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Chapter 7

TOURISM's LATEST SECTOR – PRIVATE SPACEFLIGHT

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ABSTRACT

Space Tourism is unlikely to become a major part of the overall tourism business, at least in the next twenty years, but it does nevertheless represent a niche sector which will see considerable growth opportunities over that period. The chapter introduces this most literal of high-end tourist destinations. It provides a consolidation of available market data about the potential demand for these space tourism opportunities, documents the full spectrum of possibilities for space-based tourism, makes comparisons with existing types of Earth-based tourism businesses, and provides information on a range of companies associated with the existing and future space tourism sector.

The market data provided includes demand forecasts (including price elasticity information), and also covers motivations and expectations of the potential space tourists. Also addressed are the anticipated wealth demographics of the first space tourists. There is an explanation of the various elements of infrastructure that are necessary to make this development possible, with a focus on the terrestrial spaceports, both existing and planned, at various points around the world to support the emergence and development of the new industry sector.

The chapter ends with a discussion of the issues and challenges that must be addressed in order for the business of space tourism to succeed. It is expected that sub-orbital space tourism will commence in around 2013. The number of new people entering space in the first year of sub-orbital space tourism operations will exceed the total number of astronauts flown in the first fifty years of human spaceflight. Prices will start around US$100,000 and can be expected to drop in subsequent years as the operators begin to assemble the experience of flying regularly into space.

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1. INTRODUCTION

Space Tourism is unlikely to become a major part of the overall tourism business, at least in the next twenty years, but it does nevertheless represent a niche sector which will see considerable growth opportunities over that period. This is because up to now only 9 people have undertaken a private space flight experience (due, as we shall see, to the limited spaceflight opportunities and the high price), while a new phase of space tourism is about to begin with much greater availability and much lower price points. During 2012 and 2013 we can expect to see many references in the press to this new kind of experience, as it begins to operate. Only about 500 people of all nationalities have been in space since Yuri Gagarin's first flight 50 years ago, and this new phase of space tourism can expect to take that many tourists into space in its first year of operation – so it represents a major change in how spaceflight is conducted. Although there is global interest in space tourism, and to date it has all been conducted from the former Soviet spaceport of Baikonur in Kazhakstan, this new growth phase will initially be located in the USA. There are several books (Anderson & Piven, 2005; Webber, 2010; Dubbs & Paat-Dahlstrom, 2011; Ansari & Hickam, 2010) which provide a general reference as to how the industry came about, but this chapter will focus on data which is specifically intended to be useful to the tourism industry planning community.

2. TYPES OF SPACE TOURISM

There is an entire spectrum of possibilities represented by the term space tourism (see Table 1), and it is not necessary to be a millionaire to take part in all of them.

Table 1. Types of space tourism

Type	Price (In US$)	Status	Notes
Visits to spaceports and space museums	Generally free	Available	Smithsonian, Moscow, Kennedy Center, Space Camp Huntsville, etc.
High altitude jet flights	20,000	Available	Incredible Adventures
Zero-G flights	5,000	Available	Zero-G Corp, Aurora Aerospace
Spaceflight training	6,000	Available	NASTAR Center providing experience of space flight via simulators
Sub-orbital	200,000	Coming	Virgin Galactic, XCOR, etc.
Orbital	30,000,000	Available	Space Adventures via Russian Soyuz
Point-to-Point	n/a	Not available	Being discussed, but technology needed
Lunar	150,000,000	Proposed	2 passenger places for round-the-moon

Source: Spaceport Associates, 2012.

The least expensive form of space tourism involves visits to space museums, space theme parks, and spaceports. In the USA, the Smithsonian Institution operates the two National Air and Space Museums (one on the National Mall in Washington DC, and the other at the Udvar Hazy Center in Virginia, near Dulles Airport). Both have free entrance, and the degree of public interest is obvious from the attendance statistics, which record about 5,000,000 visitors per year, of all nationalities. Furthermore, although entrance is free, we recognize of course that the Smithsonian is a big tourist draw to Washington DC, which thereby benefits from the hotel, restaurant and transport revenues and taxes.

Orbital space tourism began in 1990 when a Japanese journalist, Toyohiro Akiyama, took a flight into orbit in a Soyuz spacecraft from Baikonur. Less than a year later, a UK citizen, Helen Sharman, repeated the feat and then the collapse of the Soviet Union brought an end to such flights for a decade. In 2001, the American Dennis Tito became the first true space tourist, spending his own money to go into space for two weeks, again using the Soyuz spacecraft, but this time the craft was crewed by a Russian rather than a Soviet cosmonaut. The ticket price was US$20 million at the time. The complete list of true Space Tourists to date is Tito (2001), Shuttleworth (2002), Olsen (2005), Ansari (2006), Simonyi (first flight) (2007), Garriott (2008), Simonyi (second flight) (2009) and Laliberte (2009). Figure 1 shows a Soyuz spacecraft approaching the International Space Station (ISS).

Source: NASA, 2012.

Figure 1. Soyuz Spacecraft Provides Orbital Space Tourism Opportunities.

Soyuz was not initially designed as a space tourism craft, and indeed it is very cramped inside, with room for only a crew of two plus a single space tourist. It is for this reason that orbital space tourists must currently rendezvous and dock with something more spacious in order to have flights longer than a day or two. Currently this means docking with the ISS, which is a governmental space laboratory which is also not designed for catering to the needs of space tourists. Eventually commercial space hotels will be placed and operated in orbit to serve as destinations for the orbital space tourists of the future. The flight rate of orbital space tourists has been only about one per year, because of the high price, but more importantly because spare seats are rare; the Soyuz is generally fully occupied taking government astronauts up to the ISS. Nevertheless, every orbital space tourist has declared after their flight that the expense, and indeed the onerous training commitments (including the need to learn Russian), was well worth the investment. We shall see later that there is an unfulfilled demand for orbital space tourism seats, even at these prices, and that larger craft are being developed to help service the demand.

The next phase of space tourism, which will commence probably in 2013, is known as sub-orbital space tourism. While an orbital craft can stay in space almost indefinitely (but usually returns after about two weeks), the sub-orbital craft shoots up vertically into space, lingers for about 5 minutes in the zero-G environment at the top of the climb at about 100km altitude, while the passengers float about and take in the curvature of the Earth, the black sky, the thin veil of the Earth’s atmosphere, and then returns to the same spaceport from which it departed. Because it is a simpler operation than orbital flights, the price per ticket can be dramatically reduced, and the initial tickets have already been sold at US$200,000, with the promise of prices dropping to US$100,000 and below fairly quickly. Figure 2 shows an example of a vehicle designed to provide a sub-orbital space tourism experience.

Source: Author.

Figure 2. Virgin Galactic SpaceshipTwo, Suspended Under its Mothership, Will Provide Sub-orbital Space Tourism Experiences.

This is the Virgin Galactic SpaceShipTwo. The photo shows the spacecraft suspended underneath the mother plane (known as WhiteKnightTwo). The mother plane carries the spacecraft to over 40,000 feet, drops it, and then the spacecraft, with its 6 tourist passengers, ignites its rocket motor and heads up to space, while the mother plane returns to pick up its next load of space tourists. The SpaceShipTwo/WhiteKnightTwo combination is undergoing flight testing at Mojave Spaceport, California, as this chapter goes to press.

To complete the description of the full spectrum of possibilities summarized in Table 1, we note that already a space tourist can enjoy high altitude jet flights for around US$20,000, and Zero-G flights in a specially converted airliner which flies in a parabolic trajectory, which provides a weightless experience to those inside for US$5,000. Spaceflight training simulators have been programmed to help train the new sub-orbital space tourist candidates, and some people have opted to buy a ride in a simulator even though they cannot afford the full experience of orbital or even sub-orbital space tourism. Looking beyond the initial space tourism offerings, we note that Space Adventures of Virginia, USA is putting together a mission to the Moon which will carry two space tourists paying US$150 million each. The modified Russian Soyuz craft will not land but will circle the Moon before returning to Earth. At the time of writing this chapter, one of the two tickets had already been sold. Beyond even the lunar experience, there is some discussion about a new kind of vehicle, included here for completeness, which would be able to take off, almost reach orbit, and descend anywhere on Earth within 45 minutes after take off. This is called a Point-to-Point sub-orbital space transportation vehicle, and while there are many concepts on drawing boards, it is not something that is technologically feasible within the next twenty years, and it may never be commercially feasible with its use restricted to government operations.

3. COMPANIES INVOLVED

With the possible exception of Virgin Galactic (whose parent company runs airlines), Bigelow (whose owner operates a motel chain), and Incredible Adventures (who have been providing extreme adventure travel for a number of years), the companies involved in the new space tourism business have little previous experience operating in the general tourism industry, and this of course will have some bearing on their ultimate chance of success, and certainly will lead to the need for tourism consultants to assist in the sector. Table 2 provides a summary of the new players whose combined efforts are set to bring about this new sector of the tourism business.

Table 2. Space tourism companies

Company	Location	Products and services
Space Adventures	Virginia, USA	Travel agency
Incredible Adventures	Florida, USA	Travel agency
Zero-G Corp	Virginia, USA	“Weightless” flights in special aircraft
NASTAR Center	Pennsylvania, USA	Sub-orbital and orbital space tourism simulator training
Virgin Galactic	California, USA	Sub-orbital space tourism in “SpaceShipTwo”
XCOR	California, USA	Sub-orbital space tourism in “Lynx”
SpaceX	California, USA	Orbital space tourism (possible) in “Dragon”
Bigelow Aerospace	Nevada, USA	Space hotels and private space stations
Sierra Nevada Corp	Colorado, USA	Space tourism in “Dream Chaser”
Blue Origin	Washington, USA	Space tourism in “New Shepard”
Armadillo Aerospace	Texas, USA	Sub-orbital space tourism

Source: Spaceport Associates, 2012.

Although all of them have US addresses, this new tourism sector is attracting global attention, as we shall see later when we look at the locations of spaceports. Furthermore, arrangements are being made for the space tourism spacecraft operators to use a string of approved sales agents around the world to market the tickets for the space flight experience. Space Adventures is the company which has arranged for all the space tourism flights to date, which as we have noted were all orbital flights, and all took place using Russian spacecraft. Incredible Adventures has provided a number of near-space experiences using high altitude Russian jet aircraft, in addition to their usual fare of swimming with the sharks, etc. Zero-G Corporation operates a specially modified aircraft which flies in repeated parabolic flight patterns so that inside the hull, the participants find themselves in a weightless environment and can “fly” from one end to the other like the comic book hero Superman. The series of flight patterns can be tailor-made to include flights providing one-sixth of normal Earth gravity, and thus simulate the experience of walking on the Moon. Martian gravity can also be simulated, if requested.

A number of companies are being set up (or modified from military use) to provide simulator training for potential space tourists. The simulators can be programmed to reproduce the environment experienced in either specific orbital or sub-orbital spacecraft. The NASTAR Center is already operating and providing services, and the waiting list of sub-orbital space tourists has already been using the facilities. The Space Shuttle is no longer flying, and there are only a limited number of available seats for orbital space tourists in the Russian Soyuz (because it is generally being used to deliver astronauts and supplies to the ISS).

Therefore several US companies are developing new spacecraft which can service the latent demand for orbital space tourism. SpaceX is the company which is most likely to succeed in doing this, using their spacecraft “Dragon” mounted on their launch vehicle Falcon 9. This combination has already flown into orbit and successfully returned the space capsule to Earth, and after a few more test flights, and after obtaining the necessary regulatory approvals, could begin offering spare seats to orbital tourists. The company Bigelow Aerospace, based in Las Vegas, has already placed in orbit two sub-scale prototype space hotels, known as Genesis, and the full-scale version will be able to serve as an alternative destination for orbital space tourists, who up to now have had to visit government space stations. The technology used by Bigelow is inflatable and modular. The anticipated residents will be either orbital space tourists or astronauts from countries who wish to have their own space station separately from the ISS.

Regarding the sub-orbital sector, a number of operators are very close to being able to offer service. Probably the first will be either XCOR or Virgin Galactic. We saw the Virgin Galactic offering in Figure 2, which involves a mother plane carrying the sub-orbital space plane (SpaceShipTwo) above forty thousand feet before the craft and its occupants are released and rocketed upwards to 62 miles (100km). The XCOR spacecraft takes off under its own rocket power from the ground and conducts the whole experience without the need for a mother plane. In the case of the Virgin Galactic offering, up to six passengers at a time can be carried into space, whereas the XCOR Lynx is a much smaller craft carrying only one passenger, who has the opportunity to experience the trip sitting alongside the pilot/astronaut. At least three other companies are working at designs that could result in space tourism vehicles - Sierra Nevada Corporation, Blue Origin and Armadillo Aerospace - and all three of them have produced hardware (and in the case of the latter two companies have actually flown the hardware). While this chapter was being written in fact, Blue Origin flew its prototype to 40,000 feet before the test flight was terminated due to control issues. Beyond these three, there are many more companies whose offerings, however, remain at the early design stage. An incidental consideration, with not insignificant consequences, is an awaited decision by the US regulators about whether or not sub-orbital space tourists will need to wear space suits. Meanwhile some firms (e.g., Orbital Outfitters) are already working at producing possible lightweight suits for the travellers.

4. COMPARISONS WITH EXISTING TOURISM SECTORS

In considering the potential business opportunity represented by space tourism, it can help to have in mind a comparison with other tourism or travel sectors. One such comparison which comes easily to mind is with the early days of aviation. Aviation began with the Wright Brothers in 1903, and the early aviators were risk takers who viewed the experience of flying as a courageous, adventurous and exciting endeavour. It did not take long before the general public also wanted to share that experience. The first airlines were created (KLM for example started operations in 1919) to satisfy that need. Only the very rich could afford to fly at the beginning, and the first airline flights were short and uncomfortable. By the end of the Second World War, it became possible for less wealthy folk to fly, often using war-surplus aircraft, and by 1969 it was even possible for the public to fly supersonically. Using this analogy, we note that private space flight is now at the very beginning of offering operations. The initial vehicles will be rather uncomfortable and very expensive. Only the very rich will be able to take advantage in the first few decades. However, as with aviation itself, the accumulated experience provided by these early space tourism operations will lead to more reliable and less costly opportunities in the future. It took thirty years after the first flight to arrive at the Douglas DC3 Dakota, which provided regular airline services for so many members of the general public. It is therefore likely that a similar timescale will pertain to the availability of space travel to the general public. The clock started with the first space tourist millionaire, Dennis Tito in 2001.

It could be argued, however, that this comparison with early aviation is a flawed analogy. After all, the purpose of aviation was to get from A to B. In the case of space tourism, the object is not to travel anywhere in particular, and in fact the first sub-orbital space tourism flights will land at the very same place where they had taken off. This is true in a general sense for orbital tourism ventures also. So, perhaps a better analogy might be the cruise experience, where the ship usually returns to its home port, after having provided a memorable experience to its passengers during the cruise duration.

This would certainly be a good comparison with the orbital space tourism experience, during which the space tourists (cruise passengers) have the opportunity to view most of the planet Earth from orbital altitude before landing. In fact they circle the Earth every ninety minutes. But, of course, orbital space tourism offers much more than a cruise (including weightlessness, and appreciating the fragility of Earth's ecosystem). The sub-orbital experience, in this comparison, offers a very short "cruise" indeed, with the flight in total lasting not much more than an hour. But the views will be so spectacular that they will forever change the perspective of those who are lucky enough to experience them. Of course, the sub-orbital space tourism operators will provide much more than a one hour flight, and will generally create an entire space tourism experience including training and simulations which will take several days to complete, and which will culminate in the actual space flight. From the topmost point of the sub-orbital trajectory, the passengers will be able to see for 700 miles in every direction. They will see the black sky, even in the middle of the day; they will see the curvature of the Earth, and the thin veil of atmosphere encircling the planet. And of course they will experience weightlessness.

A third type of comparison may also offer some guidance to the space tourism experience, where we see shortcomings in the airline travel, or cruise ship experience analogies. This third analogy is that of adventure travel, which is itself a fairly recent tourism phenomenon. Nowadays tourists sign up to climb Mount Everest, visit the Antarctic Continent, swim with sharks and rays or go bungee jumping or skydiving. Certainly, the parallels are evident at least with the initial part of the space tourism experience, i.e., the rocket flight. But particularly in the case of orbital space tourism, a significant part of the experience is the very opposite sensation to the high-g rocket launch, involving the subsequent zero-g floating experience and silence, and contemplation of the infinite.

So, perhaps we may conclude that since space tourism is so special, and initially rare, there is no single analogy which satisfactorily captures the experience, but the space tourists will be undergoing thoughts and experiences which resonate with at least three different analogues, and maybe many more. Furthermore, space tourism itself will take various forms and a single comparison cannot be expected to serve each and every version. This lack of a single analogue, combined with the absence of any historical data (at least in the case of sub-orbital space tourism) presents a problem in the realm of market research, as discussed in Crouch (2001).

5. MARKET DATA

Since space tourism is such a relatively new activity, how can we know about the likely demand for the future offerings? First of all, there is plenty of circumstantial evidence. We know from just about all of the astronauts who have so far been into space (about 500 in total) that the experience was transforming, and that they all want to go back again. We also know, from the accounts of those on the short list of orbital space tourists who have so far each spent over US$20 million to go into space, they did not regret for one moment having spent that money. Indeed, one of them (Dr. Charles Simonyi) enjoyed it so much that he paid again to take a second orbital space tourism trip. Furthermore, there is a well-publicized waiting list of 400 folk who have paid deposits to take sub-orbital flights in SpaceShipTwo with Virgin Galactic as soon as it begins to operate (probably in 2013). The future astronauts on this Virgin Galactic waiting list have all signed up to pay US$200,000 for their upcoming experience. There were some early market studies (Collins et al., 1994; O'Neil et al., 1998) which provided a tempting indication that the future demand might exist, but they were very generic and not performed in a statistically valid way which would be needed to convince a venture capitalist to invest.

Collins et al. (1994), for example, conducted a series of market surveys in Japan, US/Canada, Germany and the UK. The initial research in Japan was conducted on 3,030 people in 1993 and 45% of those older than age 60 and 80% of those younger than 60 declared an interest in going into space. About 20% declared they would spend 1-year's pay for the opportunity. Females, on average, polled about 5% points lower than males in their responses. A telephone survey update in Japan in 1996 interviewed 500 respondents, 7 of whom indicated that they were prepared to pay between US$40,000 and US$80,000 for a space tourism experience. When the same basic survey methodology was used in the USA and Canada in 1995, 61% of the 1,020 respondents declared an interest in space tourism with 10.6% indicating they would pay 1-year's pay for the privilege. In the case of Germany, where the survey was replicated in 1996, 43% of Germans expressed the wish to experience space tourism, and in UK in 1999 the same survey approach, but using only a very small sample of 72, found 35% of the respondents were interested, with 12% offering to pay 1-year's salary for the opportunity.

1,500 US families were surveyed by O'Neil et al. (1998) in 1996 for a joint study funded by NASA and the Space Transportation Association. The survey found that 34% of respondents would be interested in taking a two-week vacation in the Space Shuttle, and 7.5% would pay US$100,000 or more to do it. Again, there was no attempt to obtain a truly random sample for this work, nor any way of knowing if those saying they would spend US$100,000 could actually afford to do so. So, for serious business planning purposes, high quality market data from statistically valid surveys were needed. These surveys needed to be conducted randomly with care among people wealthy enough to afford the experience, and the survey questionnaires needed to provide an unbiased account of the potential space tourism experience, with realistic price points. Fortunately, there are a few such surveys which can provide usable data, and which have been credited with forming the basis of many of the business plans for the new space tourism companies (Beard et al., 2002; Webber & Reifert, 2006; Le Goff & Moreau, 2011; Kothari & Webber, 2010; Devinney et al, 2006; Charania et al., 2006) and which when taken together provide a good perspective on the range of possible space tourism demand projections.

The first step in the derivation of the Futron/Zogby forecasts (Beard et al., 2002) was to consider the wealth demographics of the potential space tourists, so that they could be targeted for the surveys. The main deciding element in establishing these wealth demographics data was to know the price points for the proposed services. In the examples used the orbital space tourism price was assumed to be US$20 million for a two week experience, and the sub-orbital space tourism flight was assumed to be priced at US$100,000 (for a straight up-and-down space experience above the spaceport). It was assumed conservatively that in general folk will not pay more than about 1.5% of their net worth for a sub-orbital space tourism experience (and this assumption was tested by a series of questions within the overall survey related to past expenditures on vacations and automobile purchases, etc.). Therefore, in order to pay out US$100,000 as a ticket price for a sub-orbital space flight, the potential space tourist must have a net worth of at least US$7 million. The data obtained at the time of the survey in January 2002 indicated that there were about 1 million people globally with at least that amount of net worth. For the orbital space tourism experience, with a ticket price of US$20 million, the data suggested that the first orbital space tourists had paid 10% of their net worth for the experience. So, to be able to pay US$20 million for a ticket, under this assumption, a net worth of US$200 million or more would be needed. And also at the time of the survey there were known to be about 6,000 people globally in that wealth category. With this basic information to hand, the questionnaires were designed and the interviews took place with the statistically valid representative sample of millionaires (more specifically defined as having yearly incomes that exceeded US$250,000 and/or net worth exceeding US$1 million).

The interviews for the Futron/Zogby survey took a half hour over the telephone with each of the millionaire respondents. There were 61,981 attempts by the interviewers working within the sample population in order to arrive at the 450 completed surveys required to provide the statistically valid sample of the millionaires with a margin of error of +/- 4.7%. For reasons of cost, the survey was conducted solely within the US, but had wide regional sampling using Federal Reserve based data. Because of the vastly different experience and ticket cost involved, the respondents were presented with two space tourism scenarios to consider; one was a sub-orbital trip, and the other was a two-week orbital trip. To ensure realism, the mission descriptions were verified by a former Space Shuttle Commander, and indeed he provided a series of negative consequences of spaceflight, including nausea, dizziness and lower backache. The respondents gave their replies both before and after hearing the negative aspects, and there was as expected a lowering of the response rate accordingly.

In developing the forecasts, a conservative approach was favoured, and so it was the set of lower numbers, derived after the negative information had been provided, which were used as the basis for the calculations. Also, in deriving the forecasts, only results pertaining to the "Definitely Likely" responses were used, thus excluding those replying "Very Likely" and "Somewhat likely" to the questions. Table 3 provides some insights into the characteristics of the potential space tourists that were mostly derived from the Futron/Zogby surveys.

Table 3. Space tourist characteristics

Characteristic	Description
Motivation	Pioneering; Seeing Earth from space; Adventure
Age	Average 53-55
Gender	89% Male (orbital); 72% Male (sub-orbital)
Geographical	Asian interest approx. 1/3 of US/Europe
Risk Activities	2% Skydiving; 16% Mountain climbing; 48% Skiing
Vacation Time	43% take 2-3 weeks; 37% take a month or more
Other	41% - 57% of these millionaires work full-time

Source: Beard et al., 2002; Webber & Reifert, 2006; Le Goff & Moreau, 2011; Spaceport Associates, 2012.

The motivation of the tourists varied somewhat. Some of them wanted to be pioneers (and presumably that portion of the market base would diminish through time as more and more people became space tourists). We shall see later that it is expected that more people will go into space in the first full year of sub-orbital space tourism than have gone into space in all of the years combined since Yuri Gagarin's flight in 1961. It was learned that generally it takes time to amass the amount of wealth needed to be able to pay for a space tourism ticket, so the average age of the tourists will be in the 53-55 range, and they will generally be predominantly male, at least initially. Many of the potential tourists already undertake some risky activities, such as the 48% who go skiing. One potential problem with orbital space tourism is the amount of time needed to undergo the necessary training and medical testing. The initial orbital space tourists had to use up at least six months for this purpose (in addition to learning to speak Russian). The data from the survey indicated that this amount of time is significantly more than the time usually allocated by this group to vacations, with only 37% taking even a month or more. Once orbital space tourism can be conducted from the US, there will be a need to streamline the training process to fit in with the busy lives of the participants (the survey data indicate 41% - 57%

work full-time). The initial survey was undertaken by (fixed line) telephone entirely in the US (with care being taken to ensure a balanced regional spread).

Because the sample of 450 millionaires undertaking the survey had been truly randomly selected to be representative of the population of millionaires at large, it was a relatively easy process to gross up the survey data to derive global demand forecasts for the space tourism experience (although this approach ignored any potential differences that might be the result of global cultural diversity –and Table 3 carries some data from another survey Webber & Reifert (2006) which did indeed highlight such differences). The respondents therefore had no a priori inclination to undertake space flight and they had not been selected from a pool of people who in some way were non-representative through e.g., being visitors to space conferences.

Price elasticity of demand data was derived from having the respondents provide their level of interest at a range of price points. For sub-orbital space tourism, the centre point was US$100,000 and the range was from US$250,000 down to US$25,000. In the case of orbital space tourism, the respondents were questioned around a centre point of US$20 million, with a range from US$25 million going down to US$1 million. Again, in order to ensure realism in the findings, the respondents were also offered alternative ways to spend the ticket money for both the sub-orbital and orbital space flight experience. For sub-orbital, these alternatives included dream vacations and sports cars, and for orbital they included exotic homes, yachts, etc. Amongst the reasons given by those respondents who declined the flights were “too expensive” and “danger/risk” and the respondents giving these replies said that they would opt instead to invest the ticket price money, again providing a certain level of credibility to the findings.

The methodology used for the Adventurers’ Survey Webber & Reifert (2006) conducted in 2006 was not as rigorous statistically as had been the case for the Futron/Zogby Survey, and consequently did not lead to a new estimate of global user demand. Instead of using a telephone survey with a statistically valid sample of millionaires, for the Adventurers’ Survey, the 998 respondents were chosen a priori to have an interest in adventurous activities. Their origins were 63% US, 17% Europe, 6% Canada/Mexico, 5% Asia, 4% Australia/New Zealand and 3% Others. They responded to questions in an on-line survey, and the survey was hosted on the website of Incredible Adventures. These respondents, therefore, were familiar with adventure vacations, and 30% of them had already experienced mountain climbing, and 22% had tried skydiving. They provided some detailed responses to some aspects of the space tourism experience not covered by Futron/Zogby. For instance, regarding the design of the space tourism vehicle, they made a clear preference for landing horizontally on land (53%) compared to the alternatives of landing vertically on water (9%) or vertically on land (8%). The result of studying the responses for geographic preference provided a significant difference for Asian compared to US/European respondents, with the gross market figure being only a third of the level of interest for the Asians. The Adventurers’ Survey also provided information on Corporate Tourism (where there was a drop in take-up compared with personal preferences - because of the perceived potential risk there would be some reticence in authorizing such an award). Interestingly, when asked about orbital space tourism, assuming no difference in price with increasing time in orbit, there was a general preference for only a two week mission maximum (70%) with the remainder opting for a month or longer.

For the Australian Survey (Crouch & Laing, 2004; Crouch et al., 2005; Crouch et al., 2009; Devinney et al, 2006) conducted in 2005, a Discrete Choice methodology with information acceleration was used. Data were collected from a sample drawn from an online consumer panel of more than 300,000 Australians who opt to participate in surveys, and who receive payment for participating. 783 online surveys were conducted, statistically matched to the Australian population, with the survey focusing on sub-orbital space tourism. Although the sample was not targeted at millionaires, nevertheless 13% of the respondents had over US$200,000 income, 28% had assets between US$1 million and US$2.5 million, with 7% having even more. The findings were a 10% interest at US$200,000, 20% interest at US$50,000 and 30% interest at US$20,000 for the sub-orbital space tourism experience. The researchers also analysed responses to risk using the Zuckerman Thrill and Adventure Seeking (TAS) Scale which showed that "Extreme Treckers" are more likely to go (with for example an increase in the suborbital response from 14% to 17% for this category). Although the majority of respondents would be prepared to pay only between one to three month's salary, 12% indicated they would be willing to forego a year's salary or more for a space tourism experience. The study also determined that potential Australian consumers would prefer American or Australian operators to those from Japan, Germany, the UK or Russia, and that males and younger individuals are more likely to take a space tourism adventure. The range of prices explored in this study varied from US$200,000 down to US$10,000 for a sub-orbital flight. The methodology of the study makes possible an examination of how individuals make trade-offs between different types of space tourism, and between the feature levels associated with each type, but did not lead to a published global demand estimate. The study report (Devinney et al, 2006) contains a great deal of detailed results with associated standard deviations.

Spaceworks Enterprises (SEI) (Charania et al, 2006) chose a different approach using agent-based modelling as part of a NASA-funded project, called the SEI Economic Development of Space (EDS) Study in 2005. Agent based modelling (ABM) can provide solutions by allowing the modelling of dynamic interactions. In the model, each potential service provider company autonomously decides its pricing strategy given its unique capacity, costs and vehicle characteristics. The model outputs the financial health of the competing companies and explores supply/demand effects, customer preferences, etc. A series of workshops was conducted amongst experts in the commercial spaceflight domain, and during the course of the workshops, data were collected which became inputs to a suite of forecasting models, known as Nodal Economic Space Commerce (NESC) Models. For the sub-orbital space tourism sector, the model inputted the Futron/Zogby demand curve data, but opted to combine the findings for "Definitely Likely" as used by Futron/Zogby, but also added in those for "Very likely" and "Somewhat Likely", hence resulting in a higher forecast of 53,000 customers per year at peak, compared to 15,000 per year from Futron/Zogby. For the orbital space tourism sector, the researchers collected the views from a Delphi survey of 6 "Experts" and 99 "Space aware general public" and these data were used to determine the range of possible forecasting parameters to be input into the NESC Model. The demand results for orbital space tourism from this approach were 15 to 20/year passengers at the US$20 million ticket price, 35 to 50 passengers/year at a US$10 million price, and 80 to 150/year for a US$5 million ticket for an orbital space tourism opportunity. The study also found that the consensus on safety was that space tourism needs to be "as safe as a military fighter".

For the orbital demand forecasts of the Astrox/Spaceport analysis (Kothari & Webber, 2010) the method was to use the Futron/Zogby data with an extrapolation to lower price values below the US$1 million lowest point of that survey, with US$1/2 million being the main focus for the study. This work led to the conclusion that the most significant effect of lowering prices below US$1 million is to dramatically increase the available pool of people who can even consider the spaceflight experience. As Table 4 records, the demand for orbital space tourism seats goes up from 50/year at US$20 million (Beard et al., 2002) to 14,000/year at US$1/2 million (Kothari & Webber, 2010).

The most recent (2011) substantive survey, referred to as the Astrium/IPSOS survey (Le Goff & Moreau, 2011) used yet another technique to develop its demand analysis projections. The survey focused only on sub-orbital demand, however. The methodology first involved a qualitative stage, where 12 in-depth one hour interviews were conducted in 2007 among high net worth individuals who had expressed an interest in a sub-orbital trip. 6 were conducted in the US, 2 in the UK, 2 in France and 2 in Germany. This was followed by a quantitative stage, where 1,850 people, representative of high net worth individuals, were interviewed online through a questionnaire that was sent to them through the Internet. Amongst the respondents, 77% had a net worth of more than US$1 million (in addition to their main residence) and 24% had a net wealth of more than US$10 million (in addition to their main residence). The quantitative stage was conducted in two parts – first of all, in 2007, 1,250 people were interviewed with the geographic breakdown US 400, Japan 300, Germany 150, UK 150, France 150, Italy 50 and Spain 50. A second set of 600 interviews was conducted in 2010 as follows: China 150, Hong Kong 150, Singapore 150 and Australia 150. All of the interviewees, as with the Australian studies (Devinney et al, 2006), belong to online Access panels, and were interviewed online. The subsequent forecasting model produced separate forecasts for each region before aggregating them. And in fact by varying different parameters 80 models were estimated for each region. The final forecast estimates were calculated by taking the average of 70 of the models, leaving aside the 10% extreme ones. The results were then scaled up to the real population of high net worth individuals using Cap Gemini and Merryl Lynch Wealth Report data. The conclusions of the survey were that in the surveyed countries the ultimate market for sub-orbital space tourism would reach between 43,000 and 85,500/year, although it is not absolutely clear from the reference source whether the price level assumed was US$200,000. To arrive at these forecasts, however, the penetration does not need to exceed 4.5%. The survey also provided the geographic spread data that Americans and Chinese are the most enthusiastic with an estimated 20% of Americans with net wealth between US$25 million and US$50 million being interested in participating in a suborbital trip. The equivalent figure is 10% for Europeans or Japanese. Table 4 provides a summary of these space tourism demand data from a variety of sources.

Table 4. Demand for space tourism

Type	Price (In US$)	Passengers (In number per year)	Sector's revenue (In US$)	Reference
Sub-orbital				
	100,000	15,000	1,500,000,000	Beard et al. (2002)
	100,000	43,000	4,300,000,000	Le Goff & Moreau (2011)
	100,000	53,000	5,300,000,000	Charania et al. (2006)
Orbital				

	20,000,000	50	1,000,000,000	Beard et al. (2002)
	500,000	14,000	7,000,000,000	Kothari & Webber (2010)
	5,000,000	80-150	400,000,000	Charania et al. (2006)
Space Hotels – incremental business beyond orbital				
Type 1 (capacity 12)	5,000,000	70	350,000,000*	Bigelow Aerospace (2011)
Type 2 (capacity 24)	5,000,000	400	2,000,000,000*	Bigelow Aerospace (2011)
Lunar				
	150,000,000	2	300.000.000**	Anderson & Piven (2005)

*Some customers for space hotels are sovereign countries and the price is assumed to be a US$5,000,000 premium above the orbital price.
** For single flight.

Source: Author.

In round numbers, the data indicates an eventual annual demand of between 15,000 and 53,000 per year for sub-orbital space tourism priced at around US$100,000 per ticket, and between 50/year orbital space tourists at current prices increasing to 14,000 per year if prices can be brought down to US$1/2 million (which might be possible, although not for at least a decade). One can appreciate from these data that private space flight is a very price elastic phenomenon, and this is at least partly due to the fact that as ticket prices are reduced, a significantly non-linear effect is introduced because so many more people exist who are potentially capable of paying for the flight at the reduced price level; there are about 8 million millionaires in the world today, but only about a thousand billionaires. Of course, there will need to be a build-up curve to achieve the eventual indicated level of demand, and it may take 10 to 20 years from now before these levels of demand are achieved. The shape of the S-curve will be determined by the usual combination of effects, such as the amount of advertising, the amount of capacity, the number of competitors offering service, etc.

Given the wide selection of techniques used, it is some comfort to derive results in Table 4 with so much in common, which indicates that there is indeed a real space tourism demand at the price levels currently being quoted, and considerable upside once price levels can be brought down. The data on geographic variations (Webber & Reifert, 2006; Le Goff and Moreau, 2011) indicate that, at least in this early stage, there are considerable regional and cultural differences in space tourism demand. Japanese respondents, for instance, have expressed a strong interest in weddings in space.

6. INFRASTRUCTURE NEEDS

It is perhaps somewhat unusual among tourism sectors, but for space tourism to even be possible, there is a need for certain elements of infrastructure on which it can be based. Some of the infrastructure is physical, and some of it is regulatory in nature. In the US, Congress passed a law (the Commercial Space Launch Amendments Act –

CSLAA of 2004) which established the necessary regulatory regime for space tourism to take place. The appointed US regulatory agency within the Federal Aviation Authority is known as the FAA-AST, and the governmental mandate establishes certain requirements before the industry can operate. For instance, all potential space tourists must be fully informed of the risks, and they must sign an indemnification of the Federal Government in the event of an accident. Furthermore, they must receive a few elements of basic training. It is the responsibility of the regulating agency to ensure that no member of the uninvolved public is killed or otherwise injured by the space tourism activities. The FAA-AST concerns itself with licensing spaceports and in providing permits for the spacecraft manufacturers to enable them to test their vehicles and train their astronaut/pilots. In general, for a spaceport to meet the regulatory needs of protecting the uninvolved public, it is best located in a remote area. There is also a need to ensure a seamless connection with the existing air traffic control services, so that they can handle the situation when several times a day, manned rocket planes will head up into space above spaceports, and then return to base as gliders crossing all the upper flight levels normally used by airliners. A discussion of the current state of the debate on the legal aspects is provided in Mosteshar (2011). Table 5 provides a summary list of potential space tourism spaceports, and it is evident that many of the locations are outside US territory. However, we should note that in these cases, there is yet to be established the necessary regulatory regime to even make the use of such spaceports possible. Nevertheless, many countries are considering the potential economic and employment benefits of having their own space tourism spaceports.

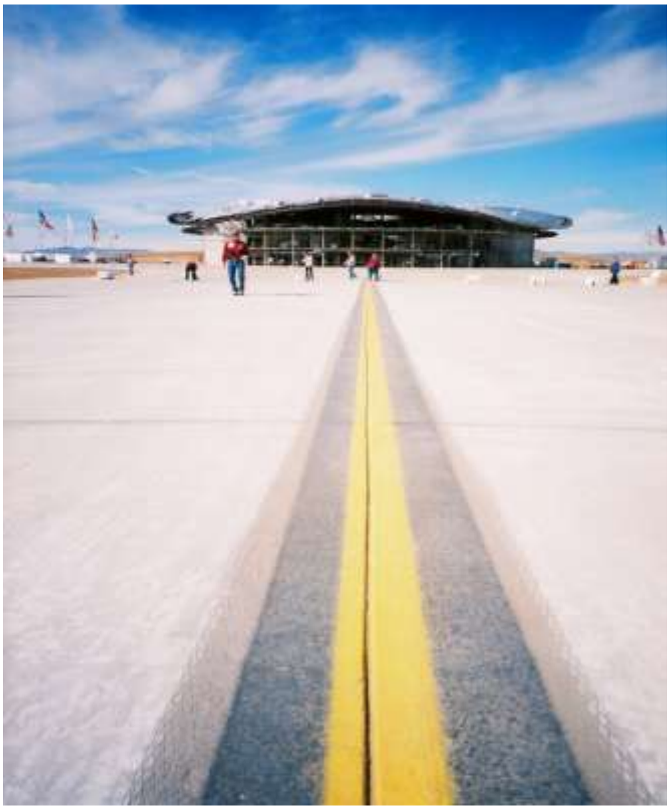
Table 5. Global spaceports

Spaceport	Country-location	Notes
Americas		
Mojave	Mojave, California	Operating spaceport
Burns Flat	Oklahoma	Capable of operation
Spaceport America	New Mexico	New facilities almost complete
Hawaii	Hawaii	Concept only (for Rocketplane)
Caribbean Spaceport	Curacao	Concept only (XCOR)
Europe		
Kiruna	Kiruna, Sweden	Existing ESA Rocket range
Lelystad	Lelystad, Netherlands	Concept only (for Rocketplane)
Barcelona	Barcelona, Spain	Concept only
Scottish Spaceport	Lossiemouth, UK	Concept only (for VG)
Bordeaux	Bordeaux, France	Concept only
	Middle East/Asia	
Dubai	Dubai, UAE	Concept only (for VG)
Singapore	Singapore	Concept only (for VG)
Japan	Japan	Concept only (for Rocketplane)

Source: Spaceport Associates, 2012.

Within the US, Mojave spaceport is the location where the sub-orbital test flights of Virgin Galactic's SpaceShipTwo and XCOR's Lynx are taking place. Burns Flat in Oklahoma has been licensed to provide space tourism operations, and initially the company Rocketplane Corporation was based there, but since that company suffered financial difficulties, at present there is not a viable space tourism operator based there. Spaceport America is being built in the desert 55 miles north of Las Cruces in

New Mexico (Figure 3) and is tailor made to become the US base for Virgin Galactic sub-orbital operations once it is completed. The runway has already been completed, and dedicated, and a large part of the hangar structure has also been built. There are concepts in Hawaii and in the Caribbean for sub-orbital spaceports in the region.



Source: Author

Figure 3. Spaceport America Nears Completion in New Mexico. The Futuristic Terminal-hangar Provides 110,000 Square Feet of Space for Virgin Galactic, its First Anchor Tenant.

There are several criteria involved in the siting of a spaceport for sub-orbital spaceflight, and an important one is the view which the tourist will receive at the peak of the flight. Hawaii and Curacao would both offer splendid views, provided all the other considerations can be satisfied. Within Europe, perhaps the Kiruna spaceport is the most likely to proceed, since they have been having discussions with Virgin Galactic for some time, the area is already used for rocket launching, and it is remote from large centres of population. Potential space tourists from Kiruna might even be able to see an Aurora Borealis from the inside. The other European locations are only at the concept stage, and whether they are ultimately developed will to a large degree depend on the success of the space tourism business operating from the earlier spaceports (and the extent to which the European governmental entities decide to create a regulatory framework to enable space tourism operations from that continent). There are potential spaceports elsewhere in the world, whose ultimate fate will to some degree mirror similar factors at the potential European spaceports.

It is of value to consider the case of Spaceport America (Figure 3), situated on 27 square miles of state-owned land in New Mexico, in more depth, because it is the first purpose-built facility for this new industry, and the example provides useful timeline data. The facility is located approximately 45 miles north of Las Cruces. First of all, it is perhaps worth noting that New Mexico has a long tradition of being supportive of new space endeavours, with both Robert Goddard (1929) and Wernher Von Braun (1946) having used the New Mexico desert for conducting early rocket launches, because of the stable weather and dry climate, and the high elevation (4,600 feet altitude). The White Sands Missile Range is close by the new spaceport, and its facilities were used for an alternative emergency landing field for the NASA Space Shuttle. Spaceport America will be able to take advantage of the proximity of White Sands, and in particular to its restricted airspace from ground level to infinity. After the success of the X-Prize in 2004, when the SpaceShipOne designers won the US$10 million prize, its organizers created an annual event, called the X-Prize Cup, to continue to reward developments in commercial private access to space, and the Cup events took place in New Mexico. In 2005, the then Governor of New Mexico Bill Richardson reached an agreement with Richard Branson of Virgin Galactic (VG) to build and operate Spaceport America with VG as an anchor tenant. The New Mexico Legislature ratified the agreement and enacted laws to enable the spaceport project to proceed. In 2007 the competition for a design for the spaceport was awarded to URS/Foster and Partners who provided an environmentally sound design which blends in with the local desert terrain. In 2008, the US Government, via the Federal Aviation Administration (FAA) awarded a launch site operator license to Spaceport America, and Virgin Galactic signed a 20-year lease agreement to use the spaceport, agreeing to make New Mexico the locality of its world headquarters. Groundbreaking began in 2009 and the 10,000 foot runway construction began in that year. In 2010 there was a runway dedication, during which the WhiteKnightTwo landed, carrying with it the SpaceShipTwo development model. The runway is 200 feet wide by 10,000 feet long and 42” thick with a 14” concrete finished surface. In 2011 there was a dedication ceremony for the main hangar complex, known as the Terminal Hangar Facility (THF). The THF provides 110,000 square feet including 4,000 square feet for a public viewing gallery.

There is still, in 2012, the need to provide more infrastructure, particularly an access road from Las Cruces, Visitor Centres and hotels. The estimated construction cost to date has been US$209 million and the new access road is estimated at a further US$11 million. The millionaire space tourists (and probably their families and friends) will need to be accommodated and taken care of during the 3-4 days required for the training at the spaceport. Advantages of the location include the low population density and the benefits of the controlled airspace enjoyed by White Sands Missile Range. Funding was provided by the State of New Mexico, whose Legislature had a surplus from energy reserves, and spent US$140 million from the state general fund, and issued bonds for the rest. Additional funding came from voted tax increases by the generally low-income desert dwellers from adjoining counties, who see the Spaceport as a benefit for their children and grandchildren of future generations, due to the assumed employment opportunities (to be discussed in the next section of this chapter). These residents and voters in Dona Ana and Sierra Counties agreed to pay 25 cents on every US$100 of sales to help meet the debt service for the spaceport.

With regard to the future of orbital space tourism, beyond its limited status at present using occasional spare seats on Russian Soyuz craft, there remains to be some further development of the role, pricing and operational model for the space hotels. At present, all orbital space tourists have used governmental space stations (for free) as their destination. This is not a sustainable model for an industry. Bigelow Aerospace has demonstrated that the technology exists to build commercial space hotels, but how would they be manned? Who would look after the life systems on board, and take care of medical emergencies? Who would arrange for the food, water and other supplies to arrive in orbit? How much of a price premium, over and above the price to get into orbit, would an orbital space tourist pay to have access to the space hotel, and what would they expect to find there? Would there need to be the equivalent of a cruise manager in the maritime cruise tourism comparison, or would orbital space tourists want to be left alone? These are questions yet to be resolved but which are clearly germane to the growth of an orbital space tourism business beyond the one per year tourist that exists today. For orbital spaceflight, there are also additional criteria to be considered in the sitting of the spaceports, in particular to ensure that the whole profile of the flight path, as the spacecraft heads into orbit, does not overfly areas of concentrated population. It is for that reason that many traditional orbital spaceports today (e.g., Kennedy Spaceflight Centre) are located in coastal sites.

7. DEVELOPMENTAL CONSEQUENCES OF SPACE TOURISM

There is an inherent conflict in the location of spaceports. On the one hand, it is necessary to be in a relatively remote place (like Spaceport America) in order to obtain the regulatory approvals to launch. On the other hand, there is a need to have public access so that revenues may be generated from the terrestrial tourism component, where the public sees the spaceport as a destination in its own right, and wish to be able to visit to see the flights and be entertained and educated. One remembers the early days of aviation when airports all had observation lounges to satisfy the public's need to see the airliners landing and taking off, and indeed it was a favourite day out for many to eat at an airport restaurant. There are expected to be many advantages to having an operating spaceport in a region (especially employment-related) (Federal Aviation Administration, 2001). Visitors to the spaceport will require hotels, restaurants, bookstores, IMAX movie experiences, tours, etc., all requiring a labour force. Some associated industries would be expected to relocate to the vicinity of the spaceport, bringing their own workforce needs. There will be many support services (Federal Aviation Administration, 2008) associated with the spaceport activities which will also result in positive economic impacts. Among those listed in the referenced document are communications, surveillance, space traffic control, navigation, meteorology and technician training services. On the negative side, a spaceport located in the middle of a desert is to some degree destroying a pristine location and maybe even habitat. Special arrangements have to be made at Mojave Spaceport, for example, to protect the desert tortoise. During engine testing, one can expect to have noise pollution (which of course to aficianados is not regarded as pollution at all, but is a big plus for the experience). Certainly during the construction phase, there is the potential disturbance from all the truck loads of equipment negotiating the desert tracks and small local communities.

At Spaceport America, in addition to Virgin Galactic, the following companies will be paying lease fees- Lockheed Martin, Moog-FTS, UP Aerospace, Microgravity Enterprises, Armadillo Aerospace, Celestis. During the construction phase approximately 500 plus workers were employed, and the New Mexico Spaceport Authority expects approximately 25-50 long-term jobs at the facility. Virgin Galactic will have between 75 and 150 people at the spaceport. In addition there will be hotels, restaurants and tour operators who will benefit. In general, the business model of the New Mexico Spaceport Authority is that the facility is designed to produce positive revenue for the State of New Mexico via economic development, tourism and educational opportunities. Revenues from the site itself will include lease fees, user fees and merchandising/tourism revenue. Economic and job creation revenue will come from on-site employment and supply chain jobs, which in turn generate new tax revenue for the state via income, property and gross receipts taxes. Economic impact studies in 2007 predicted that the existence of the spaceport would create as many as 3,460 jobs. Former Governor Richardson is still confident and says Mac (2011) "it will be a linchpin not just for jobs but science education and technology companies to come to the area. It is going to revive the economy of Southern New Mexico". Income projections for Spaceport America include US$5.3 million from Virgin Galactic in 2014. By 2016, operating income from all sources will total US$8.3 million and expenses will be US$6.9 million, according to Spaceport Director Christine Anderson (Mac, 2011).

8. ISSUES AND CHALLENGES

Space tourism is clearly going to happen. It already does happen to the extent that the orbital space tourists have been flying since Dennis Tito in April 2001. There will probably not be any significant growth in numbers of orbital space tourists for at least a decade (until ticket prices can be reduced to about US$1/2 million). On the other hand, sub-orbital space tourism is about to begin, probably by 2013, and will dramatically change the scale of space tourism operations, eventually reaching over 15,000 passengers per year (even assuming price levels remaining as high as US$100,000 per ticket). The most recent forecasts (Le Goff and Moreau, 2011) place the demand figure as high as 43,000 passengers per year. What are the issues and challenges that must be faced in order for space tourism to take its place amongst the other more established tourism market sectors? What will be the scale of the terrestrial component once the new spaceports start operating? This important variable is largely unknown right now, and therefore spaceport operators must monitor visitor traffic, and ramp up the facilities as required.

The first issue is the need for the continued successful development of the test programs of the potential space tourism vehicles, with the implicit availability of funds to carry this out. Normally, in the development of space vehicles, the costs are entirely carried by governments, but in the case of private commercial spaceflight that is not the case. There has been some government funding, but private financing has been necessary to reach the present stage. There is an inherent conflict, therefore, in completing the test program. With governmental spacecraft and relatively unlimited funds, test flights simply continue indefinitely until all aspects of a design have been fully explored. With commercial developers, there is a need to minimize the number of test flights to save costs and to simultaneously bring forward the date of revenue earning operations. Of course, it is the role of the regulator, in the US case that is the FAA-AST, to balance these opposing tendencies. It is not in the interests of a space tourism operator in any case to endanger the lives of customers by flying a craft before it is ready, and so they will want to see that sufficient testing is done to ensure the safety of passengers. So, the issue and the debate will be about what is considered "sufficient".

Another unresolved issue at this time is whether sub-orbital space tourists will be required to wear spacesuits. In this case, the regulator has not made a specific request, so the operator must decide. If the spacecraft is dual-walled and considered safe enough to fly in a shirt-sleeved environment (perhaps with auxiliary oxygen) then spacesuits may not be required for safety reasons during the relatively short time that the space tourists will be in the space environment. However, they may still be introduced for marketing reasons (customers want to be thought of as astronauts, the suits could be specially designed for lightness with company logos, the customers may want to buy their spacesuit as a memento, etc.).

A major concern is the reaction after the first accident, especially if it involves fatalities. How will the press report it? How will the families of the rich, deceased space tourists react? Will there be a call for tightening the regulatory environment to a point where it is no longer commercially viable to offer the space tourism services?

Ultimately, almost by definition, space tourism must be a global business. However, at present, only the US has put in place a regulatory regime to enable this industry to become established. So there is a challenge to convince other governments, probably starting with European entities, to act accordingly in their own interests in order to take a share of the revenues to be generated from space tourism.

Finally, and perhaps this should really be the first on the list, the industry must ensure that the first of the new group of sub-orbital space tourists have a wonderful experience, which they can share with their friends and family (either later, or even in real time via suitable communications technology). The sub-orbital space tourists need to feel that they have received value for money, and that they have earned a footnote in history as pioneers of this new industry. They need to feel that they are repeating the experience of America’s first astronaut, Alan Shepard, as he also made a sub-orbital lob at the start of the space age in 1961. The first custom-built spaceport, in New Mexico, needs to be an economic and employment-generating success in order to repay those New Mexico taxpayers whose contributions made Spaceport America a reality. Everyone who visits the spaceport complex must receive a memorable and ideally uplifting experience so that they also pass on the word to their friends and family. Because the idea is that the spaceports will become tourist destinations in their own right, the challenge will be to phase in the public attractions at the spaceports (e.g., IMAX movie screens, simulators, etc.) in coordination with the rate at which the spaceflights from the spaceport increase over time. Early revenues from the spaceports should ideally therefore even precede the first spaceflights from the spaceport. Only time will tell how big a tourist destination will be the spaceports themselves, once they start operating.

9. CONCLUSION

The chapter has described the parameters of the incipient space tourism industry, and how it relates to other more traditional tourism activities. Although destined to remain a small sector of the tourism business (only a few billion dollars annually) for at least the next twenty years, it does nevertheless represent a considerable growth opportunity, starting as it does from a very small base.

Sub-orbital space tourism will commence in around 2013 and be the way that significant numbers of the general public can experience what only 500 government astronauts have experienced since the dawn of the space program. The number of new people entering space in the first year of sub-orbital space tourism operations will exceed the total number of astronauts flown in the first fifty years of human spaceflight. Prices will start around US$100,000 (quoted by XCOR) and can be expected to drop in subsequent years as the operators begin to assemble the experience of flying regularly into space.

Orbital space tourism will always be the ultimate preferred kind of space experience, and steps are in place to make it more available, although price levels will remain very high (above US$10 million) for at least another decade. The availability of orbiting space hotels, with their as-yet undeveloped support infrastructure, will be a necessary pre-condition to any significant increase in orbital space tourism flight rates.

There will be other forms of space tourism, further off into the future, and flights to and around the Moon, provided that the sub-orbital space tourism experiment results in a viable commercial operation. The US governmental human spaceflight program is undergoing a major reassessment right now, and it is no exaggeration to say that a paradigm shift from government owned launch vehicles to the use of taxi rides into orbit for US government astronauts depends upon the success of this new space tourism industry. The operators will get their experience with the sub-orbital space tourism flights, and become efficient at airline-like operation for rides into space, and then subsequently develop the orbital tourism capability.

At the spaceports, and in their locality, there will be economic benefits due to the requirements for direct and indirect labour both for creating and subsequently operating the facilities, and supporting the anticipated terrestrial tourists who will be wanting to visit the spaceports. The exact nature of the visitor facilities that would enhance the attractiveness of these new tourist venues has still to be decided, as indeed is the likely number of terrestrial tourist visitors who will add spaceports to their list of favoured destinations. There will also be some downside consequences in terms of noise pollution in previously relatively pristine environments.

Much work, therefore, still remains to be done in characterizing and quantifying the likely developmental and economic effects of the coming space tourism industry.

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