

Routes to Market Report

32 – Space Tourism

Innovate UK

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Satellite Applications

Contents

1. Introduction and Scope	3
2. Market Overview and Opportunities	3
3. Proposition to the customer and end user	4
4. Market Competition.....	4
4.1. Orbital.....	4
4.2. Sub-Orbital	5
4.3. Stratosphere	6
5. Revenue projections	7
5.1. Revenue Projections and Market Viability.	7
5.2. Comparable Attractions.....	9
6. SWOT Analysis	9
7. Summary.....	12

1. Introduction and Scope

This reports brings together details of the future players in the frontline space tourism industry and available market forecasts. It uses tourism parallels to help to provide a potential model for growth. It highlights the UK's status as a top ten tourist destination with the advantages that brings in developing a new sector.

On April 8th 2001 Dennis Tito became the first official tourist in space when he visited the International Space Station. He has been followed by 6 others. There has been no one else since 2009.

The much predicted, and hyped, opportunity for something other than elite space tourism, costing tens of millions of dollars, now seems at last a realistic proposition. Potential sub orbital operators are on the cusp of being able to offer services. As soon as that happens a new industry and possibilities will flow.

The key challenge is how to capitalise on developments at any future spaceport based in the UK, when the vast majority of the space tourism industry chooses to be based in the United States.

The direct space tourism industry can be divided broadly into three sectors:

1. Orbital flights, or to a space station. Sub orbital flights crossing the Karman line at 100 kilometres, the official boundary of space.
2. Flights to the stratosphere either by balloon or aircraft. Zero Gravity parabolic flights to induce weightlessness.

Astronaut training. Space experiences/museums.

2. Market Overview and Opportunities

As the Chief Executive of Argyll and Bute Council stated in their bid for a spaceport at Campbeltown "The UK spaceport must offer compelling reason to operators, customers, visitors and to the support and supply community in order to be globally competitive."

The key point about businesses able to operate in the space tourism sector is that many of them do not have to offer orbital or sub orbital capabilities. These must, however be happening in the UK to provide a hook for whatever is on offer.

For Space tourism in the UK to be successful at the various levels there are a number of factors

1. Early response.
2. Ability to offer a range of space tourism possibilities.

3. Synergy with other tourist services and options to create a package that can sell the UK as the preferred destination.
4. The branding of the operational and technical expertise of the UK.

Regulatory and insurance environment underpinning operations and reinforcing the quality and safety message.

3. Proposition to the customer and end user

- Orbital and suborbital space flights for leisure passengers
- Low gravity experimental payloads
- Training flights for astronauts and laboratory technicians conducting experiments

4. Market Competition

4.1. Orbital

Bigelow Aerospace. www.bigelowaerospace.com

HQ Hawthorne, California, USA. Developing expandable spacecraft modules for commercial accommodation. NASA has contract with Bigelow to procure six flights to ISS. Bigelow is now teaming up with Lockheed Martin to put space stations in space. Target 2020 “potential as a destination for space tourism.” According to press release.

Boeing CST-100 www.boeing.com

NASA awarded Boeing \$4.2 billion in 2014 to build next US passenger spacecraft. Using Atlas rocket. Plans to take commercial passengers. Boeing website claims first passengers (not tourists) this year. Launched new spacesuit for its Starliner passengers Jan 2017.

SpaceX www.spacex.com

Space Exploration Technologies Company. Based Hawthorne California USA. PayPal and Tesla entrepreneur Elon Musk company developing re-usable rockets that return to launch area. Falcon 9 rockets having problems with turbine pump blades barring human flight until redesigned. (February 17. www.parabolicarc.com) SpaceX is supplying ISS. and plans manned missions in future.

Vulcan Aerospace www.aerospace.vulcan.com

Working on air launch low earth orbit system “stratolaunch” for satellites. The aircraft being built at Mojave Air and Spaceport is the world’s largest plane according to Reuters. Founder Paul Allen is comparing space to the mobile phone market as the next economic domain.

Space Adventures www.spaceadventures.com

Effectively a space travel agency. Up to 2009 sent fee paying passengers to the International Space station using Russian launches. Massively expensive. (\$20-40 million) Website offers wide range of experiences from circum-lunar flights to zero gravity training. Russia reported to be resuming its orbital tourist service from next year. (2018)

4.2. Sub-Orbital

Virgin Galactic. www.virgingalactic.com

Virgin entrepreneur Richard Branson's space tourism venture. Based at spaceport in New Mexico. Bills itself as world's first commercial space line. Offers seats for \$250,000. Using horizontal take-off and re-entry. After delays and a fatal accident in 2014 of the VSS Enterprise, VSS Unity is now undergoing glide tests. Meanwhile developing small satellite launch capabilities. Galactic Unite is brainchild of international community of Virgin Galactic Future astronauts. (Circa 700 according to Observer in 2015) Wants to promote: science; technology; engineering and maths education. Invested almost two million dollars so far. Richard Branson has said he would want to operate from a UK Spaceport. No official start date.)

Xcor Aerospace. www.xcor.com

Xcor Lynx Mark 11. Based Mojave Air and Space Port USA. Runway take-off, glide return. Reaches space boundary (103 kilometres.) 6 minutes in space before return glide. Offering various packages and training. Lesser lower altitude packages offered on prototype Mark 1. (60km) Partnering with Dutch Airline KLM and links to Royal Netherlands Airforce. Sir Bob Geldoff one of first to go. (ticket prices up to \$200,000.) No start date.

Orbital Access <http://orbital-access.com>

Based at Prestwick airport Scotland. Although focusing on horizontal small satellite launch this recently established SME (2015) is developing plans that would include parabolic flight with the future potential for Space Tourism. In July 2016 OA signed an MoU with USA based XCOR Aerospace which is developing a two seater Lynx spacecraft for suborbital trips. OA would use an Avro RJ short haul aircraft and a modified MD-11 for short periods of parabolic flight that could be offered to space tourist and for industrial experimentation using zero gravity.

Blue Origin www.blueorigin.com

Based in Texas USA. Backed by Amazon founder Jeff Bezos. Plans to offer astronaut experience in re-usable rocket based capsule which returns separately by parachute. Testing underway of systems. No start date.

Roscosmos. Russian Space Agency.

Target 2020 for re-usable rockets designed by KosmoKurs. Flights above Karman line at circa \$200-250,000

State assisted China Academy of Launch Vehicle Technology.

Developing Space Plane (New Scientist) Two versions projected. One 5 passenger the other 20 passenger. Vertical take off and land on runway automatically. Tests flight planned to be finished by 2019.

Sierra Nevada Corporation Space systems. www.sncspace.com

Developing NASA shuttle style Dream Chaser vehicle. Aiming at European space low earth orbit requirements. Potential for tourism.

Starchaser Industries Ltd. www.starchaser.co.uk

Based Hyde Manchester UK. Uses volunteers. Retains record for biggest civilian rocket launch from UK mainland. Nova 1 in 2001. Suggesting a three-person space tourism reusable capsule for sub orbital flights to above 100 kilometres. Also suggesting an 8 seat sub orbital space plane that could be upgradeable to orbital. However, recently flying much smaller rockets. Links to schools and university science and engineering departments. At the very least a UK based source of technical expertise and enthusiasm. However, reported to be planning to use US for further tests, because of CAA restrictions.

Airbus. www.airbusdefenceandspace.com

Has had plans for a Spaceplane for four passengers to 100 kilometres. Some testing, but no launch date. Last press release 2014. Looking for investors according to www.space.com.

4.3. Stratosphere

World View Enterprise www.worldview.space

Based Tucson Arizona. High altitude balloon technology. Plans to use its Voyager capsule for flights to above 100.000 feet. Calls its balloons Stratollites. Already offers communications and surveillance capabilities. No date for tourism start.

Zero2infinity www.zero2infinity.space/

Based Spain. Says it plans to send balloon passengers to circa 40km also plans satellite launch from balloon/rocket combination. No date for tourism start.

Zero Gravity Flights.

AirZeroG www.airzerog.com

- French based parabolic flights. £4000

Swiss Space Systems S3 www.s-3.ch

- Offers zero g at £1600. Plans sub orbital tourism craft launched off the back of an Airbus aircraft by 2020 (www.techradar.com)

G-force One www.gozerog.com

- Boeing 727 weightless £3250. Cape Canaveral and Fort Lauderdale USA

Zero G corporation

- Modified Boeing. Vienna USA Price Just under \$5000 per passenger.
- 6000 people so far.

5. Revenue projections

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Seat / Cargo equivalent (From Tauri)	373	390	405	421	438	451	489	501	517	533	4,518
UK 20% of global market	75	78	81	84	88	90	98	100	103	107	904
At £175k Per seat	£13 m	£13.7m	£14 m	£14.7m	£15.5m	£15.8m	£17 m	£17.5m	£18 m	£19 m	£158m

Assumption made in Tauri Group Report, using their baseline scenario, still seem to be relevant in 2017.

5.1. Revenue Projections and Market Viability.

The revenue from direct space tourism to date is broadly \$200 million dollars for orbital. The income from those who have already signed up for sub orbital, taking a very conservative view, is an estimated \$180 million. The revenue for Zero G flights must by now be running into millions of dollars (6 persons at c\$2000-\$5000 per flight)

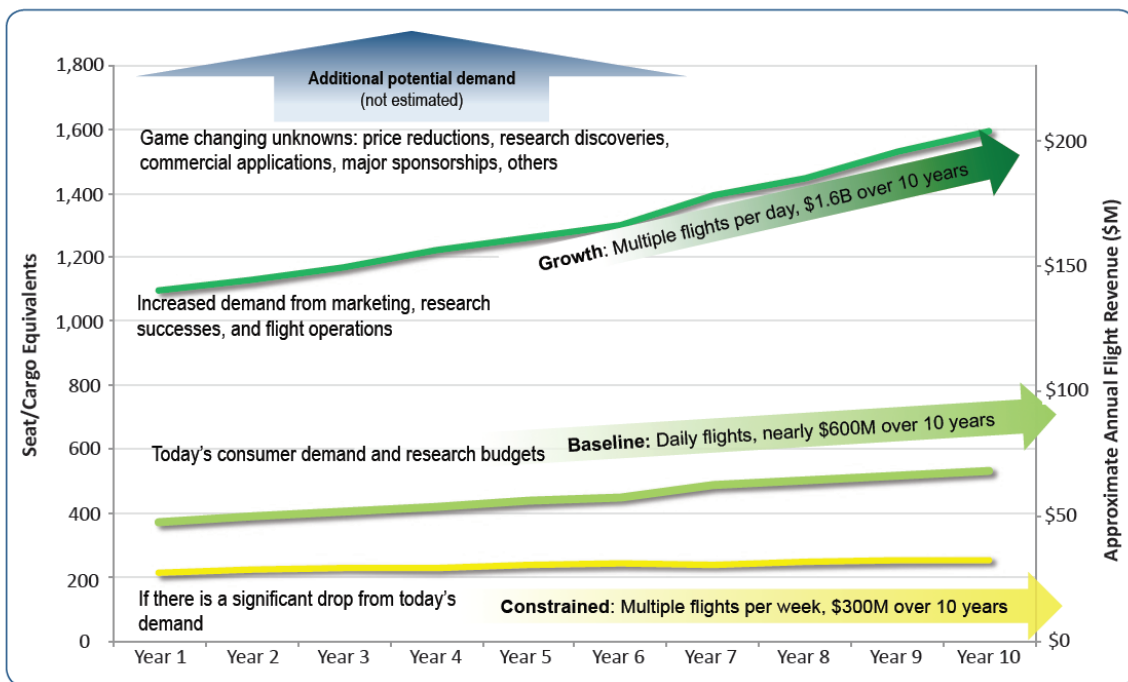
Some of the published research into the future commercial viability of space tourism should rank as works of science fiction. However, a couple do provide some projections for the direct income from orbital and sub orbital tourism, which is not the whole space tourism market.

Americaspace.com commissioned a Space Tourism Market Study from Futron (specialises in Aviation and Space research) in 2002. This is the most regularly quoted survey turning up in the European Space Agency bulletin 135 in 2008. This survey examined attitudes to orbital and sub orbital tourism in some depth.

Perhaps not surprisingly cost was a critical factor, with 30 percent of polled millionaires willing to spend a million dollars on a two week orbital trip. This dropped steeply to just 7 percent if the price was \$20 million. Futron estimated 60 orbital passengers a year generating revenues in excess of \$300 million by 2021.

In the sub orbital market. Futron estimated just under 16000 passengers a year by 2021 based on ticket price of \$50,000. Generating c.\$800 million. Whether the sub orbital market would be able to carry that capacity in the next decade is a moot point.

Another report in 2012 was compiled by the Tauri Group. (Specialises in Space, Defence and Technology) It was co funded by the Federal Aviation Administration’s Office of Commercial Space Transportation in Florida. The report suggests an estimate of 3,600 seats on sub orbital flights, generating \$600 million over ten years at current prices of between \$150,000 to \$200,000. The aggressive scenario suggested 11,000 passengers over ten years. Tauri group assumed that of the group with enough funds, individuals worth in excess of \$5 million, 40 percent would fly.



Copyright: Futron Suborbital Reusable Vehicles 10 Year Forecast (Tauri Group)

Given that Futron assumed a much earlier start to sub orbital, and orbital is not due to restart until next year, it seems fair to push any estimates towards 2030 and beyond. Space tourism is likely to be, for most customers, a once in a lifetime experience. It may be modelled by those who travel to see the aurora borealis. Iceland has capitalised on this market. In 1996 there were 200,00 visitors, in ten years that rose to around 1.5 million. Bizarrely, but probably because of the ease of flights, US visitors now regularly outnumber the entire population.

In 2015 The Tauris Group report stated demand for suborbital flights is sustained and appears sufficient to support multiple providers . Demand encompasses commercial human spaceflight, research, education, satellite deployment, and media and public relations activities . The total baseline demand over 10 years exceeds \$600 million in SRV

flight revenue, supporting daily flight activity . The baseline reflects predictable demand based on current trends and consumer interest.

5.2. Comparable Attractions

The Leicester Space Centre has seen an expansion of the numbers visiting. Since its opening in 2001 it has seen some 3 million visitors. It has around 17 thousand annually travelling on average 67 miles for the visit. About 11 percent of these in 2015 were thought to have used local accommodation and other tourist services.

The British Parachute Association currently has between 50 and 60 thousand student members. Tandem jumps (with a qualified instructor) costs around £250 to make a solo around £380. Costs are not in any way comparable with space tourism, but this does give an indication of the potential demand for an exciting activity that carries an element of risk.

Top 10 Trips of a Lifetime (with illustrative costs added)

1. Setting sail for a world cruise (\$200K)
2. Sailing the Mediterranean on a private yacht (\$750K/week for mega yacht rental for 12 passengers)
3. Calling on all seven continents (\$100K)
4. Renting a European villa (\$100K for a week in a castle on the French Riviera)
5. Visiting all seven New Wonders of the World (\$350K)
6. Photographing the “big five” on African Safari (\$30K)
7. Renting a private island (\$120K)
8. Blasting off on a Virgin Galactic flight (\$200K)
9. Chartering a private jet (\$64K “Heaven and Earth” Smithsonian private jet expedition)
10. Dining through Paris’ best restaurants (\$10K)

6. SWOT Analysis

STRENGTHS

- A key factor in ensuring the success of a UK Space Port and the associated Space tourism business it will generate is the support of the UK Government. This is evidenced by the Government £10 million scheme to incentive the commercial space flight in the UK announced in February 2017. In addition, draft legislation has been developed to enable commercial space flight from a UK based space port. The Government anticipates these actions will allow the UK to benefit from a share of the estimated £25 billion market over the next 20 years.
- The United Kingdom’s ability to attract a share of whatever the space tourism industry can generate is likely to be enhanced by a number of factors not directly related to space activity. These are best described as Brand UK.

- The UK is the eighth largest international tourism destination ranked by visitor numbers. It is sixth based on spend. Tourists only spend more per head in the USA; China; Spain; France and Italy.
- Recent years have seen significant growth, up on a quarterly basis by 11 percent in 2015 and the current weakness of the pound is already feeding through into higher current demand. An idea of the scale of the numbers can be gained from figures from London which is the most popular destination. It attracted 31.5 million internal and external tourists in 2015.
- As well as a major tourism industry geared to visitors, The UK brand has other plus points.
- The UK government via the Department for Business, Energy & Industrial Strategy is offering up to £10 million to incentivise the commercial spaceflight market. It estimates the commercial spaceflight market to be worth £25 billion globally over the next 20 years.
- In 2015 Britain was ranked second in the world for the quality of its scientific research by the World Economic Forum. From the jet engine to computers and the internet, Britain has been at the forefront of world changing technology. Britain (along with France) created supersonic passenger air travel with Concorde. The UK also leads in aerospace human factors research by firms like QinetiQ and BAE Systems which can contribute to a safe brand image.
- Britain also enjoys a worldwide reputation for highly specialist engineering, via its dominance of F1 racing. Eight of the ten F1 teams are located within 80 minutes' drive of Silverstone known as Motorsport Valley. F1 teams according to Forbes had a revenue of \$1.5 billion revenue in 2016.
- There is no reason why a UK spaceport couldn't become a high profile tourist destination bolstered by its links to scientific research and engineering. The Science Museum in London pulls in over 5 million people a year. A spaceport in a more remote location could support a tourism operation with a much smaller percentage of visitors, and an even smaller number of actual spaceflight tourists.

WEAKNESSES

- The UK has no history of civilian sub orbital or orbital launches, to help to market its expertise.
- There is also an apparent lack of the blue sky thinking, high net worth individuals who are driving the industry elsewhere. Richard Branson is the obvious exception, and he has chosen to locate his operations in the States, while saying he would be interested in operating from a UK spaceport.
- The risks associated with sub orbital travel are not negligible. Virgin Galactic claimed to have lost only 30 potential passengers out of 700 or so after the 2014 accident, during testing, which killed one of its pilots and seriously injured another. However, an accident involving members of the public might have much more serious

repercussions on the whole industry. The Lockerbie bombing of a Pan Am flight is cited as one of the reasons for the failure of that airline.

- Another limiting factor may well be the exponential leaps forward in virtual reality technology, which may only serve to undercut a more mainstream market for the real thing. This however could serve as a visitor experience for those unable, because of cost, or unwilling, to take part in sub orbital flights.

OPPORTUNITIES

- For space related tourism to flourish in the UK there ideally needs to be a sub orbital tourist capacity, to act as a high profile hook on which to hang other elements like zero g flights; astronaut training and “space experiences.
- To date Virgin Galactic looks like the most obvious contender to base part of its operation in Britain. However even an orbital satellite launch capability could be enough for downstream tourism operations to exist.
- The UK government already accepts the principle of tax breaks of 25% to help attract international film makers to Britain. As a result of the films that have been produced and shot here, the UK has developed a high level of production and specialist expertise. The tax credits create around £2 billion worth of business for the UK according to the Treasury
- Financial incentives, if only initially, are likely to be required to persuade upstream space tourism operators to locate here.
- Perhaps as important, a number of key stakeholders have to provide an attractive operating environment:
 - 1) The Space Agency along with Civil Aviation Authority and other Government departments will have to formulate clear provisions for sub orbital and orbital tourist operations. It needs to be relatively straightforward to make the necessary safety cases.
 - 2) The insurance industry will have to provide competitive products that will allow operators to function profitably.
 - 3) The activities of a spaceport with tourist facilities, connections to hotel chains and transport links, will require incorporation into local authority planning strategies, and a coordinated level of support that enables, rather than acts as a disincentive to invest in an embryonic market.
- Micro Gravity Research
 - One field that could provide an income stream for a UK based sub orbital/orbital tourist capacity is micro gravity research. This has already yielded unique insights into diverse areas such as fungi and how to construct better bone material. This has happened at the International Space Station.
 - Space X is currently contracted to provide facilities for pharmaceutical research into monoclonal antibodies, an important tool in the fight against cancers. Clearly the ability to offer the sort of short lead time operations that

would typify tourist flights, could be attractive to researchers as well. An article in Nature in 2015 predicted that microgravity research would, with the advent of cheaper more flexible options provide a major tool in pharmaceutical development. The physical sciences are also predicted to benefit massively from microgravity researchers understanding metallic crystal structure, vital in precision casting, to the technology of flames leading to clean burn engines.

- The experiments that could be conducted will require highly specialised laboratory scientists to take part in the flight as astronauts and robots are unlikely to have the required skills to manage highly expensive and complex experiments. As such some preliminary training on suborbital flights would be required prior to the 'experiment' flight.

THREATS

- The UK only pays lip service to capitalising on space tourism at a future spaceport and allows international competitors from Russia to Sweden and Curacao to gain such a lead that any small scale tourist operation will not have the chance to grow and flourish.
- The USA with its good climate for operations; most of the planned operators and legacy of spaceflight, comes to dominate the market to such a degree that it effectively sponges up most of global demand for space tourism, with perhaps Russia taking a smaller share.

7. Summary

January the 1st 1914 saw the world's first scheduled passenger airline service in the United States. Britain started scheduled services two years later, and in 1919 the world's first regular international service began from Hounslow Heath aerodrome. There have been fewer than ten space tourists to date, and no one has flown as a tourist on any of the suborbital systems under development. When that happens, it is likely to happen in the United States. There may be a lesson there, if the UK wants to attract global space tourist business, being first is useful, but it isn't as important as being a more innovative second, perhaps with the space tourist experience actually starting from one of the major airports with a dedicated service to the UK's first spaceport.