week. His friend Luke Colby had watched from the control post as May died. "It was the worst day of my life," says Colby, a Scaled propulsion engineer.

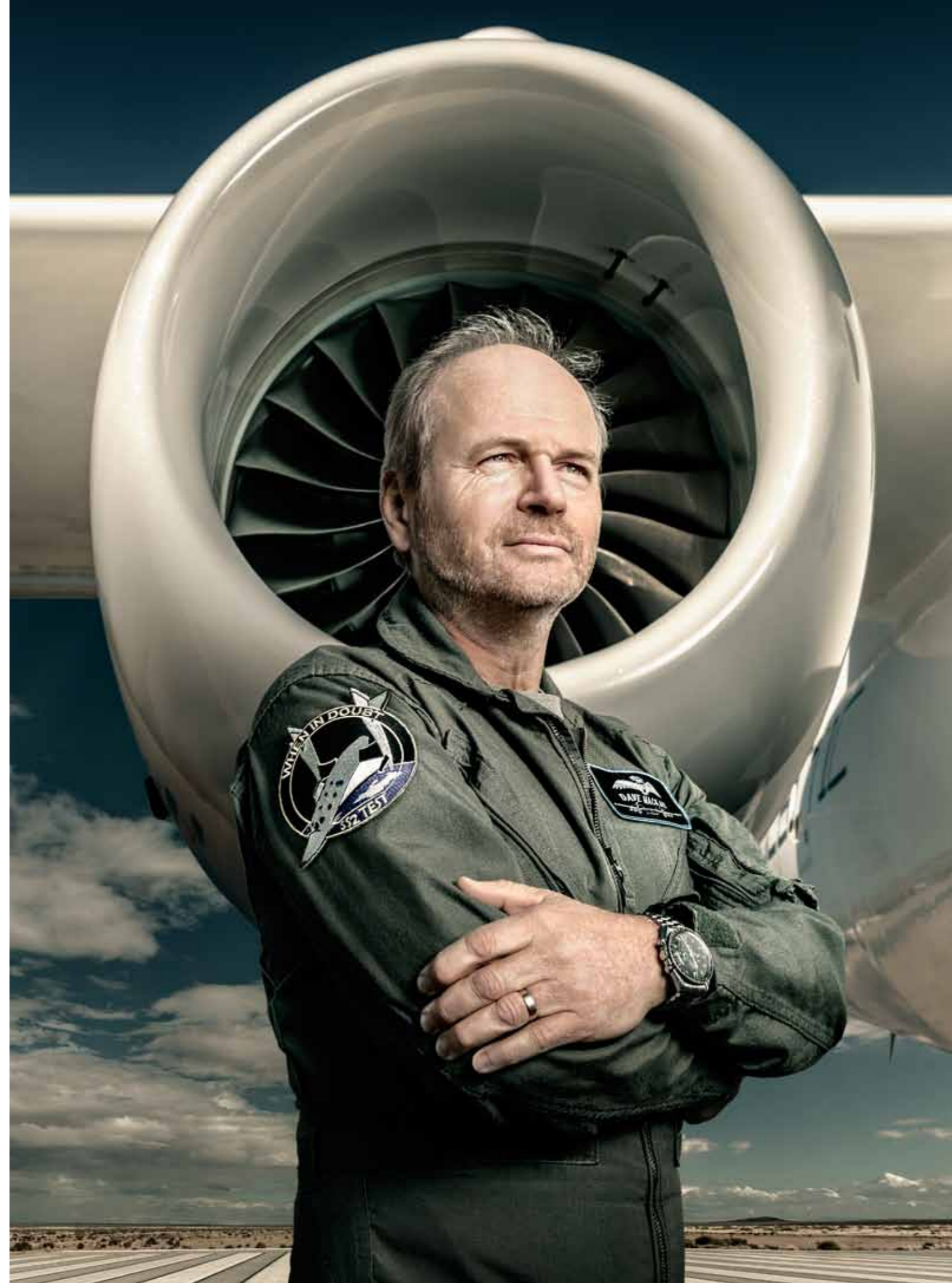
The deaths in Mojave were the first fatalities of the commercial spaceflight industry. The accident shook Rutan in

particular. In his long career of developing experimental aircraft and selling home-build plans to amateurs, the designer had always said his work had never been involved in a single fatality. Now there were three in one day. In the days after the accident, the usually aridly technical Scaled website was filled with heartfelt memorial messages. Rutan stopped work on *SpaceShipTwo* while the engineers tried to discover what had gone wrong; the programme was eventually shut down for a year. A California State investigation into the accident fined Scaled for failing to observe correct workplace practices, but was unable to explain what had happened. Soon afterwards, Rutan was hospitalised with heart problems, and stepped down from the head of the company he had founded.

Scaled launched its own investigation into the accident, calling in aerospace experts from Lockheed, Northrop and Boeing. But they, too, failed to isolate a single cause of the accident. So, to prevent anything similar ever happening again, the engineers at Scaled were forced to tear down and redesign the entire propulsion system of *SpaceShipTwo*, and replace the carbon-fibre oxidiser tank with one lined with aluminium. Nothing like it had ever been made before. While the construction and testing of *WhiteKnightTwo* continued quickly, and the plane made its first flight at the end of 2008, the *SpaceShip* team began exploring five different engine and fuel configurations for the rocket at the same time. The work took years. "It set us way back," says Stinemetze. "We've struggled a lot." Virgin Galactic's estimated launch date for passenger service slipped back, from 2009 to 2011. The total estimated costs of the programme, first calculated at \$20m, rose to between \$300m and \$400m - at least 15 times the initial estimate.

At the end of 2010, Rutan announced his retirement. In April 2011, after 36 years in Mojave, he packed up his belongings and left for a ranch in Idaho.

In May last year, the US Federal Aviation Authority granted Scaled an experimental launch permit for *SpaceShipTwo*. Galactic CEO George Whitesides - the former chief of staff at Nasa, who before joining the company had been among the early ticket buyers for a trip into space - announced that powered-flight testing would begin before the end of 2012. On a trip to promote Virgin Mobile to Poland in October, Richard Branson, in apparent frustration, told a group of students in Warsaw he had given up counting the days until he could go into space.



IN the years since the Virgin Galactic brand was first entered into the books, the market for privately funded space travel – New Space, as its proponents like to call it – has become increasingly crowded. Mojave-based XCOR aerospace – formed by engineers from the failed Rotary Rocket programme – has begun taking reservations for suborbital flights aboard its planned liquid-powered rocketplane, Lynx. Elon Musk's SpaceX is designing its own rockets and capsules, and in October last year successfully fulfilled the first part of a \$1.6bn contract with Nasa when the Dragon X rocket blasted off from Cape Canaveral and delivered supplies to the International Space Station; Musk expects to begin manned orbital flights in 2015. And in Texas, Jeff Bezos has been working in secrecy on Blue Origin – his own programme, aiming to do for space travel what Amazon did for online retailing – for more than a decade.

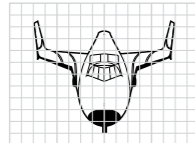
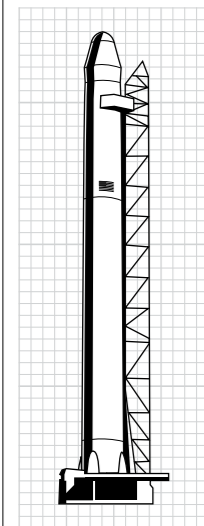
But Branson is confident that Galactic is years ahead of anyone else. "In this field we don't really have any competitors. Land based take-off – they can never compete with us for people going into space,"

CONSTRUCTION HANGAR

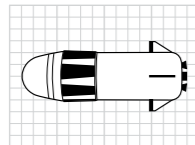
MATT STINEMETZE (RIGHT), WHO'S BEEN WITH SCALED SINCE HE GRADUATED IN AERONAUTICAL ENGINEERING



RIVAL ROCKETRY



XCOR AEROSPACE
THE SIZE OF A PRIVATE JET, XCOR'S LYNX ROCKETPLANE WILL TAKE A SINGLE PASSENGER ON A SUB-ORBITAL FLIGHT FOR \$95,000. THE VEHICLE IS LIQUID-POWERED, MEANING THAT THE ENGINES ARE RE-USABLE AND BURN CLEANLY



SPACE X
ELON MUSK'S COMPANY SPACE X IS THE WORLD'S FIRST PRIVATELY OWNED ENTERPRISE TO HAVE DELIVERED SUPPLIES TO THE INTERNATIONAL SPACE STATION. MUSK'S AMBITION IS GREATER: TO BUILD A COLONY ON MARS. ONE-WAY TICKETS WILL COST \$500,000

BLUE ORIGIN
JEFF BEZOS HAS BEEN WORKING ON HIS SUBORBITAL SPACE FLIGHT PROGRAMME FOR 12 YEARS AND, IN 2009, WAS AWARDED \$3.7BN BY NASA. THERE WAS A SUCCESSFUL TEST IN OCTOBER 2012 BUT, AS YET, NO DATE HAS BEEN SET FOR MANNED FLIGHT



PHOTOGRAPHY (THIS PAGE): TODD ANTONY

OPPOSITE: SCALED'S CHIEF AERODYNAMICIST, JIM TIGHE, WHO DESIGNED SPACESHIP TWO TO BE A ROOMIER IMPROVEMENT ON SPACESHIP ONE

RIGHT: LONDON-BASED DAVE CLARK, ASTRONAUT RELATIONS AT VIRGIN GALACTIC (LEFT OF PICTURE), AND COMMERCIAL DIRECTOR STEPHEN ATTENBOROUGH

he says. "And spaceship companies where people have to parachute back to Earth – that's the old technology. I may be being naïve – there may be somebody doing something very secretive which we don't know about – but my guess is that we are five or six years ahead of any competitor."

In July 2012, Virgin Galactic announced its own commercial satellite-launching programme, LauncherOne – a small air-launched rocket carried beneath *WhiteKnightTwo* designed to boost small payloads into low Earth orbit for a tiny fraction of the cost of a conventional system. Next, Branson has plans to replace the hybrid engine in *SpaceShipTwo* with a liquid rocket motor, with the intention of making quick suborbital flights far cheaper and far more frequent.

And after that, he wants Virgin Galactic to get into the business of using rocketplanes for point-to-point travel on Earth, escaping the atmosphere to shave hours off intercontinental journey times. But that will require a vehicle that can withstand the speed, temperatures and stresses of orbital flight, something *SpaceShipTwo* could never achieve. "If we can get people from New York to Australia in a couple of hours within 20 years, I'd be really pleased," he says. "But it's not going to be cheap to develop."

Whenever it finally happens, Branson says that the day he climbs into *SpaceShipTwo* for its inaugural passenger flight will be the most exciting of his life. He hopes not only to give birth to a new industry, but to transform humanity's relationship with its own planet. Branson believes that democratising the experience may help save the planet. "We can send enormous quantities of people into space who come back determined to make a difference."

Like Elon Musk, Branson dreams of sending human beings to Mars. "One way. The cost of a return trip is going to be horrendous," he says. "There will be plenty of volunteers." He's already conducted some research. Just before April 1, 2008, Branson and Larry Page – after a night in a bar – announced the formation of a new joint venture, "Virgle: The Adventure of Many Lifetimes", accepting candidates to colonise the Red Planet. The proposal was revealed as an April Fool a few hours later. "We had hundreds of people apply," Branson says.

On a dazzling winter afternoon in Mojave, the engines of *WhiteKnightTwo* whine to a halt outside Building 75, as it taxis in from a crew training flight, Dave Mackay at the controls. Inside, a shop crew labours beneath the belly of *SpaceShipTwo*, fitting the giant oxidiser tank for the new propulsion system. Glued directly to the skin of the spacecraft, the tank runs more than half the length of the fuselage, and has taken months to install. "This is huge. The biggest deal we've had on the programme in years," Stinemetze says. "All the plumbing has been run – it's all built. So it's kind of done."

Virgin Galactic's rocket ship is, at last, ready for powered flights. The remaining testing will not be completed quickly, but the final goal is now in sight. "You start that phase with the rocket motor systems, you end up by going into space," Stinemetze says. If everything goes according to plan, it

may, after all, be possible for the world's first commercial space-line to begin service from Spaceport America within a year. In a nearby hangar at Mojave, The Spaceship Company has already begun construction of the second spaceplane and mothership that will come off the production line.

In the meantime, \$200,000 tickets keep selling. At the beginning of 2012, Ashton Kutcher became the 500th person to sign up, joining Stephen Hawking, Philippe Starck and *Dallas* star Victoria Principal on the list of passengers. But not all the celebrities so far reported to be planning sight-seeing trips in space have reserved tickets.

Virgin has been very discreet about the full list; all it will reveal is that, in the interests of democracy, Branson has insisted that nobody will get a complimentary ride, no matter how famous they are. **W**

Adam Higginbotham wrote about empathic technology in 11.12