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A MAGAZINE OF IDEAS, SCIENCE, SOCIETY AND THE FUTURE

COSMOS

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THE SCIENCE OF EVERYTHING

A photograph of an astronaut in a white space suit with blue accents, standing on a grey, cratered lunar surface. The astronaut's helmet visor reflects the bright sun and the lunar landscape. The astronaut is holding a camera in front of their chest.

HOLIDAYS IN SPACE BOOK NOW!

Simon Singh
on serendipity

Margaret Wertheim
on cosmology

Tyrannosaurus sex:
how they did it

The puff daddy
of architecture

Is Freudian
theory dead?

Into the heart
of a volcano

Is noise driving
fish crazy?

The remarkable
Frank Fenner

Fiction by
Paul Di Filippo



STORY Robin McKie
ILLUSTRATION Kevin Stead



SPACE OR BUST

Going into space used to be something that only nations with multibillion dollar budgets could do. Now, anyone with a bit of courage and a lot of loose change can live the dream.

THE ENTRANCE TO VIRGIN GALACTIC'S LONDON OFFICE could not be more adroitly placed. Opposite the world's first space-tourism company's head office in Leicester Square, you will find the nation's principal cinemas where glittering premieres are held every month and celluloid fantasies unfold each night. Over Britain's summer holidays this year, billboards around the square were advertising *War of the Worlds* and *Star Wars III*. If you are selling the ultimate science fiction dream – trips into space – you could not pick a better spot.

And inside the building, signs of high-tech wonder continue. Buttons for the office's lift are set in a giant pyramid that stands in the middle of the ground-floor lobby like an alien sentinel. It is all chrome, steel and high-tech down here.

Then you reach Virgin Galactic's office on the fifth floor and the dream goes a bit pear-shaped: there are a few young men working at keyboards, some wall partitions, a couple of Madonna posters ... and that's it. You could just as easily be in a call centre in central Bangalore.

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Dream come true:
artist's concept of
a future space tourist
on an orbital flight.



The rocketeers

Virgin Galactic - Heir to the X-Prize-winning technology developed by Burt Rutan and backed by British entrepreneur Richard Branson. Has secured us\$18 million (A\$23.8 million), of advance orders to date. Has plans to launch a total of 30,000 passengers into space by the year 2015.

PlanetSpace - Uses technology based on the V2 rockets developed by Germany during World War II, but with an added second stage that will act as an escape capsule should there be problems with the craft's main engines. Based in Canada, it has secured us\$4 million of orders to date.

Reaction Engines - Brainchild of British engineer Alan Bond. His revolutionary engine design, Hotol, will burn air at low altitudes, like a jet, then switch to oxygen at high altitudes, like a rocket, allowing a lone craft to fly from runway to orbit in one simple flight.

XCOR - Mojave-based company that is developing a spaceplane designed around a new generation kerosene-and-liquid-oxygen engine, and which will take off unaided from a runaway and glide gently back to Earth after taking passengers on a suborbital flight.

SpaceX - California-based company that has developed the two-stage Falcon-1 (named after Han Solo's *Millennium Falcon* in the film, *Star Wars*) which will carry only small satellites. However, SpaceX also has plans to develop *Falcon-5*, which will carry passengers.

Space Adventures - The only company to have actually arranged the launch of private travellers into space. Space Adventures can organise - for a cool us\$20 million - a ride on a Russian *Soyuz* capsule to the International Space Station. However, it is also seeking partners interested in becoming involved in the potentially lucrative suborbital business.

Armadillo Aerospace - Set up by U.S. computer entrepreneur John Cormack, Armadillo Aerospace is developing a range of hydrogen-peroxide rocket vehicles. It is, for the time being however, a relatively small concern. As the company website states: "The team currently consists of a bunch of guys, a girl, and an armadillo named Widget."

Blue Origin - Established by Amazon founder Jeff Bezos, this Seattle-based company has bought a 67ha ranch in Van Horn, Texas where it plans to design and test spacecraft that will take off and land vertically, carrying three or more passengers to suborbital space.

— Robin McKie

"Passengers will experience a stomach-churning lurch as the plane is released. Its engine will ignite and it will hurtle towards the edge of the Earth's atmosphere."

"It's not much," admits Will Whitehorn, President of Virgin Galactic, the man appointed by British entrepreneur Richard Branson to mastermind his dreams of stellar greatness. "We are going to have a lavish salesroom in Half Moon Street in the West End, but it won't be ready for months. We are a virtual company, in any case. That is how we have done our business so far: over the Internet - but we've already taken a total of about us\$18 million (A\$23.8 million) in advance orders. And that's money up front, not promises."

For decades men and women have dreamed of slipping "the surly bonds of Earth", but have been thwarted by the expense of the technology involved and by the bureaucrats who control it. Then, a couple of years ago, events began to change. A host of entrepreneurs announced plans to put paying passengers on board a variety of contraptions that will fling them more than 100km above the planet's surface - the official boundary of where the Earth's atmosphere ends and space begins. There they can experience a brief taste of zero-gravity and the blackness of space before swooping back to Earth. Forget Disney's Space Mountain ride east of Paris. What these guys are offering to paying customers is the real thing (see box, this page)

But what has brought about this change? Why is there a rush to space today? The answer, say the entrepreneurs, is simple: the Ansari X Prize. Several years ago the billionaire Peter Diamandis offered us\$10 million to the designer of the first privately built spacecraft to make suborbital flights. "I got the idea from reading Charles Lindbergh's story of how he flew across the Atlantic in the *Spirit of St Louis* in 1927," says Diamandis. "Lindbergh made his epic flight to win a us\$25,000 competition, and opened up the skies to international flight."

So Diamandis decided to do the same for space travel and, in doing so, galvanised the business. More than a score of different spacecraft designers entered the competition. These now form the core of the world's fledgling space-tourism industry.

In the end the prize was won convincingly by U.S. aircraft designer Burt Rutan, whose air-launched *SpaceShipOne* soared 102.9km above the Mojave Desert on September 29, 2004, and took off again five days later, climbing to 112km. Both flights were completed within 14 days, as required under the rules, and Rutan snatched the prize.

Branson had worked with Rutan's privately-owned Scaled Composites company on a number of projects, most notably financing *GlobalFlyer*, an

aircraft that Steve Fossett flew in a non-stop solo trip around the world between February and March 2005. He got wind of Rutan's space project early on, and enthusiastically bought the rights to develop it into a commercial passenger venture, subsequently creating the ambitiously-titled Virgin Galactic.

As I sat in one of the company's tiny offices in Leicester Square, London, Whitehorn - a dark-haired, compact Scot who bristles confidence and commitment - showed videos of the maiden flight of *SpaceShipOne*, followed by a few elaborate animations of its planned successor, *SpaceShipTwo*, Virgin Galactic's ticket to the stars. Or at least, to a quick and adrenalin-pumping, suborbital flight.

The only significant difference between the two spacecraft is scale. Rutan's prizewinning technology is in the process of being expanded to turn his original three-man spacecraft into one that can carry two pilots and seven passengers. Test flights are scheduled to begin in 2007, and Virgin Galactic's space fleet should be ready to fly customers beyond the limits of the Earth's atmosphere by 2008.

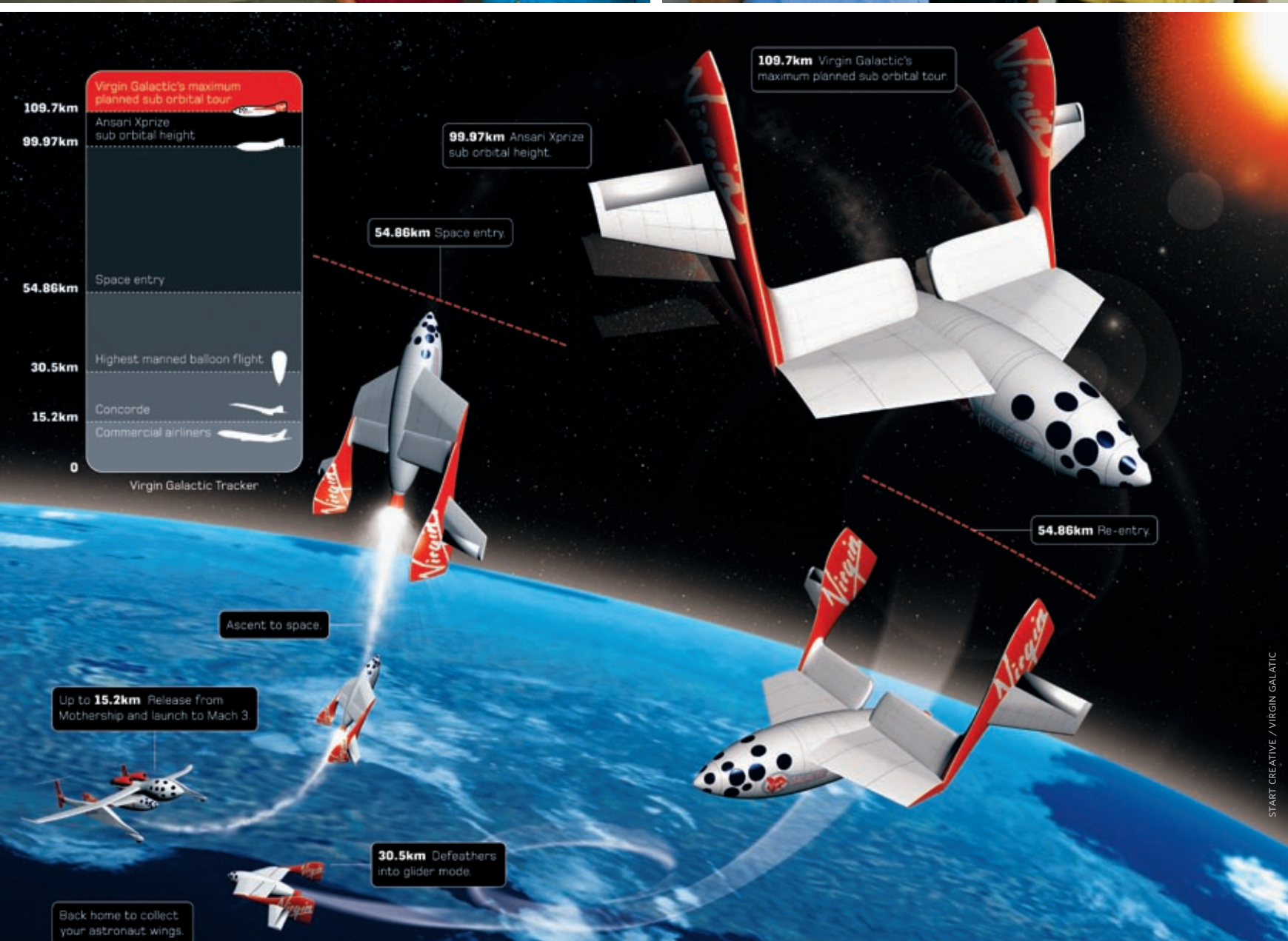
TO DATE, ONLY TWO PEOPLE can claim to have bought themselves a space flight - Dennis Tito and Mark Shuttleworth - and both men paid hefty prices (see box, page 66). Not only did it cost them us\$20 million apiece (A\$26.5 million), they had to take six months off work for pre-flight training. Virgin Galactic says it has taken great care to avoid such inconvenience to its potential passengers.

"We will be dealing with wealthy people with busy lives," states Whitehorn. "So we will only ask people to commit a week to train for a flight with us. Nor will it be gruelling. About 80 per cent of the population should be fit enough to fly. Only those with heart conditions or serious circulatory problems will be turned down. Richard [Branson] is going on the first flight and plans to take his father, Ted, who is now in his 80s. On the other hand, we will probably set a minimum age limit of 16."

But what will prospective passengers who have signed up for flights - among them actors Morgan Freeman, Sigourney Weaver and William Shatner - get in exchange for their money? Will it truly be an out-of-this-world experience? Virgin Galactic says yes (not surprisingly) although it also promises the experience will be informal and unfussy. Customers will meet in Mojave, in California, where the first flights are likely to be launched, and will then be given "a couple of days" casual training and treated to a few sessions in a flight simulator. Then, solid foods will be deleted from their menus to reduce the chances they will become space sick.

On the day of the flight, there will be no bulky spacesuits either. Jumpsuits will be worn. Then it will be time for take-off. Strapped to the belly of its mothership - a conventionally powered but especially designed jet - the spaceplane will be carried aloft from a runway take-off. After climbing to an altitude of 16,760 metres, passengers will experience a stomach-churning lurch as the spaceplane is released. Its rocket engine will ignite and the little craft will hurtle at extreme speed towards the outer edge of the Earth's atmosphere.

Clockwise from below: SpaceShipOne's team (from left), financial backer Paul Allen, pilot Mike Melvill and the spacecraft's designer Burt Rutan; Rutan's ingenious solution to suborbital flight; Richard Branson and son Sam with the *White Knight* launch aircraft. The British entrepreneur has booked seats for his family on the first Virgin Galactic flight, due in 2008.



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The Cashmonauts



As an industry, space tourism is remarkable for one key feature: its dearth of customers. So far, there have been only two people who have managed to buy their way into space: Dennis Tito, a Californian investment manager, and Mark Shuttleworth (left), a South African dot-com millionaire. Both men coughed up a hefty us\$20 million (A\$26.5 million) for

the privilege of staying a little more than a week on the International Space Station, having been flown there on Russian Soyuz capsules: not so much cosmonauts, as cashmonauts, as they were dubbed at the time. Tito was 60 years old when he flew in April 2001; Shuttleworth was 28 when he made his trip in April 2002.

The two voyages were very different in one crucial aspect, however. Tito was pilloried by U.S. space officials for having bought his way onto the station and was even accused of being unpatriotic by the then head of NASA, Donald Goldin. Tito vehemently denied the charge.

By the time Shuttleworth made it into orbit, attitudes had changed markedly. U.S. Congress had held a hearing about the issue and NASA had reluctantly come to accept that the occasional passenger could be allowed to buy a seat on a flight to the space station. As this issue went to press, another millionaire – the physicist Jeremy Olsen, who founded the New Jersey infrared camera manufacturer, Sensors Unlimited – has been scheduled to fly on Soyuz to the space station in October 2005. The trip has again been brokered by Space Adventures, the same company that acted as negotiating agent for both Tito and Shuttleworth.

And to judge from the experiences of his predecessors in space tourism, Olsen can expect a journey similar to the way most of us spend our holidays. For example, Tito used his time to catch up on sleep, photograph views from his window, and listen to his CD player – although his trip did leave him a changed man.

“I had to stay strapped in a foetal position in a small sardine can without being able to go to the restroom,” he says of his launch on Soyuz. “You can put up with quite a lot after you have done that. Now, if my baggage is lost in the airport, it isn’t the end of the world.” — Robin McKie

Within a few seconds, passengers will be flying faster than the supersonic Concorde, and they will be pressed back in their seats as acceleration continues for another 90 seconds. Then the engine will cut out and the craft will start to coast in weightless silence. One hundred and twelve kilometres below, the Earth will curve against a jet-black background. The Mojave Desert will be a tiny patch of yellowish brown. Welcome to space.

Free to float around the cabin, Virgin’s customers have six or seven minutes to enjoy the experience and indulge in an ecstasy of videoing and camera-clicking. Then their ship will start to arc back to Earth like a ballistic missile, its stubby wings turning upwards to turn the craft into a giant shuttlecock, allowing *SpaceShipTwo* to ‘flutter’ back to Earth rather than slam into the atmosphere as the space shuttle does. At 16,760 metres, its wings return to their original configuration, and the craft glides to an airport landing (see box, page 68).

It is a breathtaking prospect, although Virgin is certainly not the only team to be galvanised by the X Prize. Several other outfits – mostly American but also Canadian and British – have announced plans to launch tourists on suborbital flights. In addition, a variety of different locations for spaceports have been proposed: with Australia a favourite. “It will be our second location: plenty of open space and proximity to the Asian market,” says Whitehorn.

These ventures are being closely watched by entrepreneurial outfits such as Space Adventures, a Virginia-based U.S. company led by hawk-like chief executive Eric Anderson. “We are the only people who have actually managed to get paying customers into space,” Anderson points out. “It was Space Adventures who got Tito and Shuttleworth on the space station, after all. We know what is involved.”

Space Adventures plans to continue to launch one or two paying customers a year on *Soyuz* for the next decade, each at us\$20 million a shot. “That is not space tourism,” admits Anderson. “That is just something for billionaires to enjoy. We are watching the suborbital market very carefully to spot early winners. Then we will try to do deals with them and add suborbital flights to our portfolio.”

Both Virgin Galactic and PlanetSpace look to be strong candidates for ultimate success, according to Anderson. “The other interesting group is the one that was set up by Jeff Bezos of Amazon. He is keeping very quiet about it, but Bezos has hundreds of millions of dollars to invest.”

Bezos, Amazon’s founder, is worth an estimated us\$5 billion and has bought a vast ranch in Van Horn, Texas, where he intends to test spacecraft for his Blue Origin company. The details of his spaceship’s design remain secret, however. “In the end, it won’t just be money that will have the crucial impact,” adds Anderson. “Nor will it be the outfit that has the first system or the cheapest flights. It will be the one that is the safest.”

One common factor does unite all these different groups, however: they are all backed by computer-industry or dot-com billionaires. For example, Elon Musk – who sold the PayPal Internet payments company to eBay for us\$1.5 billion – has

established SpaceX, his own rocket company. “You had to have some kind of pre-boom to supply the capital investment to kick off the rocket boom, and that only happened with personal computers and the Internet,” he says. Similarly, John Cormack, who made his fortune writing computer games, including *Doom*, is developing Black Armadillo, a conventional rocket he hopes to use for manned flights. Rutan’s own effort was backed by Microsoft’s lesser-known co-founder, Paul Allen.

THIS IS CLEARLY GOING to be a game for the well-heeled – and it is likely to stay that way. Astronauts were said to have ‘the right stuff’ – special physical and mental abilities that qualified them to go into space. Now ‘the right stuff’ is cash: Virgin Galactic is charging us\$200,000 for a single seat on one of its first flights. That’s about us\$28,600 for every minute of weightlessness and peering out of your personal porthole (each passenger is promised their own).

Not that the price has proved a drawback for Virgin: thousands of people have already signed up and more than 90 have actually coughed up the entire cost of their flight, providing Virgin Galactic with a healthy us\$18 million kitty for funding initial development and construction of its fleet of five spaceplanes and two carrier motherships.

“By the time they are all flying, economies of scale will bring prices down to about us\$100,000 a flight – by 2013 or 2014,” says Whitehorn. “And that is the magic pricetag. Our research suggests that is what well-off individuals – not just billionaires – will

“Once suborbital flights become routine, the race will be on for space tourism companies to take passengers even further.”

be prepared to pay for a truly special experience. It costs about us\$100,000 to climb Mount Everest, for example – right to the top, not just to base camp. On an Everest climb, you’ll have a 4 to 6 per cent chance of getting killed, however. We expect our trips will be 100 times safer.”

Other space entrepreneurs agree. “We are starting at us\$250,000 a ticket,” says Chirinjeev Kathuria, chief executive of PlanetSpace. “That will decrease – probably to about us\$100,000 – but I don’t see much movement after that.”

The reason for this stability is simple: the urge to undercut rivals will have to be balanced by the need to generate cash to maintain technological momentum and create new experiences. Once suborbital flights become routine, the race will be on in earnest to take passengers even further. Both PlanetSpace and Virgin Galactic are already



This frame: the space station from the flight deck of *Atlantis*;
Below: Edward Fincke takes a space walk outside the space station, which hosted the first space tourists in 2001 and 2002 courtesy of the Russians.



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SPACE ADVENTURES

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