UNIVERSITY OF LJUBLJANA
FACULTY OF ECONOMICS

MASTER'S THESIS

# "OUT OF THIS WORLD" BUSINESS: CORPORATE INITIATIVE FOR SPACE TOURISM

Ljubljana, March 2014 JAN KRIŠTOF RAMOVŠ

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# INTRODUCTION

It has been more than 50 years since the launch of the first satellite, Sputnik 1, and a little more than 40 years since the most recent manned mission to the Moon. Following World War Two, the so-called Space Race developed, where the U.S.A. and Soviet Union vigorously fought to put the first satellite into orbit, as well as an astronaut into space and finally conquer the furthest reaches of Moon's landscape. Since then, civilization has steadily progressed in its exploration of space, sending astronauts and satellites into earth's orbit and space probes beyond it. Indeed, the space phenomenon is one of the most intriguing components of contemporary human history, not only due to popular culture in films and books, but also in aiding people in everyday life. Developments of communication and navigation technology which directly arose as a result of human space activity, have surely led to many economic and social advances (Excell, 2009; Webber, 2012). In the last 50 or so years, societies have seen great progress due to our presence in space, however individuals have also benefited from it in indirect ways. Space tourism, is an emerging niche of tourism that may have a global impact much greater than most are aware of.

For much of its history, there was little private or civilian participation within the field of space travel; however, lately there has been quite an interest shown by various private companies, as well as individuals. In the 21$^{st}$ century civilian counterparts expressed a wish to be participants in space as opposed to only being the observers, and many have made their dreams a reality at their own expense. Vigorous technological development and planning by certain companies to make space tourism an everyday reality has increased significantly in recent years.

Quite a few government sponsored astronauts have been sent into space, yet only seven self-paying civilian individuals have visited space, all of whom have done so in this century alone. Private companies are offering space travel services, yet as of now none of them have realized their goal of actually sending someone to space (Klemm & Markkanen, 2011). Although one company currently acts as an agent for orbital travel, it nevertheless depends on the services of the Russian Federal Space Agency or Roscosmos (hereinafter: RKA) and its Soyuz rockets.

However, it seems that new companies are challenging the status quo and breaking the paradigm as they will likely achieve space tourism within the near future, with two of them planning to launch their operations in 2014. Such companies not only have a vision for humanity to be a space venturing civilization, but are also keen to satisfy the economic need for cargo delivery into space. It is claimed that the privatization of such services and development of space tourism may lessen the burden of costs faced by national

governments and provide other nation-states easy access to space (Marshall, 2011; Beery, 2012).

In the last few years, Virgin Galactic has been making news' headlines with its promises to provide space travel services, and announcements that it shall soon offer, at quite a hefty price, trips to sub-orbit. It is generally agreed that sub-orbit exists 100 kilometres above the Earth's sea-level (Von Der Dunk, 2012). Hence, Virgin Galactic will provide travel to where customers may experience weightlessness, as well as the sight of earth's curvature. Even more intriguing is that Virgin Galactic is not the only company with such a mission; there are a few more that wish to offer the same type of service.

Some companies even aim to provide an orbital type of flight. Orbital flight suggests that humans would venture into outer space, where they might either orbit the Earth or board the International Space Station (hereinafter: ISS). In addition, some envision space hotels, Moon visitations and mining asteroids. Although at first such statements might seem farfetched, one must point out that a "space hotel" is already in Earth's orbit and that diligent progress through flight tests has almost made the commercial aspect of regular space travel a reality; it is only the question of time and readiness for the companies to make their long-awaited debut and open a new industry of present day economics (Klemm & Markkanen, 2011; Beery, 2012).

Many have raised concerns and disapproval about companies, governments and individuals wasting capital in such a manner; offering thrilling adventures so a wealthy few can flaunt their egos during an economic crisis. Although at first glance this might be true, proponents of space tourism argue that it is not the case. Their argument for space tourism is based on the fact that society must become space bound to be truly developed. Wealthy individuals are needed, as they serve as the main consumers for space tourism. For space tourism to succeed there must be enough demand from those who are able to afford expensive tickets.

Moreover, the need for human society to be space bound may result in various advancements in making life easier for the general public. Proponents of space tourism argue that when regular space travel is an everyday occurrence, it will lead to developments in various industrial fields, as well as in creation of further employment. Moreover, space tourism will create opportunities and resources for a more prosperous society (Rees, 2003).

It is important to understand that a major dilemma of space tourism is its start-up costs; it is expensive to travel to space and technologically demanding. However, many see that these costs would decrease over time to the point where the general public might be able to afford them, and in turn this would give way to providing cheaper services for the general

space industry, as in the case of launch costs and sending cargo into space (Goehlich, 2005). Moreover, the ability of civilians being in space may have positive consequences in the social, economic and political arenas.

To summarise, in the last century human civilization has discovered rocketry and has been to space, yet almost nothing has been done to send civilians into space. At present, companies are trying to achieve such a venture on a regular and profitable basis, and at the same time help society advance towards new heights. Although some view such course of action as a hindrance on contemporary economic policies, others argue the opposite; it is the only means to overcome such concerns as resource wars, economic crises and the dumbing-down of society. The debate is heated; companies are eager to provide services and earn a profit, while governments and individuals are split on the issues. One hopes that this master's thesis shall clarify and also justify the stance for space tourism, and the resulting global advantages it would bring to a wide array of segments in modern civilization.

The theme, and intention, of this master thesis is to give an overview of the development of private space tourism industry that can safely transfer civilians to and from space, as well as to investigate the potential economic, political and social consequences. The main hypothesis is that space tourism is a viable, profitable and future niche of tourism, in addition to having a tremendous impact upon society at large. Hence, the objectives of the master's thesis are:

1) to evaluate the framework of creation of space tourism, its management, strategies, various liabilities and the processes of how this shall be undertaken;
2) consequently analyse and interpret the consequences of space tourism on international business, the environment and society.

The master's thesis shall answer important questions, such as can space tourism be viable and profitable? Who shall bear the costs? What are the risks? Is it prudent to create a new industry during the present economic crisis, and how will the aforementioned influence nation-states and the whole human society at large? Shall space be a playground for the wealthy few to enjoy a thrill or is this the making of a future industry that will encourage the evolution of human civilization? Are we, as a human society, reaching the so-called new frontier and truly evolving towards becoming an intergalactic species or are certain individuals and their respective companies just trying to earn a quick buck? The intention of this master's thesis is to delve into such questions and find the most appropriate answers. Furthermore, the master thesis aims to give resolution, assurance and hope to companies as well as individuals, that although there are risks, travel into space is crucial and beneficial for society at large.

The methods used in this master's thesis shall be descriptive, explanatory and exploratory. For the first part, the descriptive method shall be used to shed light on the companies and individuals who are about to form the new industry; that is the space tourism industry. This part shall analyse the main actors and their developments in the field. Consequently the explanatory method shall be used to investigate the general outlook of the industry, the interrelation of companies and types of services they might offer. In addition, such a method shall be ideal at finding limitations and suggesting improvements for a solid foundation that will insure its future existence. Later the exploratory method shall be used to evaluate space tourism and understand the consequences thereof. Such a method is desired as it will clarify the impact, costs and benefits that shall result from the establishment of space tourism.

# 1 DEVELOMPENT OF SPACE TOURISM

The following section will move through history and establish an appreciation of what human civilization has overcome since man first took to the skies. It has been little over a century since man first propelled himself with a vehicle heavier than air into the sky. Since then, human civilization has progressed in many areas of flight, yet space tourism seems to be the final frontier. It is intended to provide transportation and exploration options for the general public, as opposed to only those astronauts trained and selected by governments. To a certain extent the beginnings of space tourism may be compared to aviation, as it faced many of the same challenges and technological difficulties. The profiles of the first passengers to fly on an aircraft are similar to those who wish to be the first customers of space tourism.

## 1.1 History of Space Tourism

Space tourism is in its infancy and there are few historical achievements to mention. To date there have only been seven commercial space travellers, or space tourists; although they prefer to be called space flight participant, as they see themselves as pioneers and adventurers as opposed to ordinary tourists. While Dennis Tito is often credited as the first civilian in space, he was not the first per se. Toyohiro Akiyama did not fund his own trip, but he was the first civilian space flight participant, as he was selected in a deal between Tokyo Broadcasting Service (hereinafter: TBS) and the Soviet Union to be included on a space flight on the Soyuz rocket to the Mir space station. However, as he did not pay for his own trip, he is not regarded as a "true" space tourist. In 2001, Dennis Tito, who was the first self-funding astronaut, paid a staggering $20 million for an eight day journey (Webber, 2012). He claims it was an experience of a lifetime, as he himself said after the flight "My flight into space is not a walk, it is fulfilment of my life-long dream" (Space flight, 2014).

After Dennis Tito's flight, six more individuals followed his footsteps; one of them even went twice. These six individuals made a journey into space in the same manner, firstly contacting the only travel agent for such journeys, Space Adventures Inc. The agency in turn contacts Atlas Aerospace, which is a company especially made to provide tourist with the ability to travel into space and enjoy other space-related activities (About company, 2013). Additionally the agency arranges a seat on their shuttle and possibly a stay on the Russian part of the ISS. If approved, then the wealthy customer pays anywhere from $20 million to $35 million for the service; although the procedure might seem as easy as just making a phone call, there are many other considerations.

Along with the approval and booking of the space agency, the participants are required to fulfil medical requirements, accomplish proper training and usually pay a deposit of 10%. Further difficulties have arisen recently as National Aeronautics and Space Administration (hereinafter: NASA) has retired its space shuttle program, which in turn means that astronauts may only use Soyuz rockets to travel into space; hence there are now fewer seats available for tourists to travel, which in turn makes the tickets even more expensive. It has been reported that the singer Sarah Brightman, who wishes to realize her dream of travelling to space, may face a bill of up to $51 million (Sunseri, 2012). This is due to the aforementioned limited space on the Soyuz, where as a consequence of her trip, one of the astronauts might have to stay for a whole year at the ISS instead of six months.

There are many similarities when comparing the start of aviation industry with the birth of space tourism. Early aviation faced many sceptics and critics when the Wright Brothers were attempting to get their flying machines to work, just as today many argue that space tourism is a lost cause, and that before venturing into space humans should "fix" things here on earth. Early aviation also faced technical challenges of developing airplanes, much like the reusable vehicles for space travel face in their respective environment today. The NASA space shuttle programme has been retired due to both financial reasons and its damaged reputation received from the Columbia and Challenger space shuttle disasters (Webber, 2012).

Another parallel that might be drawn is that only the rich were able to afford the first airplane flights, just as today only the wealthy are able to afford space flights. Some voice their dissatisfaction with millionaires spending their money on such selfish journeys; these critics tend to be of the opinion that such large amounts of money should be spent towards helping the poor or some other humanitarian or noble cause. Even though the critics make a good point, it should be noted that the same type of wealthy individuals were also the driving force behind the success at the beginning of aviation industry, as they provided the needed economic demand.

Additionally, one might point out that no beginnings are easy, yet the aviation industry developed into a formidable and key player of the global transportation structure, a system which provides for quick and secure delivery of cargo and passengers. If it was not for the likes of Dennis Tito, who at his own expense made a trip to space, the general public might truly think that there are no possibilities for them to reach outer space. Furthermore, a civilian putting immense physical effort and financial resources to show that something extraordinary can be achieved gives credence to much more than spending huge sums of money. It shows that there is interest among the public for travel under the toughest circumstances in order to express the willingness, curiosity and desire for exploring space.

## 1.2 From Space Industry to Space Tourism

It could be said that the space industry had its beginnings with the first rocketry blueprint made. In 1903, the same year that the Wright Brothers made their epic test flight, on the other side of the world Russian Konstantin Tsiolkovsky wrote his influential paper Investigation of World Spaces by Reactive Vehicles. The paper is famous for containing the first rocketry equation. In 1957, the Soviet Union launched the first satellite into space, Sputnik 1, and in 1961 it furthered its status by launching the first human into space, Yuri Gagarin. The U.S.A. followed in space exploration, and achieved the world famous moment of landing a man on the moon in 1969, bolstering the so-called Space Race. The Apollo missions further strengthened the U.S.A. position as the foremost player in the Space Race. Politics aside, space commercialization became quite a lucrative business. The telecommunications industry expanded via satellite launches, the global positioning system (hereinafter: GPS) was developed and countries' national security was and still is greatly improved. Support mechanisms for all the previously mentioned functions appeared in the form of sector professionals, space bankers and commercial space consultants (Webber, 2012).

After the Cold War and the fall of the Iron Curtain in 1989, the general public in the West lost interest in space until 2001, when Dennis Tito made his famous voyage to the ISS. Since that achievement, public interest increased again, to the point where businesses and individuals have tried to make the occurrence of space travel an everyday reality. Orbital tourism is still far away from becoming a commercialized everyday occurrence, as there are no travels providers except for the RKA with assistance from Space Adventures Inc. Orbital tourism will continue, though only with wealthy passengers who can afford it, at least in the near future. On the other hand, entrepreneurs have found other methods of simulating space activity; hence space tourism is already very much present and in certain categories fairly affordable. Some of the most popular types of simulating space activity are (Cosmonaut Overview Training, 2013; Soyuz Simulator, 2013; Centrifuge, 2013; Spacewalk Training, 2013; Fly MiG-29 in Russia, 2014; The Experience, 2014; Zero-Gravity USA, 2014):

- Cosmonaut training – price $ 89,500 per person;
- Soyuz simulator – price $ 15,950 per person;
- Centrifuge experience – price $ 9,750 per person;
- Neutral buoyancy training – price $ 33,750 per two people;
- Extra-vehicular activity (hereinafter: EVA) – price $7,560 per person;
- Parabolic flights – $2,500 – $5,200;
- Supersonic and high-altitude flights – price $11,550 to $16,500.

Cosmonaut training is a complete simulation of what astronauts must undergo to be able to qualify to be space ready. It is adapted so that the customer can enjoy the process of actual space training, while maintaining respect towards the harshness of the process (Cosmonaut Overview Training, 2013). The Soyuz simulator is a replica of a Soyuz capsule that is mounted on top of the Soyuz Rocket on which astronauts go to orbit and the ISS. In this process the customer learns everything from launch to touchdown procedures (Soyuz Simulator, 2013). During centrifuge training, one tries to overcome the physical strains of gravitational-forces (hereinafter: Gs), which astronauts must cope with at the launch and re-entry phases of a mission (Centrifuge, 2013). Spacewalk training is offered in two parts, neutral buoyancy training and EVA. During the former, customers put on a spacesuit adapted for water and go into a large pool to experience a feeling close to spacewalking as they float by a life-sized model of the ISS. During the latter, the customer puts on a real Orlan spacesuit, and simulation of exiting a spacecraft is performed (Spacewalk Training, 2013).

Parabolic flights use a tactic of ascending and descending during which customers may experience about 15 to 20 seconds of weightlessness. Such flights are performed by a Boeing 727 aircraft specially adapted to be spacious with cushioned walls for customers to move around freely during the manoeuvre. Zero-G Corp. offers such type of experience for sum of $5,200 (The Experience, 2014). Incredible Adventures Company also has an offering for a zero gravity flight only that it offers more of a personal experience of zero gravity. With a much smaller airplane called Rockwell Commander one may experience zero gravity for $2,500 (Zero-Gravity USA, 2014). Supersonic flights and high-altitude flights refer to going faster than Mach 1, or breaking the sound barrier and achieving altitude of more than 21 kilometres. The price depends on the time flown and the flight program, ranging from 25 minutes to an hour (Fly Mig-29 in Russia, 2014).

However fun and unique the simulated space experiences might be, they do not compare to actual space tourism that many have dreamed of and that only few have actually experienced. Therefore, companies are developing other ideas of how to reach space, and making it affordable for the general public. Apart from orbital space tourism, which is for the privileged few, some of the most common and easily executable ideas involve sub-orbital travel that bases on using reusable launch vehicles. Reusable launch vehicles refer

to a space-type vehicle which can achieve a certain altitude, land safely and within days if not hours take-off again; hence the term reusable. It is not discarded and its parts are not frequently replaced, such as is the case with today's rockets and space shuttles. This type of travel lets passengers experience g-forces, the curvature of the Earth and weightlessness by taking them up to the Karman Line, which is at an altitude of about 100 kilometres above sea-level (Klemm & Markkanen, 2011).

Other companies have proposed a more tranquil method of travelling into sub-orbit by using a special type of balloons where passengers would not have the thrill of experiencing Gs on their body; some less adventurous clientele might actually prefer such an ascent. Whichever option is taken, either using reusable vehicles that are powered by fuel or pollution-free vehicles such as balloons, the idea of sub-orbital space travel seems to hold the greatest likelihood of being realised in the near future, if not already in the present. The most important requirements that customers must meet are certain levels of medical fitness, the financial means and time considerations of such a journey.

There have also been ideas of building a space elevator. Japanese Obayashi Corporation has an unbelievable plan to build a 36,000 kilometre high elevator by 2050 that would travel at a bit less than 200 kilometres per hour with 30 passengers (Obayashi Corporation, 2012; Halverson, 2012). Even though it is a sound idea, humanity will have to wait quite some time to actually achieve it, as at the moment it is only an idea lacking technological capability. Nonetheless, once reusable space vehicles, space elevators or other types of machines are present, tourists will need a place to stay in space. Space hotels might seem like something out of science fiction novels and movies, but space habitats have already been placed into Earth's orbit, such as space stations as well as the first prototypes of inflatable habitats made for leisure or research purposes.

## 1.3 XPrize Foundation

The XPrize Foundation is an organization dedicated to achieving innovative solutions for helping the progress of humanity. Its main goal is to provide incentives through competitions that challenge the limits of present-day technological and creative capabilities. The foundation prides itself on the belief that it can achieve the impossible and it does have some credible accomplishments to its credit. It has helped increase oil recovery clean-up to three times the standard rate, helped create an energy efficient car and gave the needed push to the start-up of space tourism.

The foundation's board of trustees includes some of the most famous and renowned people within the space industry, as well as other influential business areas. The following are some of the most prominent advocates of the commercialisation of space and initiators of space tourism (Xprize Foundation, 2014):

- **Peter H. Diamandis:** CEO and Chairman of the XPrize Foundation, who is known for founding the companies Zero Gravity, Space Adventures and Planetary Resources among others. In 2014 he founded Human Longevity Inc, which deals with prolonging human life through researching genomics and stem-cell research;

- **Eric C. Anderson:** CEO of Space Adventures and Planetary Resources. Under his management Space Adventures has sold more than $80 million worth of space flights, making it quite a profitable business. In addition, he has worked for leading aerospace software firm Analytical Graphics and held many consultant positions with NASA;

- **Anousheh Ansari:** The first female space flight participant. She was CEO of Telecom Technologies Inc, where under her management the company expirienced continious high annual growth rate. Presently she is the chairwoman of Prodea Systems, a software company dedicated to providing digital in-home service solutions;

- **James Cameron:** A famous film director and screenwriter. He is known for films such as Alien, Terminator 2: Judgment Day, Titanic and most recently for the famous film Avatar, which grossed $2.7 billion worldwide;

- **Richard Garriott de Cayeux:** A hero in the culture of computer games, as well as one of the seven members civilian space flight participants. His Ultima series of games has established him as one of the "15 Most Influential Industry Players" in the Computing Gaming World. Presently he is the Vice President of Space Adventures Ltd.;

- **Eric Hirshberg:** CEO of Activision Publishing Inc, which delivers some of the biggest names in the gaming world; Call of Duty being one of them. He also founded the famous Deutsch LA advertising agency that grew from 10 employees to now having customers such as Volkswagen, Sony PlayStation and DirectTV. In 2007 he was inaugurated into the American Advertising Federation's Hall of Fame, while in 2012 he was named one of 10 most influential people in marketing.

The list goes on, but naming all of them and their accomplishments would be beyond the scope of this work. However, it is important to mention that many of them have not only founded their own companies, but also helped to create entire industries. The trustees have, or have had, high positions within the following companies: PayPal, Huffington Post Media Group, Microsoft and Google to name just a few. To emphasize, these same individuals are the driving force behind space tourism today. The sponsors and partners of the Xprize Foundation are also among the global leaders in their respective industries; Shell Oil Company, Google, the Qualcomm Foundation and Nokia.

When Burt Rutan's Scaled Composites won the Ansari X Prize of $10 million in 2004, a revolution within the space industry and space tourism began. As the biggest prize in the history of Ansari Foundation was awarded, the media quickly spread the word of the accomplishment popularizing the idea of space tourism. During the competition for the X Prize, the 26 participating teams combined to spend more than $100 million to win, while the total expenditure of the commercial space industry since then is estimated at $1.6 billion for the next ten years (McKinley, 2012; XPrize Foundation, 2014). Apart from space industry, the Ansari Foundation tries to achieve its goals within fields of energy and environment, education and life sciences.

Since the prize was awarded in 2004, many companies have received much needed faith from investors that such a business can become a reality. More importantly a vehicle was developed that can actually achieve the required objectives within the goals of space tourism. Overall, the X Prize helped break two important barriers to space tourism to becoming an everyday occurrence, those being the technological capability and the financial means.

## 1.4 Sub-orbital Design

Sub-orbital travel refers to reaching an altitude of around 100 km above the Earth's sea-level. Such travel does not require any space suits and astronaut training per se and the pre-flight preparation takes at most three days. Such travel to the edges of space takes approximately one to three hours, and therefore is not time consuming as compared to orbital travel. In addition, most of the reusable vehicles tend to have a horizontal take off similar to airplanes; therefore such travel will be more familiar to consumers.

### 1.4.1 Virgin Galactic & Scaled Composites

Virgin Galactic is a subsidiary of the Virgin Group, which was founded by the famous entrepreneur Sir Richard Branson. The Virgin Group is a multinational branded venture capital conglomerate, which has many subsidiaries in a variety of fields covering a range of sectors; most notably financial services, transport, healthcare and telecommunications. In July 2005, the Virgin Group's Sir Richard Branson teamed up with Burt Rutan's Scaled Composites to form the Spaceship Company for the purpose of constructing a fleet of spaceships that would enable sub-orbital tourism. Scaled Composites developed SpaceShipOne (hereinafter: SS1), which is a reusable space vehicle that is mounted on its carrier airplane named WhiteKnightOne (hereinafter: WK1). Scaled Composites spent $25 million on its development, and while it was awarded $10 million by the Ansari Foundation it still lost a large amount of money on the venture (Foust, 2011; Xprize Foundation, 2014). However, in comparison to the space industry as a whole, the amount is quite small, as NASA spends almost such an amount per day on space exploration alone,

the European Space Agency (hereinafter: ESA) spends an equivalent amount in a few days and Japan Aerospace Exploration Agency (hereinafter: JAXA) spends it in about a week (Collins, 2006; Klemm & Markannen, 2011).

As was agreed beforehand between Burt Rutan and Richrad Branson, the Spaceship Company would contract Scaled Composites to further improve, test and certify their prototype to make SpaceShipTwo (hereinafter: SS2) and WhiteKnightTwo (hereinafter: WK2), which are larger versions of their predecessors. As Virgin Galactic is a customer of the Spaceship Company it would develop a fully functioning and operational fleet of spaceships for the advancement of space tourism. In 2012, Virgin Galactic successfully acquired 100% of the Spaceship Company and realized the first stage of its long-term strategy (Seedhouse, 2008, pp. 27–28; The Spaceship Company, 2012). Although the SS2 is not commercially operational yet, it is in its final stages of being operational on the market, with its home base at the Mojave Spaceport in New Mexico. In Figure 1 we see the design of the SS1 and its mother-ship WK2.

*Figure 1.* Image of SS2 and WK2


Source: *Graphics and Illustrations*, 2014.

Over the years there have been many rumours about the timeframe for Virgin Galactic's first commercial launch. In 2009 it was said that it would happen towards the end of the year, then there was talk about a Christmas Day lift-off in 2013 (Klemm & Markannen, 2011; Croucher, 2013). In 2014, the reports are that it will happen later in year, as Sir

Richard Branson and 80 other soon-to-be civilian astronauts have already participated in parabolic flight to train for the upcoming debut of SS2 (Wall, 2014). The matter seems serious enough, as Abu Dhabi's Aabar Investments bought 31% of Virgin Galactic for $280 million in 2009; later on increasing its stake to 37.8% and presently considering building a spaceport somewhere in United Arab Emirates (Croucher, 2013).

Virgin Galactic charges $200,000 to $250,000 per seat, and the flight seats 6 passengers and two pilots. The price depends on the booking time; meaning the ones who were the first to reserve their seat paid a higher price. It is reasoned that the first customers are willing to spend more money on tickets, as they will become pioneers on an epic adventure and help baptise the beginning of space tourism. Even though the price may seem expensive, the company has already made 700 reservations prior to making its commercial début (Schultz, 2014). It is interesting to point out that the first customers of Virgin Galactic are not only wealthy individuals, but also world-wide recognized celebrities, including Leonardo DiCaprio (Luke & Mukuno, 2014). This suggests that Virgin Galactic is the leading company in the developing space tourism market and is actively attracting other potential customers.

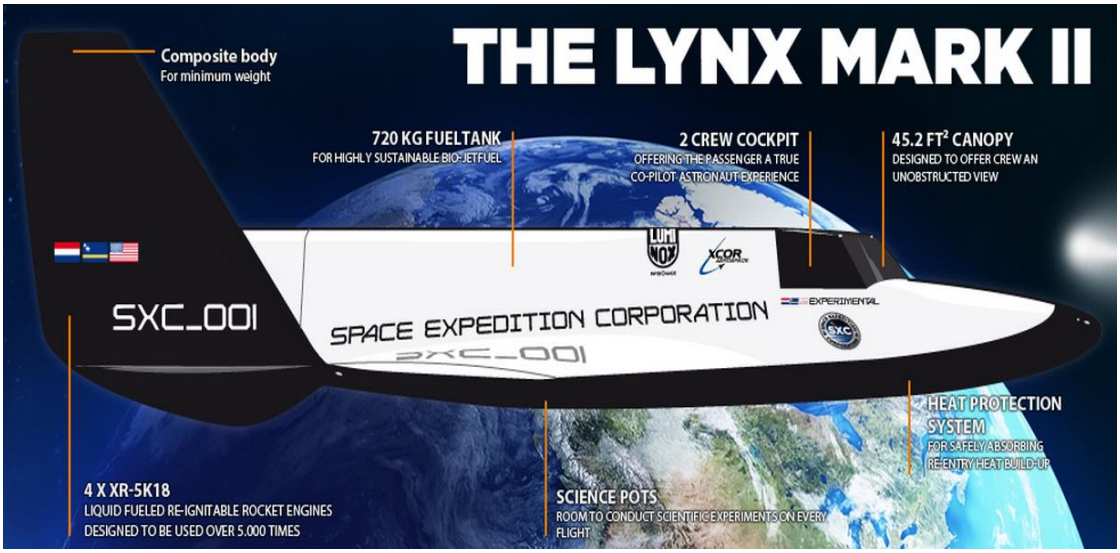
### 1.4.2 Space Expedition Corporation & XCOR

The Space Expedition Corporation (hereinafter: SXC) is based in the Netherlands, and was founded by business professionals who are passionate about delivering opportunities for travelling into space. They are focused on providing different types of space tourism services, which include astronaut training as well as sub-orbital travel into space on XCOR's Lynx. XCOR is a private company founded by Jeff Greason that began with only four team members, yet as a result of its innovative and talented engineers it has developed the Lynx 2, as shown in Figure 2, which is a reusable sub-orbital space vehicle that seats one customer next to the co-pilot. XCOR and SXC have partnered up to expand promote and expand the popularity of sub-orbital space travel. Both parties are eager and focused on the task at hand (XCOR Aerospace, 2012; About Lynx, 2014).

Depending on which package the customer chooses, they will travel directly from a spaceport to an altitude of either 60 or 103 kilometres above the Earth's sea-level; meaning there is no detachments as the case with Virgin Galactic. The flight will take about an hour's time. XCOR is also planning on building two more vehicles, one of which will be for orbital travel (Schilling, 2013). SXC serves as the main marketing and sales agent. It provides the much needed attention and service packages for space tourists, which informs and expands the public's awareness of space tourism services. Moreover, the SXC has many partners that are already established players within their own industries, such as Koninklijke Luchtvaart Maatschappij N.V. (hereinafter: KLM) and Unilever, which immensely helps their business to be a sustainable one (Partners, 2014). What's more, due

to Dutch history and the Dutch presence in the Caribbean, Curacao is an ideal location for their spaceport, while at the same time being a great tourist destination. In addition, the partnership between Curacao and SXC will provide a pleasant vacation for any space tourist, as they can easily have a stay in the Caribbean before or after their adventure.

*Figure 2*: The Lynx 2




Source: *Spaceship*, 2014.

The SXC is heavily promoting its services abroad. The Chinese are quite fascinated, as more than a 100 people have already shown interest in booking their tickets since registration for the Lynx began in late December 2013. Additionally, some company owners have booked tickets in order to represent their companies and show their leadership, and therefore further promote their own business as well as space tourism. The SXC has partnered with Dexo Travel, which is a Chinese travel agency that is helping promote the company in the Asian market. Their employees have confirmed that due to recent Chinese advances in space exploration there is great interest in such flights. The SXC is offering quite a deal to their first customers and their package is luxuriously designed. Among many things that their early customers will receive, is a stay at the Peninsula Hong Kong Hotel, complete with a limousine transfer to the airport, 4 nights' accommodation at a 5-star hotel in Curacao and their name carved into the spaceport (Juan, 2014).

The Chinese are not the only ones showing keen awareness of the SXC, however. As it has done with Virgin Galactic, the United Arab Emirates (hereinafter: U.A.E.) has shown great interest, and at least one anonymous Emirati has already confirmed a booking (Al Khan, 2013). The SXC claims that it is more competitive than other "space" companies as it charges a fee of only $95,000 for Lynx 1 and $100,000 for Lynx 2 flights; in addition the

customer gets to sit in the cockpit next to the pilot, which is more exciting and a more personal experience for some customers. SCX has already been able to sell 250 tickets and the first trips are set to take place at the end of 2014 with the Lynx 1, while the Lynx 2 will be operational in 2015 (Schilling, 2013).

### 1.4.3 Other Noteworthy Developments

Many companies have tried to participate in the pioneering of space tourism, as this is the prime time to develop and test space vehicles. Companies such as World View Enterprises Inc., the European Aeronautics Defence and Space Company Astrium (hereinafter: EADS Astrium), Masten Space Systems, Booster Space Industries and Rocketplane Inc. have all been developing their own concepts, yet little has been seen by the public so far.

**World View Enterprises Inc**. is a subsidiary of Paragon, which manufactures equipment for the ISS, and has decided to use balloons instead of rockets to reach the edge of space. While it will not actually reach the height where one can experience weightlessness, it will offer its clients quite a view of Earth. The capsule, with its helium filled balloon, will lift 8 passengers up to an altitude of 30 kilometres above Earth. The duration of the journey is not known and much of other details about the project are also still secret. However, it has been revealed that the company will charge passengers $75,000 for the journey (D'Orazio, 2013). Passengers will have a luxurious experience without encountering any extra Gs or other strains on the body. One may conclude that there will be no medical or other necessary requirements, as there are for sub-orbital experiences. For illustration and comparison, the voyage on the balloon-carried capsule will look much like the promotional stunt of Red Bull's Felix Baumgartner, just without the jumping part and with a much more spacious and sophisticated capsule. Such a service will be accessible to anyone with sufficient finances, and, moreover, is one of the safest ways to reach high altitudes.

**EADS Astrium** is a subsidiary of the Airbus Group, which is known for being Europe's leading Aerospace and Defence Corporation. It developed a concept for its spacecraft, and presented it at the Farnborough Air Show in 2012. Simply called Spaceplane, little has been seen of or mentioned about it since then, although there are high hopes for it in the future (Heath, 2012). Despite the lack of information, EADS Astrium is not to be overlooked, and it has open access to both the technology and the research and development department of its parent company. According to their website, in 2007 it was reported that the project to develop and manufacture the Spaceplane would take over 7 years, including obtaining the proper licensing. The company plans to create a fleet of 30 spacecraft, producing five per year. While the time of the first launch is still unknown, it may be presumed that space tourism is not the main priority of Airbus Group or its subsidiary (Airbus Defence & Space, 2010).

**Booster Space Industries** is a European - U.S.A. consortium that could be potentially one of the main competitors to Virgin Galactic, as it is in the process of achieving a similar spacecraft attached to a mother-ship. It would seat 8 passengers and 2 crew members, reaching an altitude of 115 kilometres above sea-level and having a 4 minute experience of microgravity. It has already adapted an Airbus 300-600 as a mother-ship, while the spacecraft itself is still under further development. The drawback is that it will not be operationally until at least the year 2016/17 (Booster Space Industries, 2012). As that is the most optimistic operational prognosis, and much of what happens in the space industry happens with delays, it is questionable whether the company will achieve its set goals, especially considering that for a similar type of spacecraft Virgin Galactic needed almost a decade.

**Masten Space Systems** is another company within the reusable launch vehicle market and is quickly gaining the respect of its competition. It prides itself on reusability, safety and having an iterative approach. The iterative approach means that manufacturing and testing the equipment is preferred as oppose to overanalysing; as Masten explains, "analysis-paralysis" is detrimental to the business practice (Company, 2014). Their company policy is that after developing software or hardware they immediately put it to testing. Through such a process they can determine the quickest and cheapest solution, in addition to rapid prototyping. In other words, they do not focus on the problems, but rather look for solutions with the purpose of having a working system. Currently their vehicles use vertical take-off and landing approach as oppose to horizontal, which suggests that they might develop an orbital space vehicle or a lunar module. The latter is more likely as in 2009 Masten successfully demonstrated its capabilities at the Northrop Grumman Lunar Lander XPrize competition winning the event, for which it was awarded a prize of $1 million (Wethington, 2009).

**Rocketplane Kistler Inc**. is a great example of how tough space tourism business can be. It was a company based in Oklahoma City that had a vision of providing its services to space tourists. It designed a concept for a spacecraft called Rocketplane XP, seating 5 passengers and a pilot, and gave initial cost estimates of $250,000 per person. In 2008, there were announcements that the company would soon be operational and a marriage would even take place aboard one of its flights. It had also promoted its services by lottery, where an airplane hostess removed a wrapping of a chocolate bar to find out that she has won a trip to the sub-orbit (Tandy, 2008; Rocketplane, 2013). However none of these plans were realized, Rocketplane Kistler filed for bankruptcy in 2010. The following year there was a public auction to sell off all of its assets as well as its patent rights (Rocketplane Kistler assets to be auctioned on November 11, 2014).

**Armadillo Aerospace**, which was one of the most prominent and leading companies in the civilian space race, has paused with its operations. The owner, John Carmack had already

invested $8 million of his own money, however, after a failed rocket test where the parachute did not open, the prototype sustained critical damage and repairs were too costly to further pursue their operations. The result is that Armadillo Aerospace is looking for investors as it is running low on funds and is at a standstill (Farivar, 2013). Both Armadillo Aerospace and Rocketplane Kistler are great examples of the tough environment of the private space business. Not only are the development and manufacture cost extremely high, but at times the results are not what one would like to see or expect.

## 1.5 Orbital Design

Orbital space tourism refers to space travel much higher than that at an altitude of 100 kilometres above the Earth's sea-level, which is considered actually venturing into outer space. This is where the International Space Station is positioned, orbiting the Earth at an altitude of 370 kilometres. There are 4 main orbiting positions: lower Earth orbit (hereinafter: LEO) from 160 to 2000 kilometres altitude, medium Earth orbit (hereinafter: MEO) at 2,000 to 35,786 kilometres altitude, geosynchronous orbit (hereinafter: GEO) at 35,786 kilometres altitude and high earth orbit (hereinafter: HEO) at altitudes above the GEO. These concepts are important to understand, as many orbital vehicles will only reach LEO, while satellites are intended to reach LEO, MEO or GEO, depending on their purpose. It is significant to recognize these concepts, so not to be confused about which orbital level orbital vehicles will travel in.

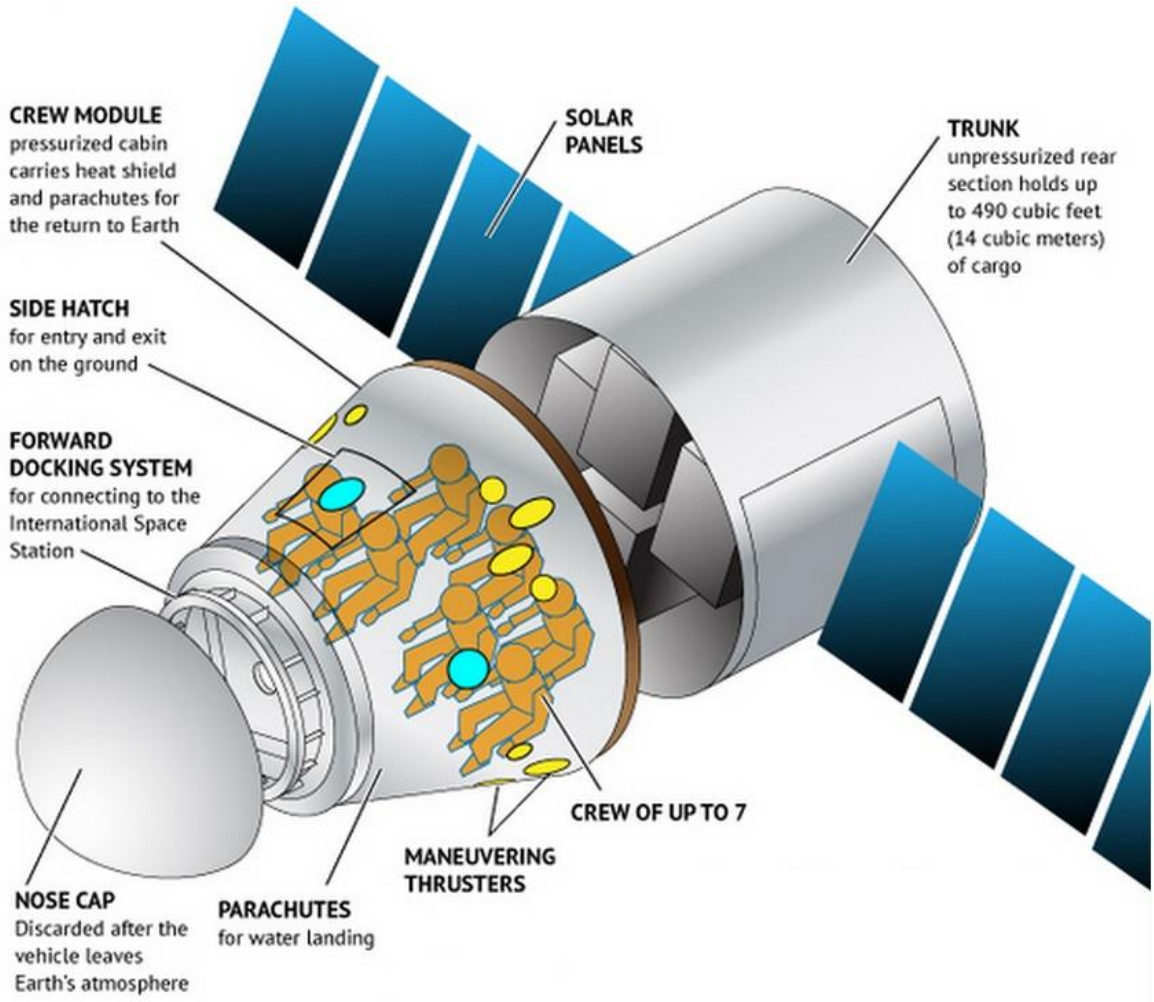
Orbital vehicles will have a vertical lift off much like the space shuttles had, using different boosters and operational stages. Although more advanced and risky, currently the only transportation available from Earth to outer space for civilians is from the Russian Federal Space Agency on its Soyuz rocket. How orbital space tourism shall develop is still uncertain, as there are many prerequisites to be fulfilled; ranging from technical capability of vehicles to the financial aptitude of companies as well as how NASA, the ESA, RKA and even Japan Aerospace Exploration Agency (hereinafter: JAXA) will handle the transitions and regulatory issues. Nevertheless, these space agencies rely on the support of companies that view orbital space tourism as a crucial stepping stone towards lowering costs and increasing the rate of space launches. The most prominent companies that could potentially offer orbital space tourism will be looked at in the following sections.

### 1.5.1 Space Exploration Technologies Corporation – SpaceX

The Space Exploration Technologies Corporation (hereinafter: SpaceX) was established in 2002 by the multibillionaire and Tesla Motors founder Elon Musk. Since its establishment, the private company has been making history in almost every aspect of its existence. In 2008, it developed the Falcon 1 rocket, which was the first privately owned rocket to reach Earth's orbit. Two months after this accomplishment it won NASA's Commercial

Resupply Services contract worth $1.6 billion. In the following couple of years it further tested and improved its rockets, which resulted in Falcon 9. The Falcon 9 rocket serves the Dragon capsule illustrated in Figure 3, which can be adapted for either cargo or crew. In 2010, the Dragon's successful re-entry into low Earth orbit made it the first privately built spacecraft with such capability (About SpaceX, 2014).

*Figure 3*. SpaceX's Dragon Capsule




Source: K. Tate, *SpaceX's Dragon Space Capsule Explained (Infographic)*, 2013.

The company has been so successful that in 2013 when it launched its Falcon 9 rocket with a satellite for Asian clients, it outbid United Launch Alliance, which is a partnership of Boeing and Lockheed Martin, two aerospace and defence giants. It is quite an achievement, especially when considering that the launching of satellites and other cargo into space is $115 billion per year industry (SpaceX Launches its first commercial satellite, 2013).

Elon Musk has a vision that space exploration and inhabitation are a natural evolution process of humanity, and sees his company as the pioneer to bring such achievements to global civilization. Indeed, with the docking of the unmanned Dragon capsule with the ISS in 2013, it became the first and only private company to do so; all others were government agencies (About SpaceX, 2014). Elon Musk also prides himself on a new project, which if successful will revolutionize the orbital travel industry. The Grasshopper is a rocket that will go into space as a first stage, release a capsule or a satellite and then return back to Earth with a vertical landing to be reused. In such a manner, SpaceX will lower present day costs twofold, as the reusability factor will provide for timelier and cheaper launching solutions (Bhasin, 2012). However, the question of when the Dragon capsule will be crew capable still remains, as does its potential to be used commercially for space tourists, or will it remain only as a contractor to NASA or other governmental agencies. Whatever the case might be, it is of great importance that a private company is making such progress and the technology for orbital space tourism is within reach.

### 1.5.2 Bigelow Aerospace & Orbital Technologies

Robert T. Bigelow, the founder of Budget Suite Hotels in Las Vegas, decided to realize his dream of making space hotels and to that purpose established Bigelow Aerospace. In 2006 and 2007, it launched the prototypes of Genesis 1 and 2 habitation facilities. Due to developments of advanced plastics and material such as Kevlar, Bigelow Aerospace incorporated an inflatable design for its future space hotels. By doing so, it achieved two very important advancements. The main advancement is the weight to space ratio of the habitat itself, which needs to be cost effective to be sent into space. The second important accomplishment was its contract with NASA to provide the new generation of habitation facility, called BEAM, which will dock with the ISS in 2015 (BEAM, 2013). The NASA contract is all the more important, as it helps to establish a connection with SpaceX, which was previously awarded the contract for cargo. This could be extremely valuable in the future, as any potential space hotels would need vast amounts of cargo shipped, and developing a strong bond now with the leading company in that field could be a great help in the future.

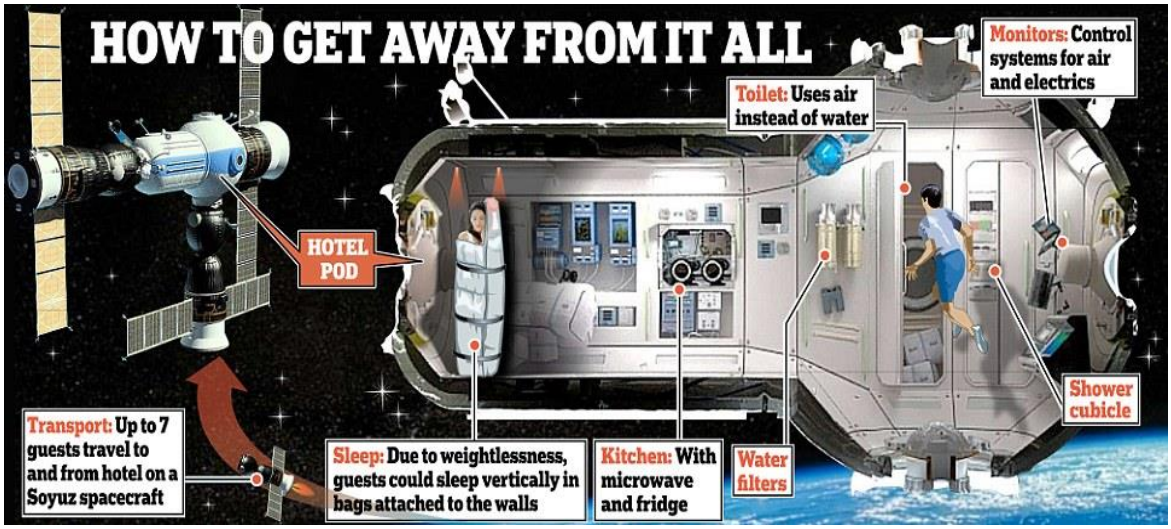
Surprisingly enough, Bigelow Aerospace is not the only company making habitation facilities in space. The Russian company Orbital Technologies is planning on launching a commercial space station facility by 2016. The commercial station will serve as a hotel for wealthy individuals that want to participate in space tourism, as well as for companies that want to do research, and will have a capacity of 7 people. Orbital Technologies promises reliable systems and an operational life of at least 15 years. On the other hand, the company is silent about its costs and its bookings (Malik, 2010; Lam, 2011). Even though the company is secretive about its intentions and the capabilities of the commercial facility, Figure 4 provides an illustrative perspective of how the habitat should look like. The

company is also strategically partnered with the RKA, and should be a strong competitor for Bigelow Aerospace, despite the fact that Bigelow Aerospace has already put a prototype into orbit.

BA 330 is the newest and most advanced space habitat that will be in orbit ready for leasing as soon as orbital space transportation is available on regular basis. The costs of a lease vary depending on the option the customer chooses. There are three primary lease options, a short-term period of 10 to 60 days for astronauts or space tourists, a monthly option for experiments and a yearly lease for naming rights to the space habitat. The short-term option has a price of $26.25 million if the customer travels with SpaceX, while a trip with Boeing is $36.75 million. This option is predominantly targeted at national space agencies and individuals that may want to indulge in space tourism or as an extra accommodation space for astronauts. The second option of a two month lease of a space amounting to 110 cubic metres of volume will be available at a price of $25 million and at a flight cost of $500,000 per experiment. This option provides governments and companies with ability to perform experiments in space at affordable prices. Space tourists will also be able to lease the same amount for the equivalent time-period at a price of $51.25 million including the SpaceX transportation fare. Lastly the third option of Bigelow's offer comes in the form of leasing naming rights, where a company might want to increase its exposure and lease the whole habitation station for $25 million a year or for $12.5 million for half a year (Opportunities and pricing, 2013). Such space habitats may be used for a variety of purposes, from commercial to governmental. The habitats are also equipped with necessary apparatuses for lab research in addition to having Earthly perks such as a microwave oven.

At present Bigelow Aerospace is making advancements of space habitats. It claims that their design will increase the volume of habitable space in comparison to what the ISS offers. In addition, the expanded habitat further provides protection from solar radiation, as well as physical debris, due to material used. As Bigelow Aerospace moves closer towards implementing its habitation facility at a lower cost, it has established itself as a true pioneer in the space industry.

*Figure 4.* Future Russian space habitat




Source*: Room with an intergalactic view: Russia firm reveals plans for space hotel*, 2014.

### 1.5.3 Noteworthy Developments

Private space business is costly and technically demanding. Nevertheless, some corporations are succeeding. It seems that the key to successful operations within the orbital space industry is primarily focused on having technically capable and cost effective equipment. Moreover, many companies depend on either angel investors who donate large sums of money or on space agencies that recognize a company's potential.

**Sierra Nevada Corporation** (hereinafter: SNC) is private company and a major player in the space industry. Founded in 1963, it has more than 3,000 employees that work on high technology electronics, avionics and communication systems it has recently completed its review of a spacecraft called Dream Chaser, which it has been developing in cooperation with NASA. For development of the spacecraft, NASA awarded SNC with the NASA Commercial Crew Development Award, Commercial Crew Integrated Capability Award and Certification Product Award, which amounted to a total of $337.5 million (Sierra Nevada Corporation Enters Dream Chaser Critical Design Review, 2014).

The goal for the spacecraft is to reach orbit and the ISS. Dream Chaser is being designed to be as safe and efficient as possible. It has a vertical launching system and the design is very similar to the retired NASA's space shuttle, yet it differs in major ways. It has lower re-entry g-forces and a non-toxic propulsion system, and can land on shorter runways while maintaining a quick turnaround time and almost effortless maintenance. It is undergoing numerous safety tests to become operational and achieve the necessary performance for orbital space flights. SNC has various long term contracts with NASA, as it is a systems

integrator and an electronic system provider for the agency; the company is aiming to replace the retired NASA's space shuttle, and launch the Dream Chaser in 2017 (Sierra Nevada Corporation Enters Dream Chaser Critical Design Review, 2014).

**Blue Origin LLC** prides itself on developing low cost possibilities for venturing into space. Its founder, the Amazon.com billionaire Jeff Bezos, has a keen eye on space, not only sub-orbital tourism, but also beyond. The development of a new capsule-like prototype, the New Shepard, is underway and similarly to SNC it relies on a vertical launch. New Shepard is being built with the intentions of lowering the cost of sending different experiments into sub-orbit (About Blue Origin, 2013). Although New Shepard is a sub-orbital vehicle and does not include a crew capability, there are indications that the next generation vehicle could possibly be used for human transportation; moreover, with future developments it might become an orbital type of vehicle. The commercial aspect of the vehicle is not known yet, however one may speculate that Jeff Bezos is aiming for the "stars" as opposed to reaching lower earth orbit. The company is well-established in the space industry and if it is not one of the suborbital pioneers, it could potentially be an orbital one.

## 1.6 Spaceports

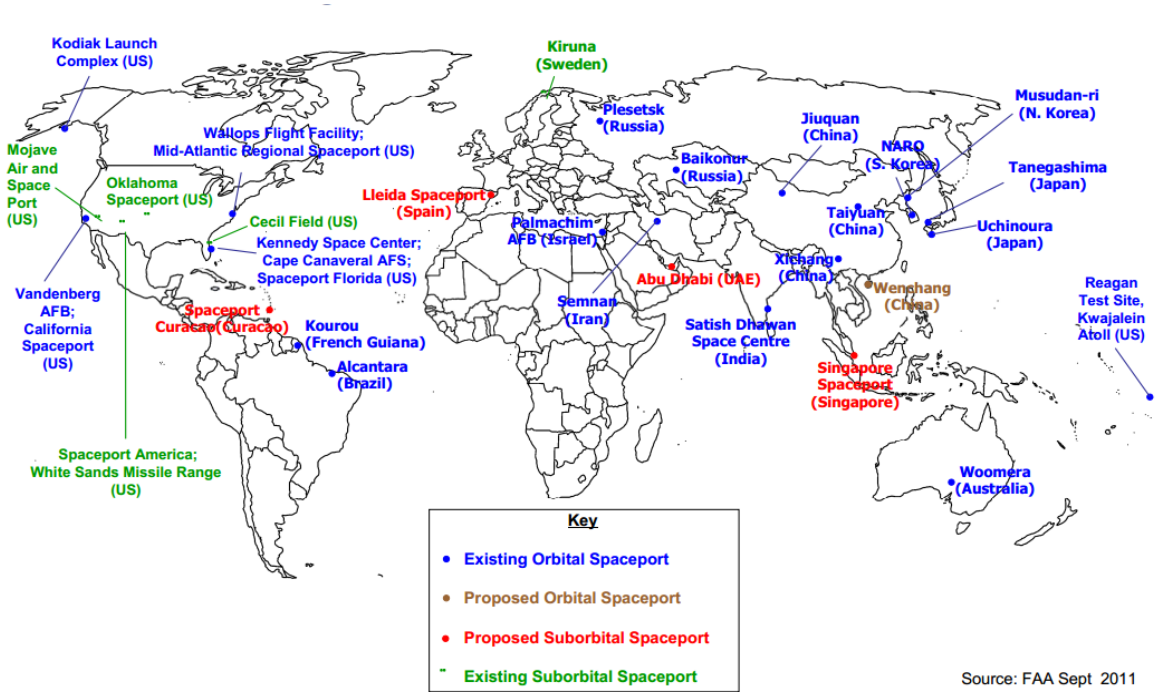
Any company that wants to participate in the space tourism industry obviously needs access to a spaceport. For sub-orbital space businesses, it would be enough to have a common runway, such as those found at public airports; however, due to traffic considerations and various legal regulations this seems not to be an option. There are a number of already existing and proposed spaceports for companies to choose from, as can be seen on the map in Figure 5. In the U.S.A. the most important commercial spaceport is the Mojave Air and Space Port, which is the likeliest place for sub-orbital space tourism to be born. Virgin Galactic will start its space tourism services from there, while SXC will also be leasing the services for a longer time. However, both companies have already made plans to have other locations available. Virgin Galactic has negotiated the construction of a new private state-funded spaceport, which will cost $200 million and be situated in Las Cruces, New Mexico. It is said to be an ideal location as it is located in a middle of a desert, where there will be favourable weather conditions resulting in no launch delays. It will be called Spaceport America, and Virgin Galactic will also establish its headquarters there (Virgin Galactic, 2013; Space Expedition Corporation, 2014).

The Caribbean spaceport of Curacao is the other location from which SXC will operate. Curacao itself is a tourist destination and offers a myriad of opportunities for a traveller to explore. The island offers long sandy beaches, scuba diving, and a variety of restaurants, as well as being classified as a UNESCO World Heritage Site (Space Exploration Corporation, 2014). Compared to the Mojave Space Port, Curacao has quite a few

advantages. For instance, the whole family can enjoy a vacation, while one adventurous member indulges in a suborbital flight. In addition, due to nice weather there will not be any complications during flight, and at the same time it offers unforgettable views from space.

For orbital tourism, currently the only spaceport used for space tourism is situated in Kazakhstan, and called Baikonur Cosmodrome. All of the space touristic RKA spacecraft have been launched from this location, which means that all the tourists who have gone into outer space with a Soyuz rocket have done so from here. The Russian government has the spaceport under lease till the year 2050 (Baikonur Cosmodrome, 2013). However, with the design and technological advancements of SpaceX, as well as its keen interest in space tourism, there is a possibility that Cape Canaveral Spaceport in Florida might become the next lift off point as it is already used by SpaceX for its commercial flight. However, its future use is unclear, because the Space Port is under the control of the U.S.A. Air Force Space Command and serves many other purposes.

*Figure 5*. Existing and proposed global spaceports




Source: J. Sloan, *Introduction to FAA Office of Commercial Space Transportation (AST) and International Outreach*, 2012, p. 20.

Alternatively, there are two other viable options for orbital space tourism to get its lift off. One is Chinese and situated in Inner Mongolia. It is named Jiuquan Satellite Launch Center after the city closest to it. Thus far the Chinese have not only launched satellites but also humans from the location. The other option is the Oklahoma Space Port, also known

as the Clinton-Sherman Industrial Airpark; however, due to its premature build up in 1999, the facilities are currently not in the best shape. This space-port is a classic example of what happens when a government acts too soon in support of an industry. In addition, if the complex receives a new owner who provides the needed funding but is not keen on space tourism, it might just become an industrial park (Whittington, 2013). Luckily for the space tourism industry there are not yet any interested suitors, therefore there still is a chance for potential orbital space tourism companies to capitalize on the opportunity and establish a functioning space port of the future.

## 1.7 International Sales Agents

As was presented earlier in this master thesis, the two most prominent companies offering flights to sub-orbit are Virgin Galactic and the Space Exploration Corporation. Virgin Galactic partnered with the already well-established travel agency Virtuoso and its affiliated member Hurley Travel Experts in the United States, while also agreeing a relationship with Club Tourism Space Tours Inc. of the KNT-CT Holdings Corporation in Japan. Such agencies specialize in luxury travel and through them one may book special flights, cruises, tours and stays at luxury destinations (Virtuoso, 2014; The Virgin Galactic Experience, 2014; Fairchild, 2014). Regarding space tourism, the purpose of such agencies is to increase public attention, help with marketing and sales of sub-orbital travel to have the greatest public outreach. In addition, such companies have specialized offline agents that help clientele choose the best option of what they are looking for. Virgin Galactic has successfully positioned itself and increased its credibility by partnering with luxury travel agents, which has also given sub-orbital space tourism much needed certainty.

SXC has followed Virgin Galactic's example, with equally established and known company. One of their partners is Uniktour, which is based in Montreal, Quebec in Canada. Uniktour is an organization that focuses amongst variety of travel destinations. With the advances in sub-orbital space tourism it decided to promote SXC in North America (Uniktour, 2014). SXC has already had sales in China and the U.A.E and has marketed itself quite successfully worldwide, and it also offered its services though the most famous adventure agency, Incredible Adventures, which provides almost every possible thrill activity that exists on planet earth and now even beyond it (Incredible Adventures, 2014). Incredible Adventures' main target market, are customers looking for thrills, adventure and anything that is considered high-risk and extraordinary.

Apart from the well-established Space Adventures agency, there seems to be little effort put into marketing orbital space tourism. Space Adventures offers lunar missions, orbital flights, sub-orbital flights and zero gravity flights. Orbital flights have already been sold and it appears that the popularity is still intact as Sarah Brightman announced that she too wishes to participate in orbital space tourism (Space Adventures, 2014). Lunar flights are

launched in cooperation with Russia partners, and only one ticket is available on a lunar mission. The cost is staggering at $150 million; however the customer wants to stay anonymous (Moseman, 2011). There is uncertainty for Space Adventures as the provider of sub-orbital flights Armadillo Aerospace is waiting for funding. There is still great uncertainty about which company will actually be providing regular as opposed to opportune orbital space travel and how that shall be accomplished.

Armadillo Aerospace has an exclusive marketing agreement with Space Adventures for sub-orbital flights; which means that customers can only book flights through the agency (Partner, 2014). However, as Armadillo Aerospace has currently suspended its operations, it is only a question of time as to when another company will replace it. There are presumptions that Armadillo Aerospace will not be able to offer sub-orbital flights in the near future. Virgin Galactic and SXC and their respective agency partners are taking over the market share held by Space Adventures. As for orbital space flights, it is possible that companies such as SpaceX will provide the needed assurance for an orbital operator apart from the RKA, and maybe provide Space Adventures with a much needed competitive advantage.

## 1.8 Obstacles to Space Tourism

As with solving any problem, the problem itself must first be identified and analysed. The subsequent conflicts and obstacles draw the reader's attention to present situations that are hindering space tourism. Identification of these problems shall provide a starting point for solutions to develop; and for some of them solutions have already been found. In addition, several of the presented dilemmas are actually opportunities from which space tourism can evolve to grow into a fruitful enterprise.

### 1.8.1 Major Obstacles

Space tourism faces many challenges to be resolved. Gibson (2012, p. 91) in Table 1 has identified the following characteristics, which are summarized below, as in what areas space tourism experiences main obstacles. There are significant obstructions to healthy development of space tourism and at the same time to making it a profitable industry.

Table 1. Primary Impediments to Development of Commercial Space Tourism

| Category Number | Category Title | Total Occurrence Frequency |
|---|---|---|
| 1 | Investment | 107 |
| 2 | Space Dangers | 88 |

table continues

continued

| Category Number | Category Title | Total Occurrence Frequency |
|---|---|---|
| 3 | Regulation | 81 |
| 4 | Transportation Danger | 76 |
| 5 | Medical/Health | 63 |
| 6 | Legal Issues | 56 |
| 7 | Pricepoint | 52 |
| 8 | Coalitions Needed | 47 |
| 9 | Inadequate Infrastructure | 47 |
| 10 | Politics | 42 |
| 11 | Inadequate Transportation Technology | 41 |
| Total | 11 Categories | 700 Occurrences; 52 Per Category |

Source: D. C. Gibson, *Commercial Space Tourism: Impediments to industrial development and strategic communication solutions,* 2012, p. 91.

The question of funding is the most crucial aspect of challenges in the development of space tourism. Investors tend to want their return on investment in a reasonable time period, and due to capital-intensive space vehicle development and production, this might take greater time than the investors are willing to accept. In addition, alternative investments compared to space tourism make more sense to the investor as greater and quicker return on investment without any significant setbacks or dangers, as in the space industry, reassures them of a profit. Investors tend to be risk averse, and proving the safety of space tourism is next to impossible, particularly due to the variety of dangers it faces. The cases of space dangers, such as space weather, radiation, space debris and other hazards pose serious risk to the investor and the company to be operating.

Excessive and bureaucratic regulation also hampers the development of space tourism as launch permits are needed from the government. As the regulations are in a flux it provides further uncertainty, which in turn repels investors even more as well as delays of received permits have their own cost. Transportation danger is self-explanatory as in space tourism rockets will be used, which carry a variety of substances that are flammable. At high speeds rockets tend to be hard to control, the process of re-entry where heating of the spacecraft occurs can lead to serious incidents and the general failure of rockets is commercially unacceptable at 5%.

Health consideration is also a prevalent obstacle when one discusses space tourism, particularly within the orbital type. Documented cases of astronauts experiencing space motion sickness have been recorded already after few hours in space. Legal issues face another barrier to space tourism as they are undeveloped and legal framework is difficult to

construct. Cases of liability and property rights complicate matters even further due to lack of regulation and legal framework. Pricing, technological capability, political and infrastructural issues are extra challenges that make the investors and potential business operators averse towards entering space tourism environment (Gibson, 2012, pp. 90–120).

### 1.8.2 Minor Obstacles

Apart from the major obstacles discussed above, Gibson (2012, p. 122) identified minor ones that also impede the development of full scale space tourism. Table 2 provides the secondary challenges to space tourism and additionally elaborates on them. The assortment of these difficulties does not occur as frequently as the problems in Table 1, yet nevertheless Table 2 gives a more detailed picture of the challenges to be resolved. The challenges stated in Table 2 are a continuation of major obstacles and therefore the category numbering is continued.

Table 2. Secondary Impediments to Development of Commercial Space Tourism

| Category Number | Category Title | Total Frequency of Occurrences |
|---|---|---|
| 12 | Insurance | 25 |
| 13 | Standards | 20 |
| 14 | Perception that Space is Risky | 20 |
| 15 | Government Does Not Support | 19 |
| 16 | Lack of Public Awareness | 19 |
| 17 | Perception that Space is Government Domain | 17 |
| 18 | Unproven Market | 15 |
| 19 | Stakeholder Conflict | 14 |
| 20 | Supply/Demand Catch 22 | 11 |
| 21 | NMBY | 2 |
| Total | 10 Categories | 162 Total Occurrences; 16.2 per category |

Source: D.C. Gibson, *Commercial Space Tourism: Impediments to industrial development and strategic communication solutions*, 2012, p. 122.

The issue of insurance is one of the most crucial and most frequently occurring problems. Insurance premiums will be quite expensive and might not even be initially available to the space industry. The liability is so great that most insurance companies would not want to risk being exposed to such an environment. Standards are an important part of space tourism; licenses, certifications, safety requirements and building codes must be

established to create rules under which governments, businesses and space tourists will function. Within space tourism, risk perception is not entirely accurate; the activity is perceived much riskier than it actually is. It is not to say that there are not real risks involved, yet risk perception by investors and the public seems to be greater than necessary.

Most governments around the world do not support space tourism; they are not interested in lowering launch costs and are not concerned with opening new markets, although this would be beneficial to them. Public awareness and support for this developing industry is significantly lacking; if the general public were be more informed about space tourism developments, then the further evolution of space tourism would be much easier, especially as investor capital would come much more easily. Yet, presently governments and their respective space agencies, particularly the U.S.A., Russian and European one, hold a monopoly on space activities and are unwilling to relinquish it; their space activity holds crucial interests to their programmes of national security and scientific research.

The existence of market demand is also questionable and a further barrier to the development of space tourism. Stakeholder conflict amongst space agencies, the academic world, private and public organizations, as well as companies, further complicates matters concerning the commercialization of space; ethical, environmental and economic reasons are most frequently mentioned. Supply and demand is also a catch-22 as Ashford simply explained "A catch-22 must be overcome. Low-cost space transportation depends on maturity, whose development in turn depends on commercial incentive, which depends on high traffic levels, which depends in turn on space tourism" (Gibson, 2012, p. 143). The NIMBY movement, which stands for not-in-my-back-yard, refers to the way people feel about the development of spaceports, factories, supersonic shockwaves and the related activity of space tourism in their community, which might disturb inhabitants of residential areas close to such facilities (Gibson, 2012, pp. 120–145).

# 2 BUSINESS OF SPACE TOURISM

The business of space tourism is in its developmental stage. Companies willing to provide services are not yet certain of how the market will respond or how the general outlook will be perceived. At present the supply is extremely limited, if existent at all, as there has not actually been any sub-orbital flight, while orbital flights have been a rare occurrence to say the least. However, this is changing as we have seen critical developments in the sub-orbital industry, to the point where reusable vehicles are all but commercially operational. There are high hopes that in 2014 people around the world will see the first public demonstrations of space companies providing their sub-orbital services. Yet, the question that remains is how will it develop the industry?

It is evident that some wealthy individuals do want to participate in suborbital flights; however, after the initial customer base is exhausted will there be enough customers to continue the operations of space tourism? Luckily, some studies have already been done, which estimate the amount of potential customers, and these shall be analysed in greater detail below. Among other things, this section will explore in depth how much demand can be expected, as well as how it will affect the future.

Preparation for flights is also an important aspect of space tourism. It is not enough to only fulfil the medical requirements to board a spacecraft; one must also be familiar with emergency procedures for a variety of circumstance. Participation in space tourism offers many other benefits than just the simple enjoyment of the amazing views or weightlessness. Although, sub-orbital tourism experiences last a considerably shorter duration than orbital ones, tourists nevertheless might want to perform marketing campaigns or other activities. With orbital tourism customers will have a longer time to plan these procedures out and experiment with a variety of resources. For the purpose of getting an in-depth understanding of a space traveller's experience with space tourism, the process thereof will be presented in detail.

As in aviation, one can expect accidents to happen, so the necessary precautions need to be taken into consideration. Obviously safety of the vehicle and the tourist experience is at the forefront, yet the procedures, legal considerations and liabilities must be taken into account and explored as well. The process of space tourism should be looked at in a holistic manner, from process of how a customer chooses the service to the return from a space experience and the risks and liabilities that may occur as a result.

Apart from the design of space tourism business, the strategies will also be investigated. One must be aware that a proper strategy is the key to a successful business, as well as the establishment of a new industry. The pricing strategy for orbital and sub-orbital operations will be looked at. In addition, the importance of public relations will be taken into consideration, as it plays a vital role in the sustainability of the space tourism. The section of potential future advancements within the industry is also worth considering for the purpose of gaining greater understanding of how the industry and its respective businesses might progress and evolve.

To put it briefly, the following section will present the process of space tourism industry for both sub-orbital and orbital travel. The requirements of businesses and responsibilities of customers will play a vital role in the future development of space tourism. It is crucial that these aspects are planned out accordingly; hence the following section will look at these aspects in close detail. Of course one must also not forget about the public relations and the profitability of the business, which is why the following sections will draw the reader's attention to these crucial issues as well.

## 2.1 Investors

As mentioned above, investors are generally sceptical and difficult to find when it comes to space tourism. Without a doubt, space tourism has so far relied on the utmost help of so-called angel investors or individuals with immense wealth who truly believe in the idea of space tourism. These billionaire investors include Paul Allen (a co-founder of Microsoft), Larry Page (a co-founder and the CEO of Google), Jeff Bezos (the founder of Amazon.com), Elon Musk (a co-founder of PayPal), and other notable wealthy individuals, who have not only created their own successful businesses, but in the process also helped to create entirely new industries.

Finding wealthy investors is not as much of a problem as convincing investment institutions and the general public to believe that space tourism is very close to becoming a reality. Perhaps not coincidentally, the successful entrepreneurs mentioned above, all made their original fortunes by developing ideas that were seen as questionable at the time, but later proved to be highly lucrative. Moreover, when the leaders of such established companies come together to promote and invest their capital in a newly-created industry, it is surely worth giving some attention to. The importance of these people's actions cannot be overemphasized, since they are the individuals who have shaped much of the recent trends in global industries.

Although there are a variety of investor risks, and some have already been encountered, as seen in the cases of Armadillo Aerospace and Rocketplane Kistler, space tourism must look towards success as would any other industry. Indeed this is happening, as Virgin Group has already formed its space tourism company and heavily invested in it, with notable support also coming from Aabar Investments in the forms of capital and potentially spaceport infrastructure (Croucher, 2013). Astounding progress in investments was made by the creation of the Space Angels Network. With the purpose of connecting entrepreneurs and investors in order to solve the problem of funding space-related ventures, the organisation established four founding members, among them New York Angels, which invested more than $95 million in start-up companies over the last decade. (Our Story: About Space Angels Network, 2014; New York Angels, 2014).

Elon Musk went from building electric cars to forming his own rocket company, signifying that space related activities are indeed at the forefront of accessibility. For his efforts, NASA awarded SpaceX a contract for resupply missions worth $1.6 billion (About SpaceX, 2014). While SpaceX is not yet participating in space tourism, it will have the capability to showcase manned transportation in the near future, which could potentially form part of the orbital space tourism market.

The investor market for space tourism is filled with uncertainty, but it is gaining momentum. With companies such as Virgin Galactic, SXC and SpaceX many see a new beginning for further commercialisation of space, which is leading towards space tourism. With time there will be more interested and willing investors. At present, the biggest investors are some of the wealthiest and the most accomplished individuals within their respective industries, which provide much needed reassurance for the space tourism industry, both in terms of economics and investor confidence.

## 2.2 Space Tourism Regulation

Space tourism regulation is probably one of the most complex areas of the new industry. The regulatory criteria is complicated, demanding, time consuming and confusing, as few countries have actually made any conclusive regulations regarding civilian space flight, which presents one of the key problems in space tourism. Presently, only the U.S.A. has made efforts to establish civilian space flight regulation and even it has been struggling to do so.

As legislators and lawyers tend to work with previously established laws and regulations, as opposed to drafting a whole new policy, space tourism regulation is similar to space law, air law and high-risk adventure tourism law. It is fair to presume that space law would have some impact on space tourism, as the United Nations Committee on the Peaceful Uses of Outer Space (hereinafter: UNCOPUOS) provides for some international treaties and provisions. Conversely, it predominantly considers national activities and nations' responsibility for these activities. Private commercial space activity is not mentioned and is still under the jurisdiction of national law, while in most cases national law does not have the proper regulation. Presently no countries except the U.S.A. have made efforts to update and regulate their national law regarding space tourism. The most progress in regulating space tourism was made by the U.S.A. when it drafted the 2004 Commercial Space Launch Amendments Act (Von Der Dunk, 2012).

The Federal Aviation Administration's (hereinafter: FAA) Office of Commercial Space Transportation and International Outreach is a particular department that handles transport related space activities. This particular department has the power to authorise the launch and re-entry of commercial space vehicles, while the Department of Defence and NASA carry out their own launches in accordance with their needs. In 2004, amendments were made to put the FAA in charge of regulating, licensing and processing commercial launches, operations, re-entries and site operations within the U.S.A. Under this regulation the FAA does not certify launch operations; rather it licenses them as to avoid any liability that may befall the commercial operator. In other words, regarding any accident, incident or failure of the mission, the operator is at fault and bears all the responsibility as opposed

to FAA. Overall, the FAA is responsible for commercial space regulation as well as experimental and developmental manned or unmanned space flight activity (Sloan, 2012).

There is a lack of international regulation regarding space tourism. There is no proper barrier set where outer space begins, and terms such as "space object" and "launch" require very clear definitions to determine liability. Due to the lack of definitions, it is unclear how possible conflicts might be resolved under such regulations. It is hoped that the Karman Line of 100 kilometres would become the established rule of international law; however this has not yet been done. Under Article I of the 1972 Liability Convention, an update to the Outer Space Treaty, a "space object" may be any object that is man-made and launched into space, while the term launch itself presumes that there is a rocket assisted vertical departure into outer space.

However, this definition may allow for differing opinions and interpretations that could lead to further difficulties, as some vehicles such as the SS2 are launched from mid-air. The SS2 detaches from the mother-ship, and hence there is room to consider which one is an actual space object. The law might cover either vehicles or only one, while the launch characteristic does not reflect the definition. Another case in point is the Lynx, which has more characteristics of an airplane than a space object and takes-off in a horizontal manner. The question here is if such a take-off is considered a launch. Both cases provide dilemmas for national space law and the Outer Space Treaty; yet considering that these objects have the purpose of reaching outer space, they could potentially be classified under space law regulation (Von Der Dunk, 2012).

The 1944 Chicago Convention is a historical foundation for air law under which each state regulates its own airspace, and as spacecraft involve airspace there should be legal consideration in this area as well. Again there is a dilemma here, as air law mostly deals with horizontal space as opposed to vertical. As stated beforehand, there is great hope that the Karman Line will be applied as a boundary to differentiate where air law and space law are applicable to space tourism. The question of liability is most related to a set of conventions stretching from the 1929 Warsaw Convention to the 1999 Montreal Convention, where liability is not held by the state over which the aircraft is flying, but is rather determined by the departure and arrival of the aircraft; moreover, the operator must compensate passengers in case of damage.

Third-party liability will be regulated under the 2009 Montreal Protocol when it comes into force; at present the 1978 Montreal Convention is followed, which gives credence to national law. Under these conventions there are many categories and types of aircraft; establishing a sub-orbital vehicle category would provide for ease of applicability. Indeed the European Airspace Safety Agency (hereinafter: EASA) was heading in the direction to make sub-orbital vehicles and crew licensed and certifiable; however, due to safety issues,

lack of statistical data about sub-orbital vehicles and the International Civil Aviation Organization's insistence on developing Standard and Recommended Practices, the U.S.A. approach is considered to take a prevailing position. In any event, the harmonization and uniformity towards space tourism policy must be kept in line (Von Der Dunk, 2012). EASA will wait and observe further developments within space tourism, and afterwards make its decisions on civil space regulation, liabilities and how other agencies and institutions react.

According to the 2004 Commercial Space Launch Amendments Act in the U.S.A., customers would limit the contractual liability of companies through a waiver that is common in high-risk adventure tourism. Such practice seems best when taken the cost of developing rules and regulations, harmonizing the international law to national law regarding space tourism and facing overall liability issues. So far this is the most prevalent case of space tourism regulation; however, this practice too might have certain drawbacks. The case of negligence by the operator and any onboard damages would not be the operator's responsibility. On the other hand, future conflicts and liability issues will have to be decided in the national courts, which could further advance space tourism regulation in harmonising and standardizing legal codes. It is no different than what the legislative branches of governments around the world are doing presently, making laws and regulating them with the help of other branches of government.

## 2.3 The Demand for Space Tourism

It goes without saying that at the beginning space tourism will only be for high net-worth individuals. For those who have millions of dollars in their bank accounts and are simply put, rich. According to the Forbes list of millionaires, the year 2013 was a record breaking one. There was a 9.2% increase in millionaires, defined by the World Wealth Report as those who have $1 million or more, amounting to 12 million people worldwide. It is presumed by the Royal Bank of Canada that the millionaires' rate of growth shall increase by 6.5% annually until the year 2015. Consequently, there will be about 13.5 million millionaires in the year 2015 (Goodman, 2013). Conveniently, that is when sub-orbital space tourism will be making its debut and establishing itself within the tourism market. Although the ticket prices may be high for ordinary individuals, there will be enough wealthy individuals with the needed resources to purchase a ticket or two aboard their choice of spaceship. Many would agree that space tourism is a privileged type of tourism and that the general public will not be able to afford it; however, while as this type of tourism is an exclusive offering; there are enough wealthy individuals to satisfy the provided supply characteristics. Certainly there have been further studies done on the viability of space tourism market.

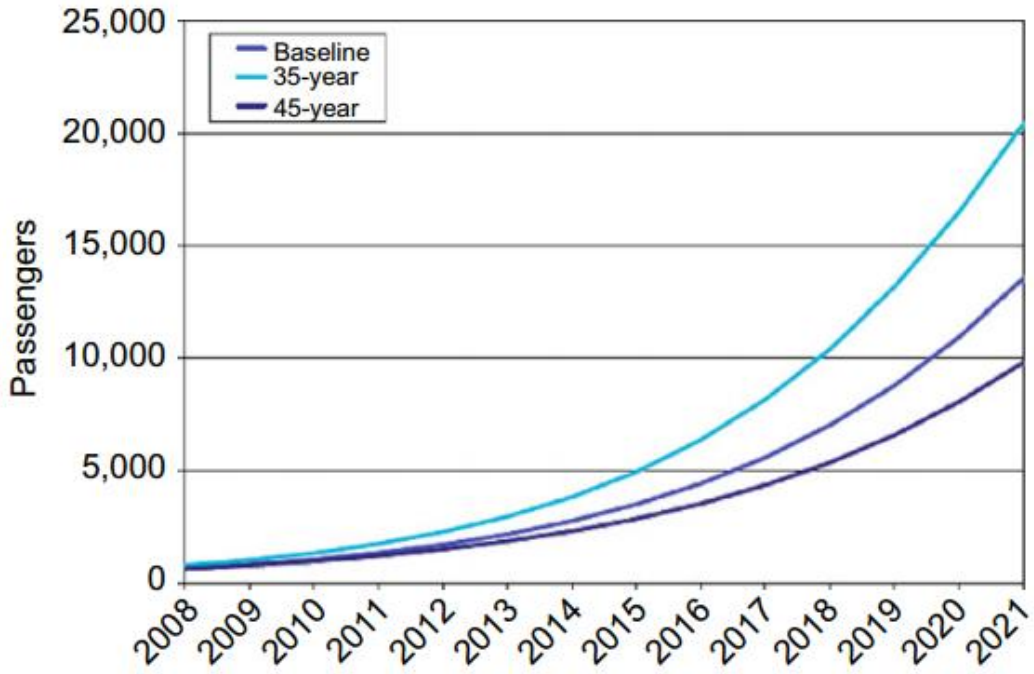
Quite a few prominent studies have been conducted by various organisations on the demand of space tourism. In 1993 in Japan, market research concluded that most people would like to see space tourism become a reality; 80% of younger and 50% of older people were in favour of space tourism (Collins, 2006). Since then, it is said that demand for sub-orbital as well as orbital tourism has been rising. Other market studies and surveys have also been done. One of the most prominent and credible studies comes from the Futron/Zogby's "millionaires market study," a market research performed in 2002 and later updated in 2006. In 2008, Incredible Adventures further updated the study with its "adventurer's survey" filling in the missing parts of the study. Another study was also performed by Ipsos, a global market research company that was hired by EADS Astrium to understand the demand for their sub-orbital Spaceplane (Ziliotto, 2009).

### 2.3.1 Futron/Zogby Survey

The Futron Corporation performed its study in the U.S.A. with the purpose of projecting a 20 year prognosis of sub-orbital space tourism. It interviewed 450 millionaires by phone in order to have a realistic sample from which it could draw its conclusions. The parameters included in the design of the survey mirrored the appropriate criteria to correctly reflect the market of sub-orbital and orbital space tourism. The criteria that were included were an annual household income of at least $250,000 or a net-worth of at least $1 million. Additional filters such as travel expenses, interviewee interest in participating in sub-orbital space tourism, pioneering influence and physical capabilities were also taken into account. A reduction in the base price was also incorporated into the study. In the updated 2006 survey, the fitness test was scaled down, as the requirements were not as stringent with the announcement of operations from Virgin Galactic; for the same reason, the ticket price was set at $200,000.

The conclusions of the study were that there is a significant demand for sub-orbital space tourism and that it would continue to grow. 19% of respondents were interested in purchasing a flight to the sub-orbit, while 18% were interested in orbital space flight at price levels of $20 million to $25 million. The most interested candidates for sub-orbital flight had an average age of 50, while for the orbital flight the average age was a bit higher at 55. According to Figure 6, if sub-orbital space tourism was offered in 2008 there would have been 600 customers to begin with, while at market maturation in 2021 there would have been 13,000 customers, with revenues amounting to more than $600 million (Ziliotto, 2009). Virgin Galactic has already made about 700 bookings on their space flights, which mirrors the representative sample from the survey fairly closely (Schultz, 2014). As Virgin Galactic is scheduled to be operational in 2014, market maturation is expected to occur around 2027.

*Figure 6.* Results of the millionaires' market study




Source: V. Ziliotto, *Relevance of the futron/zogby survey conclusions to the current space tourism industry*, 2009, p. 1549.

However, the study must not be taken at face value, but rather be considered as an estimate. Virgin Galactic will not hold a monopoly in the sub-orbital market, at least not for a long time. It will be interesting to see how SXC will compare to Virgin Galactic and which operator customers will prefer with reference to quality and price. As discussed above, the two companies have many different characteristics, including spacecraft. In addition, EADS Astrium could enter the market and some tough price wars might result. In such a case, the consumer will be the winner as prices will decrease at a faster rate, which would lead to more bookings.

### 2.3.2 Incredible Adventure's Study

Incredible Adventure's study had a different approach to its market research. Through the Incredible Adventure's website, a poll was offered that visitors to the site could participate in. As visitors to the website might not necessarily be their customers, the survey cannot be used as a representative sample; however, it offers valuable insights nevertheless. There were 998 respondents; out of those, 14% were millionaires and only 7% actually registered for a sub-orbital flight, where the price in question was between $100,000 and $200,000. Moreover, 36% were willing to wait till prices dropped to around $50,000 to actually buy a ticket, while 47% were willing to wait for advancements in technology for the decrease in price; most likely due to safety and consistency factors to be proved trustworthy. Safety

seemed very important to customers; in total 62% of respondents wanted to be assured of an acceptable price and proven safety before they purchased a ticket. The study also found that most of the respondents preferred the Lynx type of aircraft that has a horizontal take-off and landing, as oppose to the SS1, which detaches from its mother-ship WK2 during flight. Vertical landing and take-off of potential future entrants' spacecraft were also positively received; surprisingly the location of the spaceport seemed not to make a considerable difference (Ziliotto, 2009).

The study also looked at alternative funding for space tourism, as the question in the survey asked if participants would be willing to participate in a lottery to win a trip on a suborbital space flight if the lottery ticket cost $100. 31% of respondents were willing to try their luck to win a sub-orbital flight, which suggest a viable alternative for funding. Another interesting find was that if prices were disregarded, 56% of participants would choose a trip around the moon as their favourite type of space flight 47% would choose an orbital flight (Ziliotto, 2009).

Many have found orbital tourism to be even more appealing; however the ticket prices are extremely high, even for the wealthy, while at the same time are rarely available. The long procedure of booking a ticket and preparation for the trip, as well as lack of supply of such services, would force the customers to wait. The Futron/Zogby survey found that out of the 18% of respondents who were interested in orbital flight, 22% would be willing to pay between $22 million and $25 million. If sub-orbital tourism would be an everyday occurrence and could potentially fund the orbital tourism segment of the industry these prices might fall to a range of $5 million to 8$ million, further increasing demand to somewhere between 10,000 and 100,000 customers in the not so distant future (Seedhouse, 2008, p. 82; Ziliotto, 2009).

These are only estimates, and the reality of how many customers there would actually be is still questionable. Nevertheless, these conclusions are insightful for orbital space tourism. Considering that there have only been 7 civilians in space so far, the number reaching the thousands would surely support the belief that there is a significant demand for orbital space services. If companies such as SpaceX, Blue Origin and EADS Astrium, which have the needed financial, technological and historical experience, would start operating there would be a profound way of maximizing their revenues and establishing market share. It is evident that there are many people who want to be space explorers and venture to places few have been to. Considering that the rich are always looking for new experiences, to have thrills as well as further establishing themselves as elite, they would "gobble up" the services provided.

Such studies suggest that the Lynx plane is properly marketed by SXC. The price on a Lynx is $100,000 and most likely within the 5 years it will have significantly decreased as

they too will use the price skimming technique. Incredible Adventures is already marketing their offer with the Lynx 1, and at the end of 2014 these flights should already be operational. In 2015, the Lynx 2 will be operational, which can satisfy the customer's desires of travelling up to an altitude of at least 100 kilometres. The pioneering effect seems to be important only for a small group of people; nonetheless, as there is limited availability of seats both flights should be fully booked according to the results.

### 2.3.3 Ipsos' Market Research

After the Futron/Zogby and Increidble Adventure's studies, there was a more detailed and recent market research performed. EADS Astrium, a subsidiary of the Airbus Group, wanted to perform a feasibility study of the potential market for their sub-orbital Spaceplane and in those efforts it hired Ipsos, due to their global market outreach and excellent credibility within the industry of research. Ipsos developed a detailed study of qualitative and quantitative measures. The qualitative part was conducted by personally interviewing 12 high net-worth individuals who wanted to participate in the study, while the quantitative study was performed through an online survey of 1850 people. The qualitative stage wanted to find how the customers feel about sub-orbital tourism, what their perceptions were and where they attach their values.

The study also wanted to understand what price customers would be willing to pay in addition to finding their outlook of similar products of luxury tourism. The quantitative, online part consisted of two segments of interviews, one performed in 2007 with 1250 high net-worth individuals in Europe and Japan, while the other, performed in 2010, with 600 individuals who were from Asian countries and Australia; it defined high net-worth individuals as the ones who earn an income greater than $250,000 annually. The quantitative part tried to draw insights from questions that touched upon their awareness and perception of sub-orbital travel. The questions tried to determine the amount spent on travelling, leisure and sport activities, while at the same time attach an evaluation of their assets and willingness to participate in sub-orbital space tourism (Le Goff & Moreau, 2013).

The results of the qualitative stage of the study revealed that many of the interviewees were very much interested in sub-orbital flight; all of the participants rarely show up to the interview. The study showed that most knew about sub-orbital flights. The aspects of sub-orbital flight that were most intriguing to the participants were primarily the view of the Earth from space, while the experience of the flight was a close second. The luxury feature also seemed very important, as the exclusivity of the trip made them feel special and unique. Amongst other the aforementioned aspects, the interviewees also found pleasure in getting to know their co-travellers, taking photos while on the trip and the application of new technology. When the results of the quantitative study came out they were scaled up to

reflect the real population. With the data acquired from Capgemini & Merryl Lynch World Wealth Report of 2009 the demand estimates could be realistically portrayed. To further add to the accuracy of the report the blow of the financial crisis was taken into account, as well as the increase of high net-worth individuals at 4% for the next 16 years (LeGoff & Moreau, 2013).

Market research revealed that there are 5 main groups of space tourists (LeGoff & Moreau, 2013):

1) **Enthusiastic Elite**: group of wealthiest and most interested individuals;
2) **Blase Group**: almost as wealthy, yet see sub-orbital tourism as just another touristic opportunity for them and therefore are not as passionate;
3) **Adventurers Group**: almost as enthusiastic as the Enthusiastic Elite, however it is not as wealthy;
4) **Risk Averse Group**: interested in the flight, yet concerned with the safety features of the flight and the group needs time for reassurance;
5) **Low End High-net Individuals**: not interested and concluded that they could not participate on the trip.

According to the previously mentioned groups, the research simulated two price scenarios. Shown in Table 3 are the cheapest and the most expensive price scenarios that portray how many passengers would accordingly take the trip annually. In the first year the research found that there would be between 600 and 750 customers while as the market would reach its maturation in 16 years, there would be about 43,000 to 85,000 customers annually (Le Goff & Moreau, 2013). It is important to understand that these results are intentionally calculated in the most conservative manner with the present day perception of sub-orbital tourism; many more people might be willing to participate in such space flights, especially after marketing campaigns are initiated and word-of-mouth spreads amongst the populous.

Table 3. Demand at high and low price scenarios

| **Years after market starts** | **Number of passengers per year** | |
|---|---|---|
| | **High Price** | **Low Price** |
| 1 | 606 | 756 |
| 4 | 2,965 | 5643 |
| 8 | 14,762 | 21,711 |
| 12 | 34,549 | 58,340 |
| 16 | 43,148 | 85,464 |

Source*:* T. LeGoff & A. Moreau, *Astrium Suborbital Spaceplane Project: Demand Analysis of Suborbital Space Tourism*, 2013, p. 148.

The three studies have drawn companies to conclude that the market is viable for space tourism and that the demand should grow as prices decrease over time; revenues would also be positive and the business would be an operationally worthy venture. At first only the enthusiastic elite would be drawn to sub-orbital space tourism, as the feeling of being the first, experiencing new technology and being one of the privileged few would bolster their experience. Furthermore, studies have shown that not only is there interest in sub-orbital tourism, but also that customers are willing to spend at least up to three months salary for the experience. It seems that by nationality the most interested candidates are Americans and Chinese, while Europeans are the most risk averse. There are estimates that 20% of Americans who have a net-wealth between $20 million and $50 million would be eager to participate in sub-orbital flights and 50% of those with a net wealth above $50 million would be (Le Goff & Moreau, 2013).

The studies show that after the pioneering effect subsides and the safety factor is established, sub-orbital space tourism would be a tourist experience many would want, at least within the scope of luxury tourism; even those who cannot afford it would be willing to save up the necessary funds to be able to partake in it. Such type of tourism would apply to customers who perceive themselves as happy, adventurous, influential and privileged. These types of customers are looking for an experience that would either satisfy their social rank or experience something truly out of this world.

## 2.4 Strategy for Space Tourism

In this section some approaches will shed light on how strategies will need to be implemented to manage the business of space tourism. Particularly there are many concerns regarding pricing, safety, marketing and public relations. As has been noted, the price is a major factor that has to be precisely established and manage to take in as much of the consumer surplus as possible; in addition this will play a vital role in achieving a sustainable business model. The price must not be too high as to lose customers, particularly those who want to participate yet may have to save up for the trip for an extended period of time. On the other hand, the price must not be too low, as the result would be a demand surplus and therefore not maximise utilisation due to the limited supply of the spacecraft's capacity and maximum rate of launches.

The safety aspect of the flight is also one of the most crucial parts of space tourism; Europeans are particularly risk averse and desire to be certain that space tourism is a safe alternative to other touristic options that they can choose from. Individuals who are risk averse must be convinced that all the precautionary measures have been taken into consideration, while the reliability of the new technology is consistent and trustworthy. Furthermore, the message of price and safety must be consistently and concisely conveyed to customers. Not only must the message of price and safety be clear and justified, the

indescribable sensation of weightlessness and beauty of Earth must be illustrated in the most fantastic manner to further draw customers, as well as imprinting the uniqueness of the experience.

### 2.4.1 Pricing Strategy for Space Tourism

It goes without saying that price is in correlation with cost, demand and supply. Determining the ticket price for a reusable space vehicle, be it sub-orbital or orbital, is much harder due to the relationship between supply and demand, as well as development costs, manufacturing costs, operational costs, maintenance costs and unpredictably incurred costs. In 2005, for better understanding and comprehension of the future of sub-orbital and orbital space tourism, the Japan Society for the Promotion of Science (JSPS) and the Alexander von Humboldt Foundation (AvH Foundation) sponsored research that would elaborate on the future market and prices of space tourism. R. A. Goehlich performed a case study establishing price strategy by keeping in mind that the priority was to optimize launch system parameters, such as reduction of costs, while at the same time increasing total revenues through price strategy schemes.

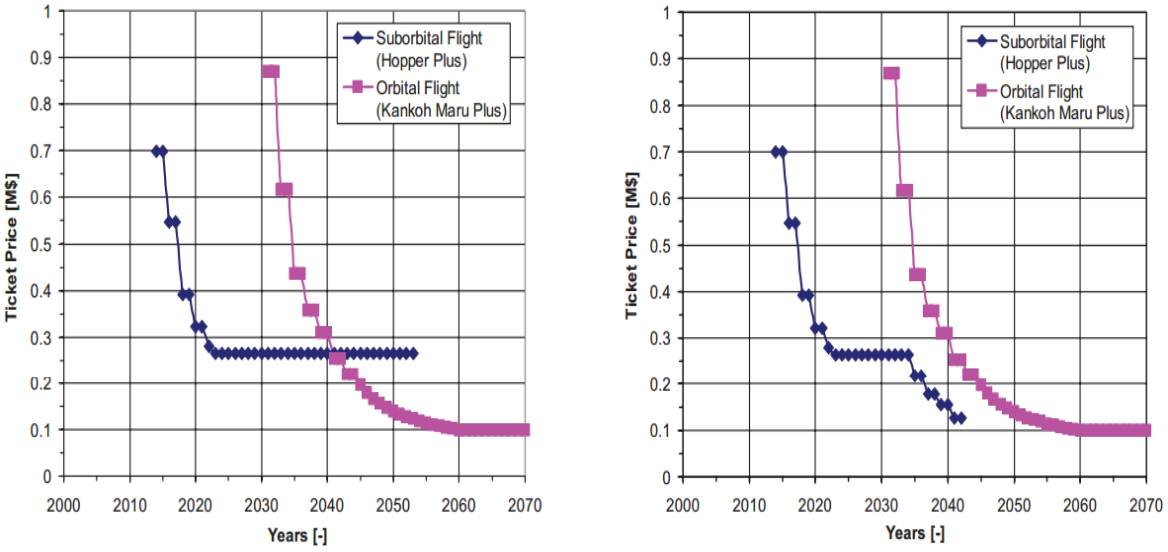
Goehlich (2005) started of his study by taking into account the previous design concepts by EADS of their potential reusable vehicles. With some modifications he called the sub-orbital one Hopper Plus, which had horizontal take-off and landing capabilities, and the orbital one Kankoh Maru Plus, which had vertical take-off and landing capabilities. The assumption was that there would be no other vehicles on the market and that Hopper Plus would start its operations in 2013, while Kankoh Maru Plus would start operations in 2030. The reusable vehicles' operational and development costs were compared to present day conventional rockets and aircraft. The results concluded that cost per unit of kilogram for development of a space vehicle, either sub-orbital or orbital, were lower than the conventional rocket and higher than the conventional aircraft, while the productions costs were higher than with both conventional rockets or aircrafts. Goehlich found that the skimming price strategy would be the most profitable strategy to use. Such a price strategy is used to maximize revenue, where an initial high price is offered and through time decreased to achieve a greater number of customers. The optimum ticket price for Hopper Plus would start off at $699,000 for 360 passengers in the first year and after 29 years would drop to $126,000 with 2700 passengers. For the Konkoh Maru Plus the price would start off at $869,000 with 1250 passengers and drop to $99,000 with 100,000 passengers.

The setting of the price was derived based on the following calculations of optimizing the enterprise operations. The calculated development cost for a fleet of spaceships of Hopper Plus was $7.9 billion while for the Kankoh Maru Plus it was $9.7 billion. Hopper Plus would incur $12 billion in cumulative costs and $7.1 billion in fiscal costs. With that in mind the return on investment would be 5% for private investors, while public investors

would receive nothing due to negative cash flow. The break-even point would occur after 15 years for the Hopper Plus enterprise. The Kankoh Maru Plus would incur $112.9 billion in cumulative costs and $3.9 billion of fiscal costs. The return on investment would be 47% for private investors while 56% for public investors. The break-even point of such an enterprise would be reached in year 8 (Goehlich, 2005).

As shown in Figure 7 the case presented the best price strategy for Hopper Plus, that there would be only one enterprise holding a monopoly for 30 years and the demand for the service would stay at a maximum by decreasing price accordingly to about $280,000. However, as Hopper Plus would start off its operations in 2013 and Konkoh Maru Plus would be introduced in 2030, they would only operate within the same time period for a bit more than a decade. The case B pricing strategy would result in a sharp decrease in price in year of the Konkoh Maru Plus introduction; falling sharply from $280,000 to $126,000 within the next 13 years. Lastly case C was derived from case B, which assumed that with the advance in technology and the appeal of orbital flights, only a few or none would buy tickets for the sub-orbital service. The consequence is that sub-orbital flights would cease to exist and would be closed down. The income acquired would be less than the costs of operation and in that respect sub-orbital tourism would become obsolete (Goehlich, 2005).

*Figure 7*. Pricing strategy for monopolistic (left) and oligopolistic (right) markets




Source: R. A. Goehlich., *A Ticket pricing strategy for an oligopolistic space tourism market*, 2005, p. 303.

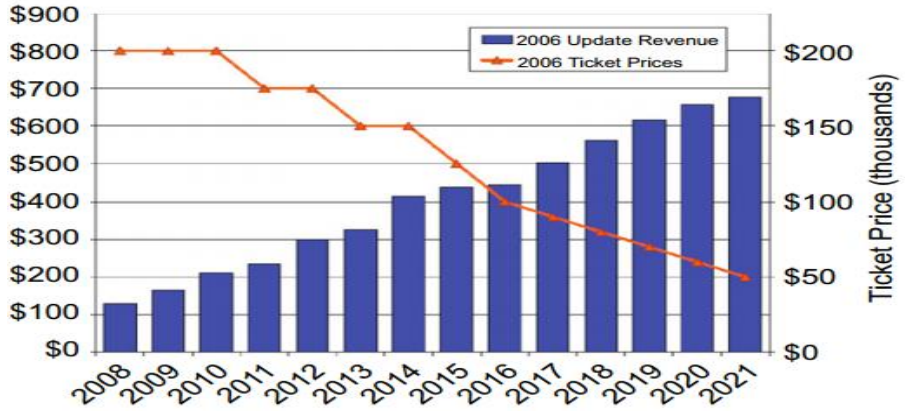
The study shows the potential to make space tourism profitable and portrays the price scenarios for the two aforementioned spacecraft and their interrelation. It also shows that revenues can be achieved by offering such services to the public and that it is not a waste of investment. For the sake of argument, one might say that in fiscal terms the Hopper Plus

in would burden the public investor, yet sub-orbital tourism is the precursor to orbital tourism, and therefore a necessary step to fulfil the greater goal of orbital space tourism.

The case demonstrates that it is possible for a private company to offer such space tourism services and make a profit. Investors receive confidence about operations of orbital space tourism, as well as opportunity to invest in other segments related to orbital tourism, such as spaceports, orbital habitats and other potential infrastructure. Sub-orbital tourism is a testing point for orbital tourism, as well as an opportunity to increase revenues. Instead of going straight to orbital operations and encountering problems or waiting for a major investing injection, the enterprise already has capital to work with in addition to having certain operational bases, credibility, knowledge, experience and credibility within the consumer market place.

The Hopper Plus seats more passengers than the SS2 or Lynx 2, yet in terms of decreasing price strategy certain conclusions can be made. The first ticket on the Hopper Plus is $699,000 and Virgin Galactic's is $200,000, as the price drop amounts to about 82% with the price skimming strategy in addition to the final introduction of the orbital vehicle to the market, one may conclude that Virgin Galactic's price could drop to as low as $36,000 per passenger. Figure 8 shows the Futron ticket price based on the SS2 specifications. Similarly the Lynx 2 may expect that there is an 82% difference between the pioneers and the final customers, to where the price would be only $18,000. These are significant price differences and should be kept in mind when talking about both, the pricing strategy or the ability of space tourism to be a viable segment of tourism industry. Although the price will still be relatively quite expensive, it would be affordable for those eager to venture into space. At an expense of saving up for a reasonable amount of time, such as few months, the customer would be able to afford space travel and appreciate the services offered.

*Figure 8.* Shows price skimming strategy




Source: V. Ziliotto, *Relevance of the futron/zogby survey conclusions to the current space tourism industry*, 2009, p. 1549.

In respect to orbital flights, Konkoh Maru Plus seems to be a viable and fairly inexpensive option. In comparison to today's prices for orbital travel which can reach $50 million, the initial price of $869,000 is a tremendous step forward. With the price decrease to $99,000, the whole niche of space tourism may truly become a standard experience and not an experience of the privileged few. As the lowest price would be achieved around the year 2070, other questions must be raised about how far the technology and energy alternatives will have advanced. While there is the possibility that technological developments might stumble upon alternative energies that have greater output than input and are thus self sustainable, the previously built up infrastructure would provide steady transition and easing of the burden of travelling beyond Earth.

### 2.4.2 Risk and Insurance Considerations

Space tourism will encounter two main types of risk. One type of risk is identified by the passenger, where health requirements will have to be met. Health aspects will be analysed in the section of preparation for the voyages and how they will be managed. The other risk encountered by the operator is the safety of the space flight. Rockets are dangerous and in a split second things many go terribly wrong. Scaled Composites have witnessed the devastating outcome of an explosion at their testing facility when they were experimenting with nitrous dioxide for their rocket motor. The accident left terrible consequences for the employees as well as for the reputation of the company and hindered the faith in space tourism. The resulting accident left three dead and another three seriously injured (Leonard, 2007).

The accident at Scaled Composites was significant, taking a toll on the employees and the company itself. It raised serious doubts for the public, who reasoned that if accidents were already happening during the testing, then they might also occur during operations. Rocket fuel is flammable and overall a dangerous mix of chemicals to which passengers will be in close proximity when taking the trip. There are numerous other risks that must be accounted for and properly managed. The insurers, brokers and other agents within this field play a vital role at managing such risks.

Their job is to prevent or properly handle the potentially devastating consequences of unforeseen events. If on its inaugural flight the SS2 and its carrier ship WK2 encountered problems and something went wrong, such as an event as devastating as the one seen by Scaled Composites during testing, then space tourism might stay grounded for a long time. The demand side would certainly be hampered, but could be properly managed, yet operational costs incurred would potentially be devastating; in such an outcome both public perception and repair costs would be significant consequences. As a result of this, the insurance industry and their respective agents must further discuss their much needed role in the development of space tourism in general.

Apart from establishing air and space boundaries, one of the main issues of the insurance business is actually coverage of hull risk. For the marine and aviation sector, hull risk refers to the hull or body of the vehicle, the machinery used and the all of the equipment of the vehicle. Hull risk covers the time period of transportation and operation of the vehicle unless certain exclusions are made by the underwriter. If the hull risk is justifiable the underwriter must repay the owner to the state of before the incident or compensate to the "Agreed Value Basis". In other words, the "Agreed Value Basis" is an agreement of value between the underwriter and the owner for the cost of incurred damages (Bensoussan, 2010). Lawyers and underwriters will have to come to an agreement of contractual definitions and applicability thereof.

Another insurance issue deals with liabilities either to the passengers or third parties. At present only the U.S.A. Federal Aviation Agency has compulsory insurance coverage pertaining to space tourism vehicles launched from U.S.A., which cannot exceed half a million USD. As for passengers, there is no such liability offered. Indeed, passengers would board spacecraft at their own risk, while to protect their business, the operator would demand that informed consent waiver be signed. Although in such a way the operator would protect itself and the business from any legal consequences, it is recommended that for a profitable and sustainable business the operator would also buy liability insurance for any bodily injuries incurred by the passenger during the training or flight processes. Thus, passenger insurance would consists of the aforementioned operator's liability, insurance coverage of the training and flight participation, as well as of an indemnity provision that covers the costs of travelling if there is an accident or illness (Bensoussan, 2010).

The primary importance to the insurance market lies in reliability of new technology, as well as the safety of the passengers participating in the flight. It is of utmost importance for insurers to be confident of these two crucial aspects of operations before any coverage can take place. According to Bensoussan (2010), no insurance agency shall sign an insurance contract with an operator till at least 10 to 15 flights are made and the actual details of the flight process are known in terms of realistic performance and discrepancies. All of the players involved in space tourism realise that adventures in space flight will inevitably encounter difficulties, accidents and irreparable personal consequences. The most accurate reliability figure is an accident rate of 1 in 50,000 flights; which, compared to the aviation industry in developed countries that has 1 death in 8 million flights, or developing countries where the number is 1 in 2 million flights, is quite concerning.

In light of this, insurers are averse in offering their services for such a risky business. In addition, if insurers decide to cover such a volatile business, the premiums for such insurance coverage will be incredibly high, unfortunately though it is not yet specified.

The insurance market is still uncertain how tourism space will evolve and what their role will be, apart from that is a critical one. The flight operators and owners need them in case of any accidents or incidents that may hamper the development of space tourism. The price will be high at first, yet if everything goes according to plan, the insurance coverage price shall certainly fall. As the saying goes, it is better to be safe than sorry. In the space tourism industry this is a vital saying, as the costs and potential legal actions on behalf of the customer or a relative might devastate the business of space tourism. This is why it is so important to make proper and legal discrepancies to avoid any unnecessary backlashes.

It is highly advisable that operators pay the high insurance premiums, because even if there are not any accidents, flights might be delayed or nonoperational due to mechanical or other issues or it might encounter some other unpredictable and unforeseen problems. As the customers would be ready to board, they would surely be highly disappointed and dissatisfied. Moreover, as most of the initial customers will be wealthy individuals or even celebrities, both of whom demand special and luxurious treatment, the necessary coverage will have to be in place. In such a manner, the business practice will be ethical, profitable and most of all safety and the minimization of risk will be put forth for sub-orbital as well as orbital space tourism.

### 2.4.3 Public Relations & Marketing

Public relations and marketing are of great importance to space tourism, almost as much as the risk management strategy. Actually they correspond and depend on one another. The key to success of space tourism is to increase demand with proper pricing, while also increasing supply with proper venture capital and good investor relations. In the aforementioned cases, public relations, marketing and crisis management with the public, as well as coalition building with stakeholders, are all part of the needed push to establish a sustainable space tourism industry. To elaborate, the public relations strategy of space tourism will need to be expanded in order to attain trustworthy relations with the public (Gibson, 2006).

Public relations firms will primarily need to effectively participate in the knowledge sharing process and stimulate public awareness of space tourism to attract more customers and ease their doubts. A secondary task will be making the general public aware of the potential risk through information sharing of space tourist activities, this is especially important in a crisis management situation if an accident occurs. By conveying the potential risks and explaining the precautions taken by the operator a double-edged sword is dulled. On one hand, the customer as well as the general public is aware of the risks, while on the other hand the customer and the general public feel more secure and trust the measures taken to provide a safe and enjoyable experience. Indeed, this is a paradox. On one hand, there are thrill seeking customers who would want to join space tourism to

experience life on the edge, while there are others who would want to experience the beauties of space adventure without having to think they might not return to Earth. Through such a public awareness and public relations campaign both sides of the public get a favourable bargain by achieving maximum safety, while at the same time promoting or better the said emphasizing risk.

Certain investors have already been convinced that space tourism is a future niche of tourism, however they need patience as in any developmental stage there are setback and bottlenecks. The stakeholders will have their fair share of conflict; some will want the space tourism industry to progress as quickly as possible to achieve the quickest return on investment, while the operator will have to bear in mind that safety is an important factor. Therefore, with proper communication and explanation of the advances and comprehension of the setbacks, the investor-operator relationship will be transparent and cohesive. Among the stakeholders there are also regulatory bodies, such as space and transportation agencies, which on side do want progression of space tourism as their costs would decrease and revenues would increase, such as in the case of space cargo delivery or the updating and upgrading of space infrastructure, while in other areas they might face a backlash in the case of an accident or improper legal repercussions. Hence, in all these areas of conflict, public relations and marketing firms must participate towards the sustainable development of the space industry and managing conflicts in an affordable, ethical and purposeful manner.

Marketing campaigns have also been spurred into action; from various interviews with the founders of space companies, such as Sir Richard Branson, to promotional exhibitions such as those of SXC in China and UAE. Marketing campaigns are not yet in full swing as they do not need to be. High-net individuals are the first ones needed to be drawn to space tourism, while the rest of the public will follow later when prices are appropriate for their income The primary task to date has been to convince the millionaires of the world that such a trip is safe, extraordinary and most importantly exclusive. The added value of luxury is also a dominant factor in convincing the ultra rich to experience sub-orbital tourism.

Sony Pictures Television has signed an agreement with the SXC to create a reality TV show of space boot-camp called MIPCOM - Milky Way Mission. Dutch celebrities will compete for a prize to be sent to sub-orbit; most likely on the Lynx 1 or 2 that is produced by the SXC. The TV show has already been sold to Nederland 1 and will be showing contestants training and performing challenging tasks. Sir Richard Branson seemed to like the idea of a reality TV show and has sealed the deal on his own marketing plan to expand and draw awareness to Virgin Galactic. The producer Mark Burnett, know for the reality TV show Survivor, will lead the TV show “Space Race”. The wining prize will be a flight on the SS2 (Andreeva, 2013; Virgin Galactic, 2013). Reality TV shows have been very

popular with mass audiences and will bring space tourism more general awareness; a perfect promotional technique to market future sub-orbital trips.

## 2.5 Design of Space Tourism

It is quite certain that space tourism will be a near future reality, at least sub-orbital space tourism. It has been shown that the general public demands such services and is also willing to pay up to few months' salary to be able to participate in space tourism activities. Nevertheless, not everyone will be able to participate in space tourism, as in addition to financial limitations there are also health criteria, especially for the orbital type of flight. Companies offering the services will have to design a training course, and also arrange entertainment activities during the flight itself. Conducting post-flight analyses and measurements of customer satisfaction is also crucial. Operators of space tourism services will certainly have to consider travel factors, accommodation options and potential value-added activities for the customer. As customers might consider travelling with friends or family, in such cases the necessary adjustments for them would need to be provided for. There must be ample consideration for an award system for the customers who participate in space flights. Many operators of space tourism services have already discussed the possibility of establishing special clubs for customers to join after completing their trips, and additional consideration has been given to awarding certificates or badges of achievement after a successfully completed trip. The following section will look at the general details, practicalities and design of each area mentioned.

There are many particularities before, during and after the flight that need to be considered when offering space tourism services. Customers will also have obligations and requirements of their own. Customers in general will demand luxurious treatment as they are high net-worth individuals and are accustomed to special VIP treatment, while space tourism in its own right is an extraordinary experience that few are privileged to participate in. The composition of these elements must mirror the seriousness and quality of the experience.

Spreading positive affirmations of the privileged treatment of customers is of utmost importance for the business practice to be successful, second only to the crucial issue of safety. It is not only the customer who is at the forefront of satisfaction though, the staff must also be considered. As will be explained, the pilot's role will be much greater than simply piloting the spacecraft. The training course and medical' examination will have to reassure and prepare customers to be physically as well as mentally stable. Hence, all this and more must be taken into account when one is looking at the design of space tourism services; safety, quality, luxury and special treatment are at the forefront of such an industry.

### 2.5.1 Preparation

There is much to be done before a flight launches into sub-orbit or orbit. Depending on the space operator and type of the vehicle used, the procedure should be more or less the same as the preparation for space flight. Upon contacting a tourist agency or an operator directly and making a booking, the customer will have to go through medical examinations and a training procedure. The training one receives, would last from 3 days to 2 weeks for sub-orbital trips, while for orbital trips at present the training is anywhere from one year to two years. In the future, orbital flights will require such training to be less time consuming as to appeal to a wider variety of customers. Those who will sign up for an orbital trip are presumably rich as the trip itself is quite expensive, and these individuals tend to have time constraints which need to be taken into account.

For sub-orbital space tourism, after the ticket is booked the operator will direct the customer to the proper FAA-flight approved doctor to perform a medical examination. For sub-orbital medical examinations the requirements are not as stringent as with orbital flights. When a customer passes the test, they will receive a Space Flight Medical Certificate and be eligible to partake in the flight. In cases where customers fail a medical examination, they may appeal or be referred to another medical examiner to receive a second opinion. The standard medical exam includes the following tests (Seedhouse, 2008, pp. 47–51):

- **Vision:** tests are performed for near vision, intermediate vision and colour vision;
- **Hearing:** should be able to distinguish a conversational voice within a range of 2 metres;
- **Pulse rate:** will resolve if there are any imbalances within the cardiovascular system;
- **Blood pressure:** if on average it is greater than 155/95 mm Hg, it might have to be treated;
- **Psychiatric evaluation:** if a customer experiences psychosis, bipolar disorder, severe personality disorder, epilepsy or similar disorders, they would not be eligible to participate;
- **Dental examination:** customer provides X-rays not older than 2 years.

A customer is deemed ineligible and immediately disqualified from participating in a space flight if suffering from any of the following conditions (Seedhouse, 2008, pp. 48–51):

- **Illegal substance abuse:** abuse of substances such alcohol, sedatives and/or illegal drugs in the previous to 2 years;
- **Diabetes mellitus:** customer requiring hypoglycaemic medication used in type 2 diabetes, which is resistance to body’s secreted insulin;

- **Coronary heart disease:** customer suffering build-up of plaque in coronary arteries, which may result in angina or a heart attack;
- **Myocardial infarction:** irreversible necrosis of the heart muscle, which may result in heart stroke or heart attack;
- **Cardiac valve replacement:** customer had heart surgery to replace heart valves;
- **Permanent cardiac pacemaker:** customer had heart surgery and a pacemaker implanted due to an irregular or slow heart beat;
- **Heart transplant:** customer had surgery to replaceme their heart;
- **Severe psychosis:** if a customer experiences psychosis, bipolar disorder, severe personality disorder, epilepsy or similar disorders they not eligible to participate.

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After a customer passes the medical requirements, the training period may begin. The type of training is greatly influenced by the type of spacecraft the operator uses. For instance, Virgin Galactic does not require any type of space suits and has no emergency egress procedure, while other sub-orbital operators might have one. The general outlook of sub-orbital training would encompass familiarity with the spacecraft, the space environment and the crew as well as passengers.

The flight participants would be greeted at the airport and transferred to the hotel where administrative procedures would take place. Sometime later, a final pre-flight medical examination would take place. At the operator's training facility customers would receive various informational and study materials, ranging from manuals to mission patches. At this stage they would be provided with space suits if the operator deems them necessary. Later, the passengers would mingle with one another and get acquainted with the crew. As they become familiar with each other, they would tour the spaceport facility seeing mission control, training facilities, and the spacecraft that would them to sub-orbit.

Consequently, the space flight procedure manual would be studied in detail. At this moment, their education of space activity would begin. Future space flight participants would study things such as the history of the first astronauts, space flight theory and rocket engines, how the vehicle performs and more specific technical details. Further knowledge would be acquired in physiology, survival training and high-altitude functions. The most physically straining part of the training would be concluded with the g-tolerance experience. Over the next couple of days the theory would be revisited and more performance tests would be done; ranging from centrifuge runs to systems training (Seedhouse, 2008, pp. 52–77).

The whole training process would be a combination of studying the given material, performance tests and lectures by professionals, who might even include some famous astronauts. To be truly well-prepared for the upcoming space flight the high-altitude training will deal mostly with emergency protocol and recognizing the signs of such an

event; this is probably one of the most important parts of the entire programme. The company might also want to include parabolic flights and extend the training for customers to get the sensation of microgravity. It is also noteworthy that some customers might have already experienced some of the training courses with other companies, such as parabolic flights or flying with jet aircraft to experience g-forces; in such cases it is still advisable that they do the necessary training to be part of the team, yet it is not required of them.

For orbital trips the medical requirements are much more stringent and demanding. This is due to the duration of microgravity one will be experiencing. Resulting effects will put a strain on one's body and must be accounted for. The medical examination will be equivalent as those for astronauts and many potential customers will likely not be eligible. Participants' bodies will experience a variety of strains and stresses, the most common being (Seedhouse, 2008, pp. 109–133):

- **Cardiovascular system:** will bear a lot of strain due to the microgravity, resulting in heart rate to beat twice as fast as in a resting position. Along with the cardiovascular challenges, the body will also experience;

- **Disuse osteoporosis:** which refers to the loss of bone density and muscle atrophy, which refers to loosing strength of the muscles. The more concerning and the least understood, is the bone density issue. The space flight participant will start losing bone density immediately upon entering outer space, which may have negative long-term consequences. This largely depends on the amount of time one spends in space, as the longer time one is there the more bone density one will lose. Scientist understand that a trip of a week to two weeks will not cross anythreshold; yet in cases of astronauts staying in orbit for up to half a year their bone density can deteriorate by 10%; even after a decade they still have not recovered fully or achieved their before-flight condition;

- **Immune system:** will also suffer due to various orbital stresses on the body and one may be more susceptible to disease upon return. The neurovestibular system, which deals with the orientation in the surrounding environment, sends conflicting signals resulting in a sensory mismatch and space motion sickness; this also holds true for sub-orbital trips;

- **Isolation:** depending on the amount of time space flight participants stay in space, one might experience home sickness, claustrophobia or other psychological disorders. While it is unlikely that space tourists will stay for such long periods, these effects may still occur;

- **Radiation:** is a common concern for astronauts. Space flight participants will not experience long periods in orbit, at least in comparison to astronauts who tend to stay for months, and therefore such concerns are not so serious for space tourism, at least at the present. However, radiation is hard to measure, due to either protective clothing, spacecraft and the electromagnetic field of the Earth. At present there has been no actual proof of its negative or long term effects on the human body.

The training for orbital space flight will take a much longer time, and will be much more intense physically and psychologically due to the sophisticated nature of the trip. Dennis Tito and others who ventured into the hostile territory of space spent 6 months training, which amounted to 900 hours in order to be properly qualified to join professional astronauts. Once orbital trips become widespread, the preparation would last somewhere around 3 months, yet it would cover all of the same fields as earlier programmes. Space tourist would train for 258 hours comprising 5 modules.

Orbital space tourism operators indeed require customers to master all emergency and safety procedures in order to be able to properly respond in those situations. Presently space flight participants that have gone on a flight with the Russian Soyuz rocket have had intensive physical and psychological training in addition to mastering a variety of safety procedures. Crew members rely on each other and must be able to handle emergency situations with the utmost proficiency. In this regard, they are required to be familiar with the Soyuz capsule, certain technical operations of and mastered all safety procedures.

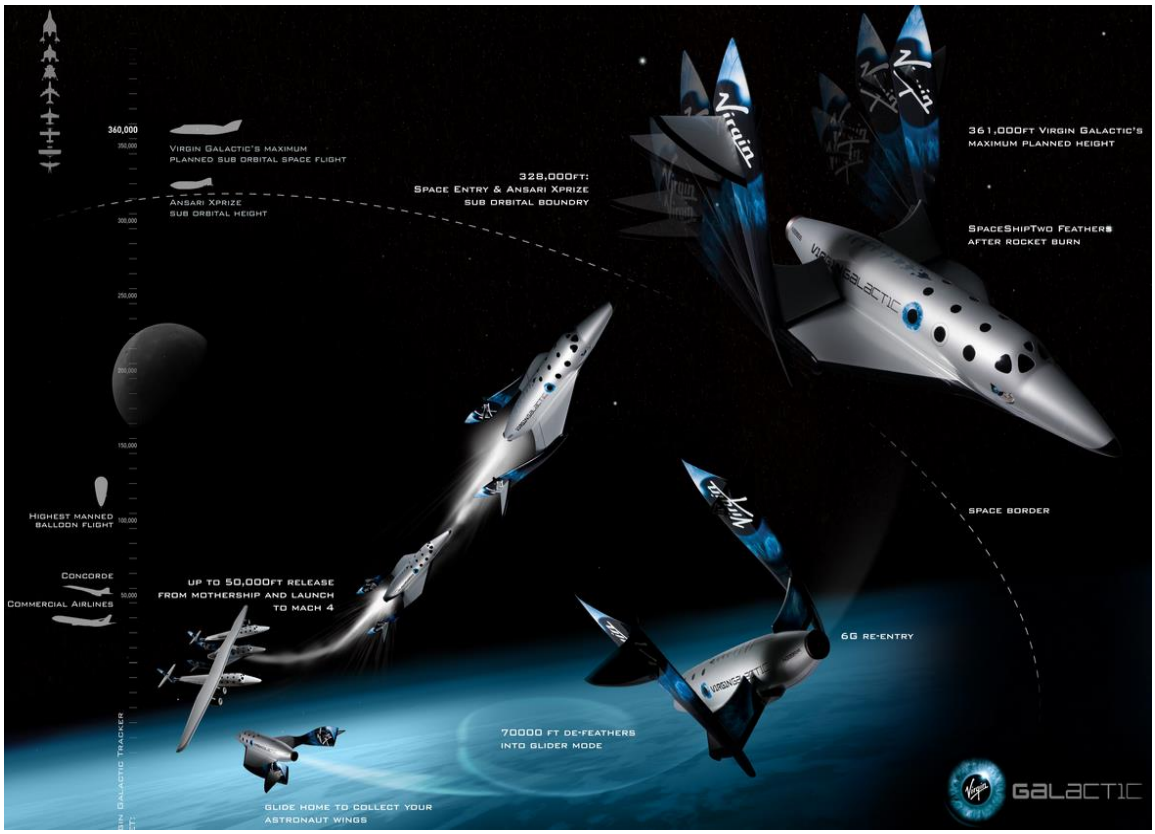
The first module would include the introduction to the space environment, explaining the process of rocket functions, hazardous environments, the need to exercise in space and other basic information about space that an astronaut should know. The second module would be a theoretical and practical approach to survival training; such training deals with realistic essentials of survival in the desert, ocean, Arctic and mountains. The third module would require the future space tourist to accomplish training in medical proficiency; being able to perform cardiopulmonary resuscitation, use telemedicine and ultrasonography (also known as diagnostic sonography), as well as being familiar with the use of radiation-monitoring systems. The fourth module would involve high-altitude and g-tolerance training, and the fifth module would be a combination of flying and skydiving. The flights would consists of advanced aerobatic manoeuvres, supersonic flights, parabolic flights and 12 skydiving jumps from an altitude of up to 4.4 kilometres (Seedhouse, 2008, pp. 139–152).

### 2.5.2 Voyage

There are two types of take-off, horizontal and vertical. Depending on the further advancements and successes of sub-orbital spacecraft, operators will most likely use a

horizontal take-off. Spacecraft will either be linked to the mother ship, as in the case of Virgin Galactic, or a single vehicle, such as the Lynx 1 and 2. Either way, it will have to include a rocket to achieve the altitude of the Karman line for the passengers to feel microgravity. To better understand the process of the journey, both the Virgin Galactic and SCX voyage types will be described. Figure 9 shows the sub-orbital voyage process of Virgin Galactic.

*Figure 9*. The voyage plan of Virgin Galactic

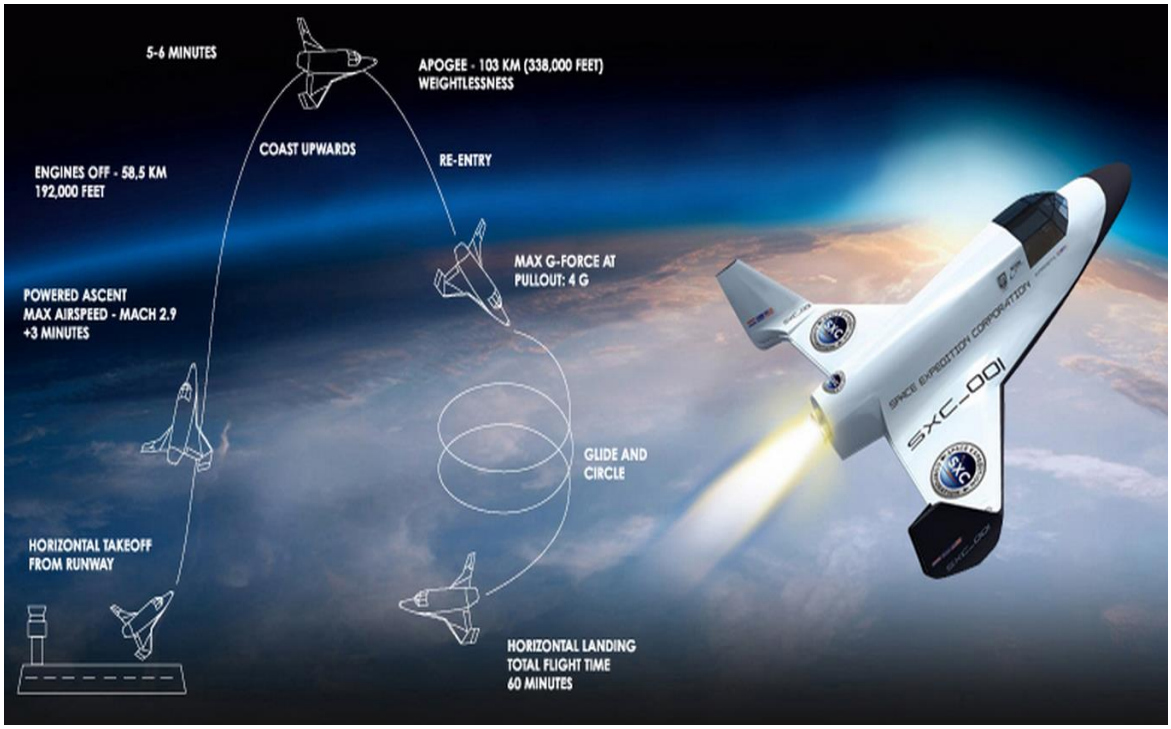



Source*: Graphics and Illustrations,* 2014.

After boarding, both the mother-ship with the SS2 spacecraft attached take off, and in about an hour climb to an altitude of some 15,000 meters where a countdown for the release of the SS2 begins. Upon release, the SS2 ignites its rocket engines and achieves a speed of about 4000 kilometres per hour, during which time passengers will experience subsonic flight of Mach 3. After 60 to 90 seconds the rocket engine will shut down and passengers will find themselves experiencing zero-gravity. Upon reaching microgravity, passengers can unbuckle their seatbelts and float around, perform manoeuvres that they cannot do on earth and maybe even decide to see how water or other substances behave in such an environment. After 3 to 4 minutes they will be asked to return to their seats for descent. Re-entry is one of the most crucial steps for both the spacecraft and passengers. The SS2 will experience heating of the hull due to the density of the atmosphere, while

passengers will experience up to 6 Gs of force on their bodies, although their inclined position will ease the tension. The SS2 will safely land and passengers will disembark after an unforgettable experience (Experience, 2013). In journeys with SXC, the process will be a bit different as shown below. Only one passenger will board the Lynx 2, and will be seated in the cockpit next to the pilot. The detailed process is illustrated in Figure 10.

*Figure 10.* Voyage of SXC's Lynx 2




Source*: Space Flight,* 2014.

The spacecraft will taxi to the runway and take off. The take off will be different as than that of the SS2, as the Lynx will immediately have a steep incline and will break the sound barrier within less than a minute. Over the next two minutes, the passenger experiences Mach 3 and at 60 kilometres in altitude the engines shut down, yet vehicle continues upward to experience zero gravity. The passenger of the Lynx 2 experiences weightlessness for 5 to 6 minutes, and then the spacecraft proceeds towards re-entry. Upon re-entry the pilot and the passenger feel the exertion of 4 Gs on their bodies (Spaceflight, 2014). The whole trip takes about an hour, and then the passenger is back on the ground with new sensations and memories.

In both cases, passengers will feel a force of 1.5 to 4 Gs on takeoff, reaching speeds of Mach 3, and on descent experience a force of 1.5 to 6 Gs. Although such high exertions on the human body are serious, it will nevertheless be part of the space tourism experience that many look forward to. The orbital spacecraft will have to use at least a two stage

spacecraft to reach orbit unless there is some great revolution within the propulsion systems industry, which is quite unlikely in the foreseeable future. A two stage spacecraft means that a part of the space vehicle will detach somewhere along the trip and be returned safely to Earth by means of a parachute and be reused in the next trip. SpaceX is making great progress with a 2 stage type spacecraft with its Falcon rocket and Dragon capsule; yet it will still be some time before commercial orbital flights are widely available. Sub-orbital flights are at the forefront, and the one of the most significant parts of the trip has thus far been given little attention, namely the space pilot.

Humans are not yet ready to trust automated processes when it comes to space travel. To instil complete confidence in customers and assure them that they have someone to rely on if something goes wrong, sub-orbital tourists will need a special kind of pilot. Additionally automated processes tend to be more expensive to develop, so human pilots are another way for space operators to minimize their costs. According to present day standards sub-orbital pilots must have a Federal Aviation Administration class 1 certificate, which is also held by commercial airline pilots. Although this is enough, in the future sub-orbital pilots will need to train on simulators to be completely competent for the operations of the flight.

While it is officially sufficient qualification for a sub-orbital pilot to hold a license, it is highly recommended that the sub-orbital pilots have a background in the air force or are experienced test pilots. This is primarily due to the reason that the pilots will be experiencing high g-forces while operating a rocket propulsion vehicle, and will have to have quick reaction time while withstanding the strenuous conditions of the flight. Moreover, the pilot will have to be charismatic and a somewhat good tour guide to make passengers feel secure, confident and provide proper support to the ones experiencing space motion sickness. Such pilots will have to be well-compensated and motivated (Goehlich, Anderson, Harrold, Bemis, Nettleingham, Cobin, Zimmerman, Avni, Goyea, & Ilchena, 2013).

In the case of U.S.A. commercial companies, the pilots receive the following salaries as provided in the table below. At first they might not need to receive a full captain's salary, as at the beginning the motivation and prestige of being a space tourism pilot will be high; however, in time and with the development of the sub-orbital industry, salaries will have to be above those that commercial pilots receive. U.S.A. commercial pilots salaries' range from about $33,000 to about $250,000. It predominantly depends on the airline's plane fleet as well as on seniority and rank of the pilot. On average, the pilot's salary was $103,000 in 2013 (Plaehn, 2013). In the beginning, sub-orbital pilots could have a salary of around $100,000 annually, while in a few years time it would have to increase to about $200,000 as the motivation and prestige of flying such a spacecraft would decline.

Orbital tourism will be a completely different experience compared to sub-orbital flight. After intense preparation, space flight participants will board the spacecraft that is then launched vertically into space. They will most certainly wear space suits and will stay in space for a much longer duration then a mere 5 minutes. They will have many more choices of what they want to do when they are up there. They can decide if they want to orbit the Earth at specific locations for sightseeing; for instance some of them may want to fly over the Red Sea. Many will choose to board the ISS or other potential space habitats such as the one that Bigelow Aerospace is developing.

Once in orbit they might experiment with myriad of different things, ranging from eating food to seeing the behaviour of liquids. Some of them might even want to perform scientific experiments. As these shall be wealthy individuals, they might decide to promote a certain idea, organisation or their business. When Felix Baumgartner made his epic jump from the edges of space the broadcast was televised all over the world; Red Bull was undoubtedly happy to see its logo have such a tremendous reach. Similarly, in the future orbital tourists might decide to perform such campaigns, while also enjoying the experience of a space environment; not only an extraordinary experience, but perhaps ever a profitable one as well. As orbital space tourism progresses, trips to the moon, or at least to orbit the moon, might become available, providing tourists with further options and activities. In any case, the future orbital space tourists will have a variety of choices of how to spend their 1 to 2 week vacation.

### 2.5.3 Return

Upon returning to Earth from a suborbital trip, passengers will surely feel exuberance. The exclusivity of the extraordinary experience must be commemorated. The space flight participants will surely be decorated with their achievement by receiving an astronaut badge or space wings, as well as a certificate of accomplished training and the sub-orbital space flight. This process is as crucial to the customer as to the operator. The operator affirms its credibility and further promotes its business venture. In addition, the customer feels fulfilled by achieving an accomplishment that few others have. Moreover, the accomplished space flight participants might attend a future gala dinner and share their experiences; if positive and properly marketed it could serve as unique promotional campaign to draw even more customers to sub-orbital tourism. Virgin Galactic has already concluded a partnership with NBC to televise the first sub-orbital space trip and the feelings, experiences and joy of the participants will echo around the world (Virgin Galactic, 2013). To capitalize on such a momentous achievement, customer satisfaction and privilege must be at the forefront. Operators of sub-orbital space tourism services will also want to hear feedback from customers; hence a quick survey might be designed to find out about future improvements of the business.

In the case of orbital space tourism, the after-flight experience will be different. The momentous occasion will be properly honoured and documented as in the sub-orbital type; however, a medical examination and post-flight procedures will also have to be followed. Medical assessment is crucial for the customer's safety, as well as for further research on the effects of the space environment on the human body and psyche. Many professional astronauts have already become public spokesmen for orbital space tourism, promoting it by way of speeches, research and funding. Dennis Tito was so touched by his space experience that he is now planning, coordinating and funding a manned mission to Mars (Woollaston, 2013). Although such a campaign is lacking further funding and most likely will not happen due to the time constraints of having the proper alignment of Mars to Earth, it nevertheless shows the efforts and the direction space tourism is moving in.

## 2.6 Potential Advancements

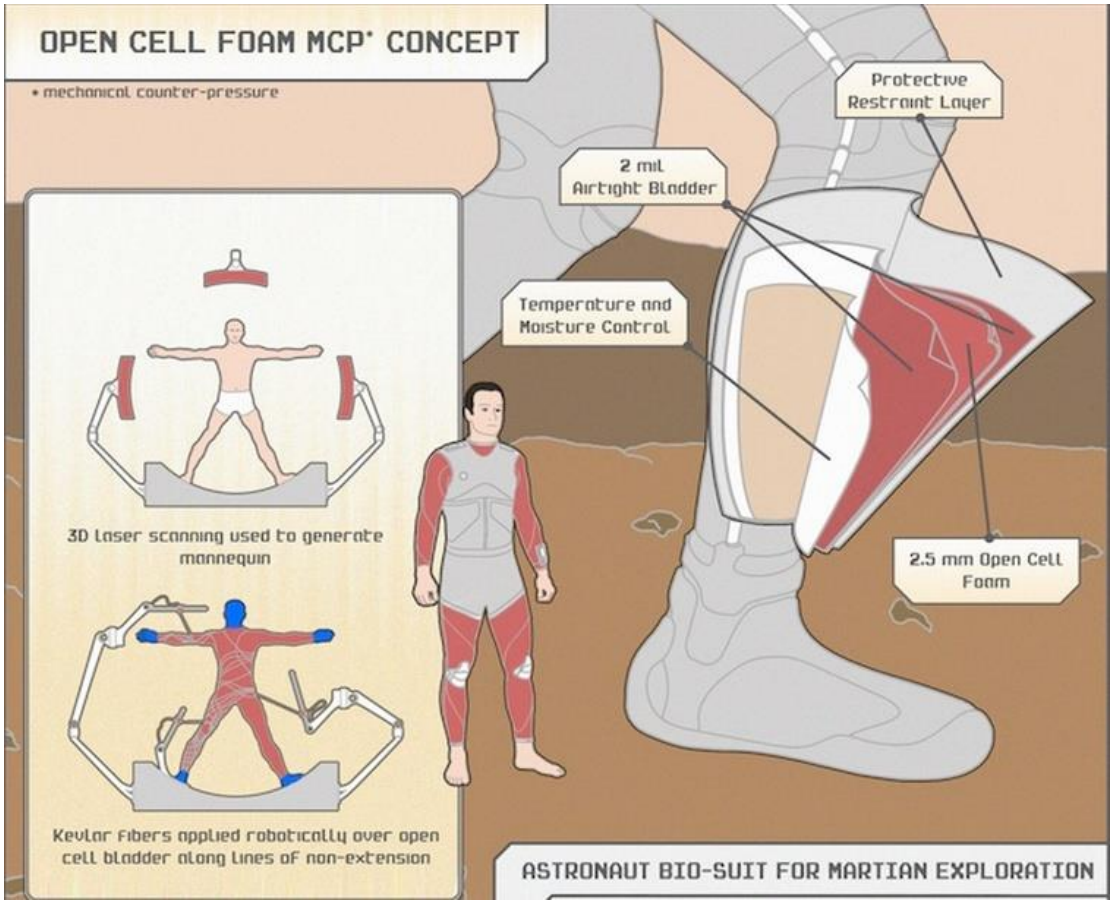
**Reaction Engines**, which is a British company, is developing a revolutionary engine called Synergistic Air-Breathing Rocket Engine (hereinafter: SABRE) for the space-plane of tomorrow, the Skylon. SABRE is a modern feat of engineering that will revolutionize the space industry. SABRE can within hundredths of a second cool down air from 1000 degrees Celsius to -140 degrees Celsius without freezing other parts of the engine or the spacecraft. This is an important feat, as it allows the engine to be cooled at speeds of up to Mach 5 and still function properly. Skylon uses normal hydrogen jet engines which suck in air for cooling, but when it reaches high altitude it switches to rocket engines and the liquid oxygen provides for further cooling. With such technology Skylon will be able to take-off horizontally like an airplane and deliver cargo or crew into space orbit and return as needed in a cheap and quick manner. There will no longer be time delays or lengthy planning to reach the ISS or satellites. In addition, if used as a commercial airplane it can make trips anywhere around the world within 4 hours. Alan Bond and Reaction Engines Company need $417 million to realise the project and have already received $90 in funding from the ESA, while they are still waiting on the rest. The SABRE prototype should be ready by 2017 and Skylon should be making its maiden voyage sometime around 2020 (Shubber, 2013).

**The Golden Spike Company** is challenging the boundaries of not only the market but also of the imagination. The founders of the company are trying to achieve Moon expeditions on a regular basis, and then offer such services to governments, companies and even individuals. They have already contracted Northrop Grumman, a defence company, to help them with the design of a lunar rover, and have also partnered with Honeybee Robotics to design an unmanned lunar vehicle (Bergin, 2013; Golden Spike Company, 2013; Business Objectives, 2014). Exploration of the moon may serve further advancements in space tourism; a moon hotel and moon golf course has already been talked about. Indeed, Space Adventures is presently making an offer to orbit the moon for $100 million per passenger.

There will be room for 2 passengers aboard the Soyuz rocket travelling into the Moon's orbit and back to Earth (Seedhouse, 2008, p. 294). So far none have applied or paid the deposit, yet it seems that in the future this will definitely be part of the space tourism offerings, especially when technology advances and ticket prices decrease.

**The BioSuit** is one of the most important elements of future space tourism and is being developed at MIT. Such a space-suit is a "mechanical counter-pressure" suit that allows one to survive in the vacuum of space by creating a third of the atmospheric pressure on the body. Its advantage is that it is not robust or rigid as the ones worn today by astronauts; additionally it is easy to repair if a small abrasion or tear occurs. Another suit, the exercise counter-measure suit, will be used on an ESA mission in 2015. Such a suit recreates body weight loading and counters muscle atrophy, which is detrimental to the human muscle system. Although NASA has stopped funding the BioSuit project, it could be fully developed within couple of years if a proper investor could be found (Annear, 2013). The concept of the mechanical counter-pressure suit is shown in Figure 11, as well as its layers and the process of manufacture.

*Figure 11*. Open cell foam mechanical counter-pressure concept




Source: S. Annear, *BioSuit: The Future of Space Gear Is Being Built Out of MIT*, 2013.

**The Mars One Foundation**, as reported by Cable News Network (hereinafter: CNN) in 2013, is going through the selection process of 200,000 volunteers to be sent to colonize Mars in 2025. Heavyweight companies such as Lockheed Martin and Surrey Satellite Technology have partnered up to provide assistance. The former will build a landing vehicle, while the latter will devise a concept study for a satellite. The mission will cost $6 billion with an interesting twist to the plot, namely, it will be a one-way trip for the 4 passengers aboard. There have also been ingenious ways of financing such an adventure; a reality TV show might broadcast the whole thing and help out with the funding (Landau, 2013). Such a mission truly shows the willingness and the extent to which ordinary people will go to participate in space activities. Risking their lives to be the first to step on Mars, to conquer space and become the new Christopher Columbus.

**Deep Space Industries** (hereinafter: DSI) has already been thinking far into the future and is considering mining asteroids. With ex-NASA contractor David Gump leading the company, it may actually realize its dreams. Critics say that it would be too costly to send any raw material back to Earth; however, the company does not want to do this. It actually wants to keep it in space in order to build up space infrastructure. What is interesting though, is the direction of such thinking and where it is leading the commercialisation of space (Paramaguru, 2013).

**Planetary Resources,** with the backing of wealthy individuals such as Google founders Larry Page and Eric Schmidt, are working on similar plans as DSI (Paramaguru, 2013). Maybe one day companies really will mine asteroids and surely partial credit would have to be given to space tourism as the industry that pioneered the commercial advancements in space. Moreover, with a variety of infrastructure to be created there will be more opportunities for space tourists to partake in an assortment of activities, such as sports or research.

**PayPal Galactic,** a branch off of PayPal, wants to be the first to provide a payment and financial transactions scheme in space and between space and Earth. It has teamed with the Search for Extraterrestrial Intelligence Institute to create a system of payments and establish some sort of regulatory basis for future transactions (Tsukayama, 2013). In this respect PayPal Galactic is the first to make it possible for future space tourists, as well as current astronauts, to have the ability to purchase online music, books, movies and other applications in space via the World Wide Web. Such a move further strengthens the case that space tourism is on the brink of being established. Presently the major ideas are in the phase of conceptualization and development, and when the time comes for space faring tourists to take to the skies the groundwork will have already been laid.

# 3 CONTRIBUTIONS OF SPACE TOURISM

Although much of space tourism is still at the stage of power point presentations, developments are certainly forthcoming. Much effort has been made in terms of promotion, development, investment, regulation, research and strategy in order to have space tourism operational in the near future. One is witnessing the beginnings of commercial civilian space activity, where one day space flight will be as common as taking a cruise or boarding an airliner. It is also true that such services will at first only be available to the very rich, while with time they will be more accessible to the general public. Space tourism is however much more than an exploitation of the human desire for adventure, and may hold many positive side effects in the areas of economics, environment and social progress.

Sub-orbital tourism will enable the growth of orbital tourism, which in turn will facilitate the commercialisation of space and allow for the further progress of human civilization. Sub-orbital tourism will primarily establish an infrastructure for orbital tourism by achieving credibility amongst the public and investors, proper regulation criteria within the aspects of law and also encourage the much needed development of technology and research that will make future space exploration possible.

So far government agencies have held a monopoly on space, which seems unfair, especially if one considers the amount of possibilities that lie within the realm of space. Contributions in medical research, energy development, resource exploitation, job creation, potential discoveries and many other features would certainly promote the cooperation, sustainability and development of human civilization on Earth. The following sections will analyse the implications of space tourism and where it might lead human civilization in the future. More specifically, the consequences and implications of space tourism relating to economic growth, social impact and environmental stability will be analysed. Will space tourism really help contemporary society or will it hamper its advance?

## 3.1 Economic Growth

Space tourism is a means to minimize launch costs in the space industry. Space tourism also provides economic growth by creating jobs, utilizing advantage of tourism and forming new industries. Additionally, western countries have a competitive and comparative advantage in technological aptitude compared to developing ones, and one way of maintaining that technological advantage will be the development of space tourism. Otherwise, due to an unfavourable environment western companies might transfer their operations overseas to countries such as China and India, which would result in western technological degradation, loss of profit and an imbalance of global competitiveness.

### 3.1.1 Launch cost minimization

When NASA contracted SpaceX to design a rocket that could reach the ISS and carry satellites into orbit, it estimated that the cost would be $4 billion using traditional approaches and at least $1.7 billion using a commercial development approach. To NASA's surprise and disbelief, SpaceX spent only $300 million on the Falcon 9, and to be fair one might add another $90 million worth of investment, as the Falcon 9 incorporated some technologies developed by the Falcon 1. In sum, the cost of $390 million in comparison to NASA's estimates of up to $4 billion is further proof for the much needed commercial development of space activities (Messier, 2011).

Not only was SpaceX able to provide NASA with a cheaper rocket, it also reduced its launching costs by two thirds. The new technology employs a reusable rocket, meaning that the rockets are not discarded as they were before. The cost per kilogram of cargo is also much cheaper, resulting in more space flights and greater appropriation of funds to other areas. The SpaceX's soon to be operational Falcon Heavy launch costs are $77 million, and the rocket can carry up to 53 tons to LEO, resulting in a cargo cost of $1453 per kilogram (Capabilities & Services, 2014). To clarify, Air Force awarded United Launch Alliance with its Evolved Expendable Launch Vehicle project. If the same project would have been awarded to SpaceX's, then the resulting performance would amount to savings of $11.6 billion (Harwood, 2014). Moreover, considering these costs with respect to the annual budgets of the four most established space agencies, NASA's $17 billion, the RKA's $5.6 billion, ESA's $5.6 billion and JAXA's $2 billion, and comparing them to what a private commercial company can achieve emphasises the potential cost savings even further (De Selding, 2013; Onuki, 2013; National Aerospace and Space Administration, 2014l; ESA Budget 2014, 2014).

It highlights the lack of cost efficiency and the general inefficiency of government led space projects and space related activities. Moreover, with such extensive budgets little has been given in return to the public or economic sector. It is true that government agencies contract companies that are highly profitable, yet in most cases these are the same few companies. Boeing and Lockheed Martin have been the predominant NASA contractors for year, and together they also formed the United Launch Alliance, which furthermore dominates the space launch market. It is no wonder then that Boeing has a market capitalization of $87.74 billion and Lockheed Martin is worth $39.4 billion (Alfonso, 2013). It is more than evident that there is lack of competition, which in turn leads to market inefficiency. Although, the two aforementioned companies undeniably have resources and know-how, the interrelation of NASA, Boeing and Lockheed Martin degrade cost efficiency, public transparency and access to space; particularly advancements in the field of space tourism.

### 3.1.2 Employment

Historical statistical evidence suggests that there has been a decrease in employment in the aerospace industry. U.S.A. launch vehicle manufacturing and services employment decreased from 28,617 to 4,828 and employment in satellite manufacturing decreased from 57,372 to 31,262 between 1999 and 2002. Europe experienced even greater reductions, with space industry employment decreasing by 20% from 1995 to 2005, while EADS Astrium laid off 3000 employees between 2003 and 2006. In addition other major European contractors decreased their workforce by 13.5% in 2005 alone (Collins & Autino, 2010).

Employment opportunities to be gained by establishing space tourism and its related activities are enormous. For example, Gibson (2012, p. 25) reported that construction of Virgin Galactic's Spaceport America alone will produce $331 million in economic activity, while total economic activity by the year 2020 is projected to amount to $1.341 billion. Furthermore, the variety of employment possibilities that could arise from space tourism is unprecedented. The following section discusses the impact that the development of space tourism could have on specific fields of employment and areas of expertise:

**Engineering, manufacturing and production:** space tourism would have an immense need for engineers in different fields:

- Chemical engineers would be needed to develop the best mixture of fuel, new materials used in spacecraft design and for optimizing various processes of material structures for space use, ranging from clothes to space habitats;

- Civil engineers would be needed for constructing, designing, and maintaining infrastructure on Earth and in space. They would be the main facilitators for the much needed build-up of spaceports, space hotels and other crucial structures that space tourism requires;

- Electrical engineers would be needed to install an array of electrical systems which link software to hardware. Moreover, the generation, transmission, distribution and connectivity of electricity is a crucial part of space tourism functioning;

- Mechanical engineers are also an essential part to the success of space tourism. Aerospace engineers are categorized under mechanical engineers that are crucial for the development, improvement and maintenance of spacecraft.

**Information technology (IT):** is vital for the proper functioning of computers, telecommunications and data management:

- Database administrators provide space tourism operators with a properly functioning database of customers and materials in addition to providing a secure storage area of information. Such databases are a crucial part of information storage and provide for proper business management;

- Systems developers and analysts will maintain and improve the internal operations of operators' businesses while upholding the efficiency of electronic systems. Space tourism will rely on their expertise to have up-to-date software for use on spacecraft, in control towers, space habitats and other areas;

- Network engineers deal with computer communications between and within electronic systems. These will be of utmost importance as they are responsible for global area networks that encompass everything from local connections to satellite communications;

- Web designers, as in any business, must maintain the graphical and informational appeal that focuses on not only attracting customers, but also on dispensing and updating information. As space tourism emerges, this branch will need to communicate the greatest appeal to customers.

**Management:** are a vital part of the administration, supervision and operations of the space tourism business; taking care of customers as well as general business success. Amongst the most obvious management categories, there will have to be special consideration given to the following:

- Marketing and public relations managers have the responsibility to convey, inform, persuade, reassure and promote the business of space tourism. They are the much needed voice to get space tourism of the ground;

- Hospitality managers will take care of demanding customers who require special treatment. The quality and excellence of the customer experience must be guaranteed for space tourism to gain popularity amongst undecided potential customers;

- Financial managers will have to manage every financial transaction with customers as well as businesses,ranging from formidable deposits to proper placement of funds. This will be a significant turning point of the growth and sustainability of space tourism operators;

- Human resource managers are key players, who are charged with having properly qualified personnel who show responsibility and decisiveness, and perform their tasks to the highest standards.

**Medical and healthcare professionals:** will be needed for the evaluation of space flight participants before, during and after the flight. As customers will experience many physical and psychological strains, they need proper care from:

- Psychologists will have to prepare and evaluate customers' behaviour before allowing them on a mission to space. Any psychologically unstable individual could cause a disturbance, if not a disaster, during a space mission;

- Doctors and nurses will be needed to determine and treat the physical conditions of space flight participants when they go through training, as well as establish that they are physically competent for space tourism activity. Any injury during training or the space mission itself will need to be properly taken care of;

- Chiropractors will be in high demand especially when orbital space tourism becomes a reality. Due to the loss in bone density and muscle atrophy that the space environment has on the human body, future orbital space tourists will need to be properly treated;

- Physical trainers with medical degrees will be an essential part in preparing orbital space flight participants for the challenge of the space environment.

**Variety of professions:** an assortment of other professionals will be required, which are hard to categorize under one field; some of the most important contributors to the sustainability of space tourism are listed below:

- Most scientists in a variety of fields would be privileged to conduct or partake in scientific experiments in a micro-gravitational environment. Biomedical and biochemical scientists would most likely stand out the most, due to the great interest of the pharmaceutical industry in conducting such experiments;

- Underwriters, insurance brokers and attorneys will have plenty of work as a result of the formation of standards, regulations, insurance policies and legal court cases establishing where matters regarding space tourism are applicable and where they are not;

- Professional spacecraft pilots will be an emergent profession without which space tourism cannot exist. Even if piloting a spacecraft eventually becomes automated, customers will most likely want a competent pilot in the cockpit in case of an emergency;

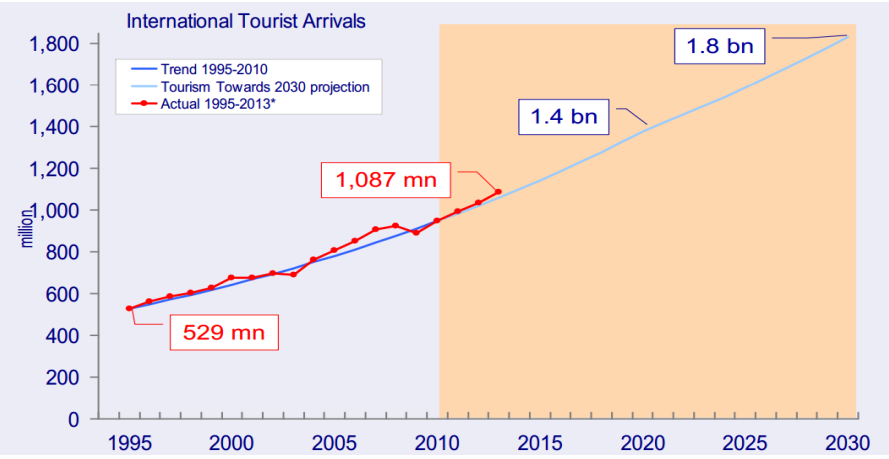
- Painters, sculptors, photographers, spiritual gurus and environmentalists will find the micro-gravitational environment inspiring for creation and extension of their fields of work.

### 3.1.3 Advantages from tourism

Evidence suggests that space tourism is not only the most viable option for space-related business expansion, but is also the quickest and easiest means of reaching economic growth. According to the United Nations World Tourism Organization (hereinafter: UNWTO), tourism activity has been growing, with international tourism arrivals growing by 5% and surpassing the 1 billion marker point. According to UNWTO Secretary-General Taleb Rifai "International tourism continues to grow above expectations, supporting economic growth in both advanced and emerging economies and bringing much needed support to job creation, GDP and the balance of payments of many destinations. It is particularly encouraging to see the strong results in many European destinations, where the tourism sector is, undoubtedly, one of the engines of the economic recovery" (United Nations World Trade Organization, 2013).

Figure 12 shows that international tourist arrivals have been increasing worldwide, even during the financial crisis, furthermore establishing the sector as a solution to the problem of stagnant economic growth. It is reasonable to apply the same logic to space tourism, and conclude that it will lead to economic expansion and economic growth. Moreover, the projected growth further emphasizes the potential that awaits and needs to be extracted.

*Figure 12*. International tourism arrivals projection




Source: J. G. C. Kester, *2013 International Tourism Results and Prospects for 2014*, 2014.

As terrestrial tourism is experiencing growth, the niche space tourism sector will further encompass the high-end tourism destinations market. In such a manner tourism will

increase its growth rate, space tourism will begin to develop and the path to economic recovery will be much quicker than otherwise. As growth is projected until at least 2030, there is no reason to think otherwise, unless some disastrous act disrupts the present trend.

### 3.1.4 Industry creation and expansion

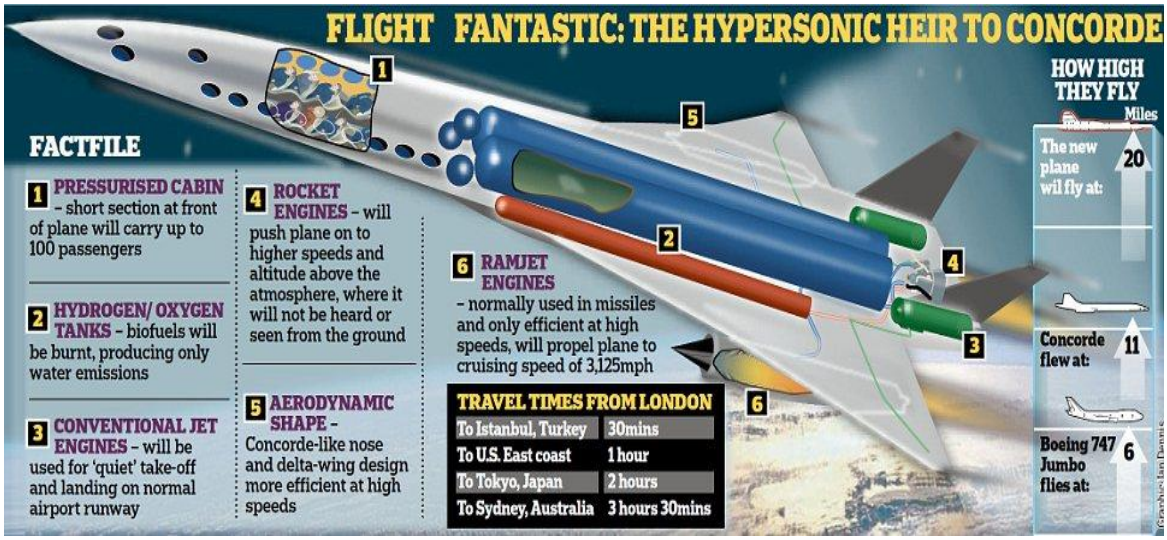
Another point to be raised is the ability of sub-orbital space vehicles to fly to almost any destination on Earth within a short period of time. As a result of reaching such heights they have the ability to land at other spaceports around the world, enabling transportation systems to be much quicker and more exclusive. Such a "space" transportation system would be quicker yet more expensive than present airplanes, and passengers could choose them instead of ultra long-haul flights of 12+ hours, at least the ones who could afford them. As with space tourism in general, these flights would eventually become cheaper, allowing passengers to use them for both pleasure and the journey itself.

Indeed conceptual designs have already begun to develop a hypersonic travel industry, which has not existed since the Concorde airplane was retired in the early 21st century. Figure 13 shows EADS Astrium's Zero Emission Hypersonic Transportation (hereinafter: ZEHTS) airplane, which is the latest proposal to fill the air transport gap left by Concorde. The ZEHTS would be able to reach Mach 4, fly at altitude of 32 kilometres and carry a capacity of 100 passengers. Its greatest achievement, as the name hints, is that it would have zero emissions, running on a mixture of hydrogen and oxygen, and emitting harmless water vapour. It would be a supersonic aircraft that could fly from New York to Paris in 90 minutes or circumvent the entire Earth in only six hours. Unfortunately, it will take billions of dollars to develop and its lengthy development phase means that if it ever becomes operational, it will not be before the 2040 (McDermott, 2011).

Lockheed Martin's Skunk Works SR-72 hypersonic airplane is already under construction and according to CNN reports it will try to achieve speeds of Mach 6. It is the successor to the famous air force airplane SR-71, otherwise known as Blackbird. It could become operational in 2023. It should be noted that the airplane is designed for military, as oppose to civilian, purposes (Lendon, 2013).

As sub-orbital space tourism relies on reusable vehicles that need to reach altitudes of 100 kilometres and achieve at least speeds of Mach 3, while air transportation desires to achieve fast flight over long distances, the two businesses might collaborate, and the result could be mutually beneficial. Moreover, EADS Astrium is already considering its market entry into space tourism with the Spaceplane. There could also be great advancements within the future of aviation and space tourism that would ease the travel to space as well as terrestrial destinations.

*Figure 13*. Zero Emissions Hypersonic Transportation




Source*:* N. McDermott, *London to Tokyo in two hour: Blueprints for 3,000 mph hypersonic plane are unveiled... but it will take 40 years to build,* 2011.

Orbital space tourism could also provide an answer to potential future economic problems. With its establishment it would draw in variety of other businesses that would no longer be limited to the terrestrial realm. In time, business activities such as catering, cleaning, research and development, entertainment, water supply management, waste disposal services and asteroid mining operations would provide for new industry growths and entrepreneurial initiatives. It would greatly expand employment in various business sectors ranging from engineering to financial services.

Undeniably, if governments and their respective space agencies get onboard with the commercial space programmes, their return on investments would be greater, while present costs would be lower. It would be economically sustainable resulting in the creation of new industries, new employment and technological advancement. Moreover, the whole economy would benefit from a newly created sub-orbital space industry, which is estimated to be worth $1.6 billion; meanwhile orbital space tourism would be worth hundreds of billions of dollars for related businesses (McKinley, 2012).

### 3.1.4 Western technological competitiveness

Western governments and other developed counties must realize the necessity of space tourism for sustainable economic growth and act upon it; otherwise the continuation of outsourcing jobs to developing nations and lack of significant job creation could prove harmful; especially as countries such as China and India are already heavily involved with space-related activities. Aerospace, due to being a technically demanding field, remains a

competitive advantage of the developed world, yet that might change if policy-makers, financial institutions and the general public do not voice their concerns.

China recently landed a rover on the moon and is progressing quickly in other fields of space activity. For western countries to maintain their competitive advantage over developing nations they must act now with regards to space tourism, otherwise developing nations will surely be in an even better position in near the future, which may lead to further geo-political tensions, economic instability and other harmful conflicts that would weaken the economic stability of the western world. In a span of 5 years the space programmes of developed nations have invested the staggering amount to around $1 trillion in satellite and launch vehicle manufacturing (Collins & Autino, 2010). If some of that funding were be diverted to commercial space activity it could create new markets, an industry thriving with financial and employment opportunities and greater access to space for a variety of scientists in their respective fields. From an economic point of view, the western world needs to develop new industries, particularly space tourism, as it provides for the easiest and greatest job creation, financial turnover and competitive and comparative advantage.

## 3.2 Societal Implications

It has been well documented that in the time of the Apollo space programme society received massive inspiration and increased interest in the study of space related activities. In particular, university science and engineering programmes not only had increased enrolment, but were viewed as the primary source of civilisation's development. When asked if the Apollo programme's massive funding was justifiable in comparison to feeding the poor, Buzz Aldrin answered that "Yes it certainly was. At that time, there was no greater goal, and our achievement has yet to be matched in any field of endeavour, in my opinion. Our efforts spurred a technological and educational push that led to incredible advancements" (Gibson, 2012, p. 141).

Surely, if space tourism would start today and be properly marketed, in time students around the world would be drawn to science and engineering departments of universities around the world. There would be an increased interest in many fields pertaining to space tourism. Additionally the spirit of exploration and adventure would be renewed, and many would see themselves as the modern version of Christopher Columbus. Due to the availability of potential employment, space tourism would further be more appealing and gratifying for students. Science would become one of the major facilitators of space tourism and in turn space tourism would promote science; it is a virtuous circle that would benefit both areas and the society at large, reducing unemployment, poverty, international conflict and resulting in heightened human awareness.

### 3.2.1 Medical benefits for society

It is no surprise that due to the physically demanding space environment, in addition to great micro-gravitational scientific experimentation, there have been advancements that were applied to treating patients. The following points are some of the most significant outcomes of human space travel, space exploration and other involvement in space activity that were adapted to the medical field.

**Reusable Handheld Electrolyte and Lab Technology for Humans** (hereinafter: rHEALTH): in pursuit of its goal of sending astronauts to Mars, NASA had to develop health monitoring technology that would test for disease and any blood deficiencies. The result is a blood testing machine that does not use conventional cartridges that need to be discarded after every use. It performs blood test more accurately and faster than any other device on the market in addition to be easily transported. Hopefully in the 2014 it will be approved by the U.S.A. Food and Drug Administration (hereinafter: FDA), and patients will no longer need to wait for blood test results, which would provide invaluable help to remote and poverty stricken areas of the world (National Aerospace and Space Administration, 2014a).

**Complete Ophthalmic Analysis System** (hereinafter: COAS)**:** during the process of designing a space telescope and evaluating of mirror quality, a process was uncovered that allowed a small part of a mirror to be immediately tested and the quality of the whole mirror could be determined. The method not only skipped the polishing process of space telescope design, but helped create COAS which in turn helped develop iDesign, which is used in measuring eye cataracts, reduced vision and eye movement; hence providing a quick and easy solution to patients' eye treatments (National Aerospace and Space Administration, 2014b).

**Rotary Cell Culture Systems** (hereinafter: RCCS): scientists at NASA were on a quest to find a cure for anaemia, which is a deficiency of haemoglobin or a decrease in red count blood cells. To find a treatment for the disease they had to grow erythropoietin, which is a hormone that regulates red blood cell production. Scientists accidentally stumbled upon a solution during lunch break and later on patented and improved what is now known as RCCS. RCCS is an important tool for medical research and with future developments could provide vaccines for Hepatitis B, treatment of Type 1 Diabetes and aid patients in transplant procedures (National Aerospace and Space Administration, 2014c).

**Lightweight Trauma Model** (hereinafter: LTM): common interest in advancing health care systems for astronauts and the military brought NASA and Impact Instrumentation Inc. to share resources. LMT resulted from the cooperation, which records patients' vital signs and assists doctors in pre-hospital care and transport of patients. Moreover, the

display uses iRevive software with which remote doctors can see patient's status in an easy-to-read and medically sound care plan (National Aerospace and Space Administration, 2014d).

**Light-emitting diodes** (hereinafter: LED): were developed for experiments on the Space Shuttle to grow plants, while recently Quantum Devices Inc. adapted the technology to create WARP, hand-held device that helps soldiers and patients relieve pain. It is used as first-aid on the battlefield and helps post-surgery patients with pain. It is also used in treating patients with multiple sclerosis, diabetic complications, Parkinson's disease, bone atrophy and is even used in cases of visual problems (National Aerospace and Space Administration, 2014j).

**Aural thermometer**: originally developed to measure the temperature of stars and planets, it was adapted to create the infrared thermometer, which can be used to measure body temperature in newborns and incapacitated patients. Its advantage lies is that it does not come in contact with mucous membrane and thus avoids cross infection (National Aerospace and Space Administration, 2014k).

As future space tourism evolves, so will society's wellbeing, as cures for various diseases might be found. Numerous experiments are possible in the microgravity environment of space, which could potentially help put an end to certain diseases, while also discovering life saving vacancies. Moreover, certain bacteria and viruses behave differently in the microgravity of space than on Earth; some become dormant while others become more aggressive and virulent. Recent microgravity experiments with Salmonella bacteria have been able to identify the genes that are masked if tested on Earth. Scientists are already replacing these same genes to turn Salmonella bacteria into a cure against Streptococcus pneumonia. Moreover, it is claimed that pharmaceutical companies would expand their healing capabilities, while at the same time increase their profits (Koebler, 2012). With space tourism underway, more of such experiments would be possible at a lower cost benefiting society's ailing people, while at the same time advancing the medical spectrum of knowledge.

### 3.2.2 Increased standard of living

The progress of the space industry also had an impact on the common everyday life of individuals. The result is that society has an increased standard of living as a result of space-related research. The following are examples of new advancements that make our lives easier:

**ÖKO H2O Advanced Filtration Water Bottle**: As outer space is a dry place and astronauts do get thirsty, NASA water filtration systems come in handy. Argonide Corp.,

with the help of NASA, invented a system that purifies and filtrates water in a quick and efficient manner. Even sweat and urine could be drinkable after the filtration process. Argonite licensed the filtration technology to Ahlstrom Corporation which sells the ÖKO water bottle at competitive prices. ÖKO Water Bottle is offered at their official online store for prices ranging from $22.95 to $24.95; the difference in price depends on the size of the bottle (Shop, 2014; National Aerospace and Space Administration, 2014e).

**DreamSaver's Home Protection System:** came from the idea of using the thermal protection system that the Space Shuttle used upon re-entry to prevent it from catching fire and disintegrating. The DreamSaver is a footlocker sized box used for storage of customer's valuable items; anything from photographs to other memorabilia. It can withstand heat of 1871 Celsius, which in layman terms means that it can withstand 98% of residential fires. Moreover, it is also waterproof as it can withstand 99% of water disasters (National Aerospace and Space Administration, 2014f).

**Airocide:** for longer missions NASA has considered growing food in space for astronauts. Plants grown in a closed environment resulted in them releasing a gas named ethylene, which in turn accelerated decay of plant life. NASA developed a technology called the "scrubber" with which it preserved a seed on next space mission. Akida Holdings acquired the patent and marketed the technology for air purifying purposes. The Airocide is remarkably efficient as it eradicates mold, fungi, odours and any airborne bacteria or viruses (National Aerospace and Space Administration, 2014g).

**Ministry of Supply** (hereinafter: MOS): is a company that specializes in phase change materials invented for astronauts' gloves. The material heats up the glove if the outside temperature is too cold and if it is too hot it cools it down. MOS applied the PCM technology to its line of men's dress shirts called Apollo. Additionally they further developed the technology for material to become moisture, odour and wrinkle free. The best part is that the designers understand how the shirt stretches and therefore seams are placed in proper places so the shirt stays tucked into pants. MOS further expanded their collection with an undershirt called Core and pants called Aero, incorporating same technologies as in its Apollo model (National Aerospace and Space Administration, 2014h).

**Cationic Hydration Interlink hairstyling iron** (hereinafter: CHI): NASA's research into nanotechnology allowed Farouk Systems Inc. to use these technologies in developing its CHI hairstyling iron. As the iron is heated to between 180 and 200 degrees Celsius it released ions that efficiently maintained the hairstyle one wanted to achieve. With the success of the CHI hairstyle iron, Farouk Systems Inc. further diversified its product line using offsets of the nanotechnology to create CHI nail polish, which prevents microbial nail growth, and CHI Nano-hair dryers. CHI hairstyle irons are offered at the official sotre

for variety of prices; depending on the model they range from $66.99 onwards (CHI Straightener, 2014; National Aerospace and Space Administration, 2014i).

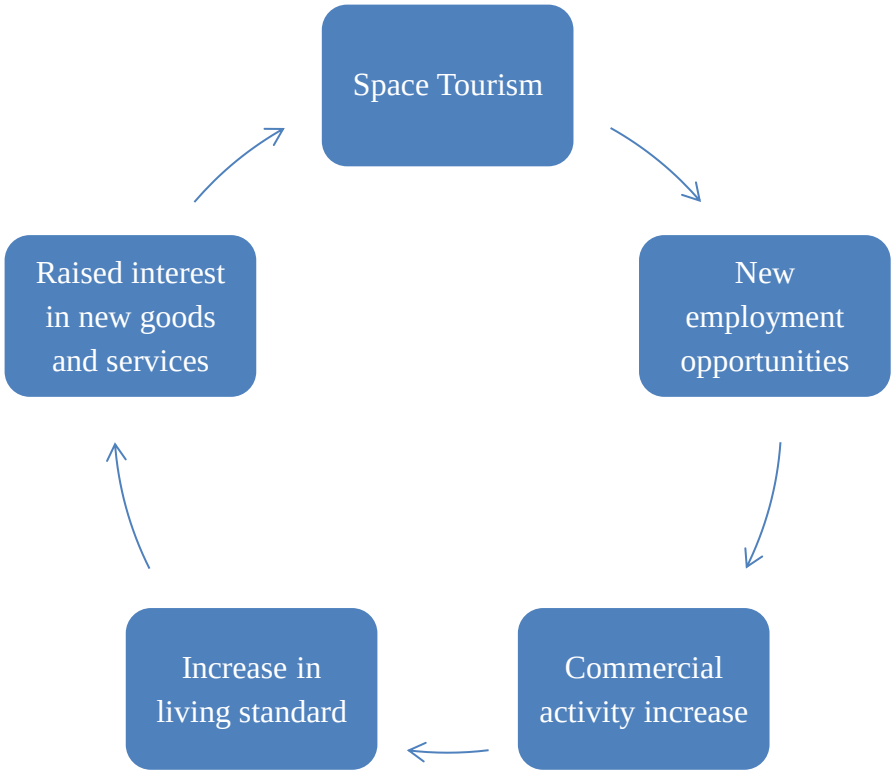
By utilizing space technology in everyday life, society achieved an efficient, affordable and increased standard of living. Various products mentioned help one to go through a day clean, quenched, breathing clean air in their home and storing personally valuable memorabilia in a safe place. There would be many more such advancements if space tourism were established. Companies would encounter new challenges for which they would have to develop new products to keep their space flight customers satisfied, while in turn they could further sell the same products to a wider segment of customers. In such a manner living standards and commercial activity would increase solely due to space tourism.

### 3.2.3 Poverty and crime reduction

Due to higher employment opportunities there would be a reduction of poverty and social wellbeing would increase. The younger generation would have something to aspire to; being a space pilot, a space engineer or an interstellar explorer would amount to equivalents of what it used to mean to be an astronaut in the 1960s. Social norms and values would solidify the concepts of multi-ethnicity, which would prevail as opposed to racism, nationalism or other ethnic alignment. Ethnic background would not play a vital role, as when in space people would rely on each other and call planet Earth their home. It would become the commonality that we're from planet Earth as oppose to saying one is German, French or American.

During the evolution of space tourism, society in general would be newly shaped. As previously mentioned, as a result of the new industry many employment opportunities would become available, resulting in less unemployment as well as less poverty. There would be a greater quest for knowledge in scientific and technological fields, which society must have for its progress. In turn the greater quest for knowledge and greater employment opportunities would lead to an increase of commercial activity both on Earth and in space. Due to the increase of commercial activity, standards of living would be greater. As people would generally have more wealth, they would spend more, and space tourism would be among the choices of what to spend money on. With time more people will become space tourists, while some might even take jobs in space, not to mention that the adventurous types who will push the boundaries of exploration. As shown in Figure 14 there will be a new cycle of wealth creation generated solely from the initiatives in space tourism.

*Figure 14*. Wealth creation cycle




### 3.2.4 Global consciousness awakening

Once humanity reaches space on a massive scale, the experience will have a profound effect on individuals. Many astronauts have talked about this effect, which is presently termed "The Overview Effect" (White, 2012). It describes the experiences that astronauts had when looking at Earth from the vastness of space. There are no more artificial boundaries created by man, distinguishing one country from another, yet there is a perception of the universal unity of our planet and the interrelation that exists between humans and the ecosystem. The appreciation of nature, biological systems and the interrelation of humans provokes a holistic approach to viewing human civilization, which is bound to grow out of its infancy of conflict, war and poverty. It seems that "The Overview Effect" raises awareness and understanding of human civilization, in addition to appreciating the beauty of and feeling humility towards the planet.

The concept of resource wars suggests that natural resources are limited on Earth and access to them is of vital national interest, causing conflicts among nations. Not only access, but control, exploitation and trade of these resources provides further frictions between countries, which tend to sway spheres of influence and even lead to wars. Taking into consideration that the global human population is drastically increasing and that there is a great inequality of wealth distribution, the future for humanity does not seem bright.

Furthermore, it is reaching a critical point as has been shown by the Iraq and Afghanistan wars and massive worldwide protests against governments, banks and industry in general in recent years. It should be noted that in the last decade wars had costs of $1 trillion, which could have been spent developing space tourism and space affiliated activities, such as asteroid mining and perhaps solved the dilemma of resource dominance and resource wars.

In a certain sense it is almost absurd that western governments act in such an unreasonable manner regarding space tourism and advancements thereof. One can see that there would be positive global impact in cases of medicine, technology, increased cost efficiency of space activity, social progress in education as well as in global awareness and easing of tensions in the geopolitical arena. Yet, western governments are steadfast in their lack of support for the advancements of space tourism, holding a virtual monopoly on space with their control of the transportation systems. It is a great hope that such an attitude towards space tourism will change and that space tourism will be looked at with the respect it deserves and not just some ideas of science fiction.

## 3.3 Environmental Impact

There are quite a few concerns and uncertainties regarding the environmental pollution from space tourism. The most recent study of soot, which is a black carbon derived from the incomplete combustion process of fossil fuel, biofuel and biomass. It has a profound impact on the ozone layer, as well as on the upper atmosphere, or stratosphere. The study, performed by Aerospace Corporation and National Center for Atmospheric Research, took into consideration 1000 flights per year and their effects on the environment. The study measured the “radiative forcing”, a term that describes the measure of how much extra energy the Earth and atmosphere absorb.

The study found that the “radiative forcing” of black carbon was 100,000 times greater than that of carbon dioxide. It further suggests that at the north and south poles temperatures would increase by 0.2 degree Celsius for most of the year, while the peak was 1 degree Celsius in winter. The result of such an increase in temperature would cause 18% ice shrinkage at the poles in the summer time. Scientists are puzzled however, as the soot should warm air in the stratosphere resulting in an increase of ozone in at the poles while depleting it in the tropics. It has been observed that a lack of ozone actually provides for warmer temperatures, however, scientists are trying to explain the ozone interaction with radiation. In any case, scientists are still trying to comprehend the matter in full and one thing is for certain; black carbon would have an effect on the warming and cooling of the Earth's (Shiga, 2010).

Space tourism pioneers are quick to warn that their impact on the environment will not have such a profound effect. Many point out that there will not be 1000 flights per year initially, although sometime in the next decade that might become a reality. XCOR's Jeff Greason questioned the accuracy of the study, saying that the kerosene rockets that were used in the study appear to be outdated and that the current magnitude of emissions is much lower. Furthermore, he commented that his Lynx spacecraft have 20 to 40 times less aromatics than traditional rockets, and hundreds of times less than hybrids or solids (Shiga, 2010; Rosenblum, 2013).

Indeed, making a general study without clearly specifying particular rocket fuel types is inconsistent; Virgin Galactic uses a hybrid rubber burning rocket, while the Lynx uses a kerosene and liquid oxygen burning rocket. Nevertheless, proper regulation and further research will have to be performed with regard to emissions and space tourism, as it might very well be the case that the industry is a significant polluter. In general, it is presumed that the beginnings of space tourism will not have a high rate of flights and therefore there should be little concern as to the environmental impact. In addition, it is relatively a small cost to pay in the long term when compared to the benefits that it may bring to global civilization. .

Gibson (2012, pp. 21–25) identified several points where pollution might occur at the start of space tourism. The following points refer to sub-orbital as well as orbital tourism, and some of them may have an immediate effect on both the terrestrial and alien environment:

- **Earth may contaminate space:** space tourists might contaminate alien environments upon landing in their ecosystems; refers to the Moon and nearby planets;

- **Space may contaminate earth:** space tourists might bring some bacteria or virus back to Earth, which could cause harm the environment. At the ISS fungi and mold frequently grew in the corners and some of it might come back down to Earth with the visitors;

- **Space may become polluted:** inattentiveness and carelessness of tourists might that leave trash behind or take souvenirs where they should not, may defile the natural environment;

- **Earth may become polluted:** the greatest concern is that the Earth's atmosphere will become polluted with carbon dioxide due to rocket emissions;

- **Vandalism in space:** at times tourist are self-centred and want to leave a memory behind, such as in writing their name, logo or some other sign that upon return they might recognize;

- **Terrestrial noise pollution:** deals with the noise generated by spacecraft and their impact on the environment; if a spaceport is near residential areas, there might be quite negative consequences;

- **Terrestrial explosion:** a fatal accident involving a spacecraft might not only harm the passengers, but the explosion and debris returning to Earth might harm spectators or even nearby inhabitants;

- **Lunar dust:** is finely ground and could pose serious damage to the lungs, ears, eyes and other parts of the body of future space tourists.

It is commonly agreed that any exhaust coming from a machine that runs on fossil fuels is detrimental to the environment. Space tourism though, may offer a solution from a different perspective. Space tourism will use rockets, at least in the beginning, which is unfavourable to the environment. Yet, by allowing for cheaper launch costs and easier maintenance of satellites JAXA proposes that by putting solar panels into orbit and then transferring solar energy via microwaves or laser to Earth, it would create more energy efficient, abundant and environmentally sustainable ways of providing the public with the required power.

Indeed, scientists at JAXA are already in the process of developing the Space Solar Power System (hereinafter: SPSS), and by 2030 they hope that their mission will be accomplished. Solar panels in space offer many more advantages compared to solar panels on Earth (Sutherland, 2013). For one, if positioned properly, solar panels would be in constant sunlight as oppose to Earth where there is night. Solar energy is one of the most environmentally friendly and safe technology of energy creation. It is also silent as it does not involve any moving mechanical parts. Moreover, in cases of emergencies, such as experienced in Japan during the tsunami disaster, the ability to provide a certain region with electricity directly from space would be invaluable. Additionally, with an increase in such energy generation, the less dependable society would be on fossil fuels and other harmful energy sources.

The Earth's environment might be affected by rocket launches, yet only at the beginning of mass-scale space operations. Society would make greater use of advancements in technology such as the SPSS, which could generate electricity in-space and then transfer it to Earth. In turn many environmentally harmful energy generating industries would become redundant, as it would be more profitable to produce energy in space, further providing sustainability to the planet.
The SPSS would generate much more energy meaning that one receptor per area would be needed as oppose to each house having one. There could perhaps also be a solar gathering farm from which energy would be dispensed. This is where scientists have run into

problems though. The technology is not yet developed for an efficient transfer of solar energy, however, solutions to this problem should be found in the future. Over time, with the advent of space tourism and progress made in technological ability of The SPSS, the environment could be preserved in the near future in the most efficient manner with little or no cost.

For the success of orbital tourism and the further commercialisation of space, orbital debris and other junk would need to be removed. Garbage disposal units could branch out to help with the clean up. Space tourism could also put forth an initiative to have a new entertainment activity of collecting floating debris via spacewalks. Such activity would be both thrilling and personally gratifying for the individual, while society would increase environmental sustainability. It should be noted that Earth is reaching its limits of sustaining the human population and its activities, thus making further social and environmental stability a necessity.

# 4 SPACE TOURSIM FOR "OUT OF THIS WORLD" BUSINESS

Global human society is at a precipice of taking its first steps towards becoming a galactic civilization. Space tourism is the starting point to providing a link of continuous and regular travel between Earth and its orbit. It is an imminent reality that will lead to future business ventures outside the boundaries of Earth. Once the connection is securely established, the second stage of proper adjustment to the new environment must be made. The result is the creation of self-sustaining space villages with a space command centre that oversees general activity.

The command centre will be an administrative centre in charge of space operations and oversight thereof. It will deal with organisational order and security as well as management and maintenance of the entire space community. It will provide companies such as DSI and Planetary Resources with assistance in exploring and prospecting on asteroids, harvesting and returning asteroid materials in addition to processing those materials to use in space and on Earth. Mining asteroids is highly profitable as they hold large concentrations of platinum metals, iron, nickel, cobalt and volatiles such as nitrogen, carbon monoxide, carbon dioxide and methane. If the command centre is the brain of the habitat, the space village is the heart of it.

The self-sustainable space villages are a combination of solar power-plants, space hotels and a space "gas stations". They will produce energy and transfer some back to Earth or nearby colonies, while docked spacecraft will be recharged to continue with their operations. There will not be as many space villages as there would be newly formed colonies. Space villages would serve as an intermediary between the colonies and the Earth. Space villages will be self-sustainable providing tourists with unique sports facilities

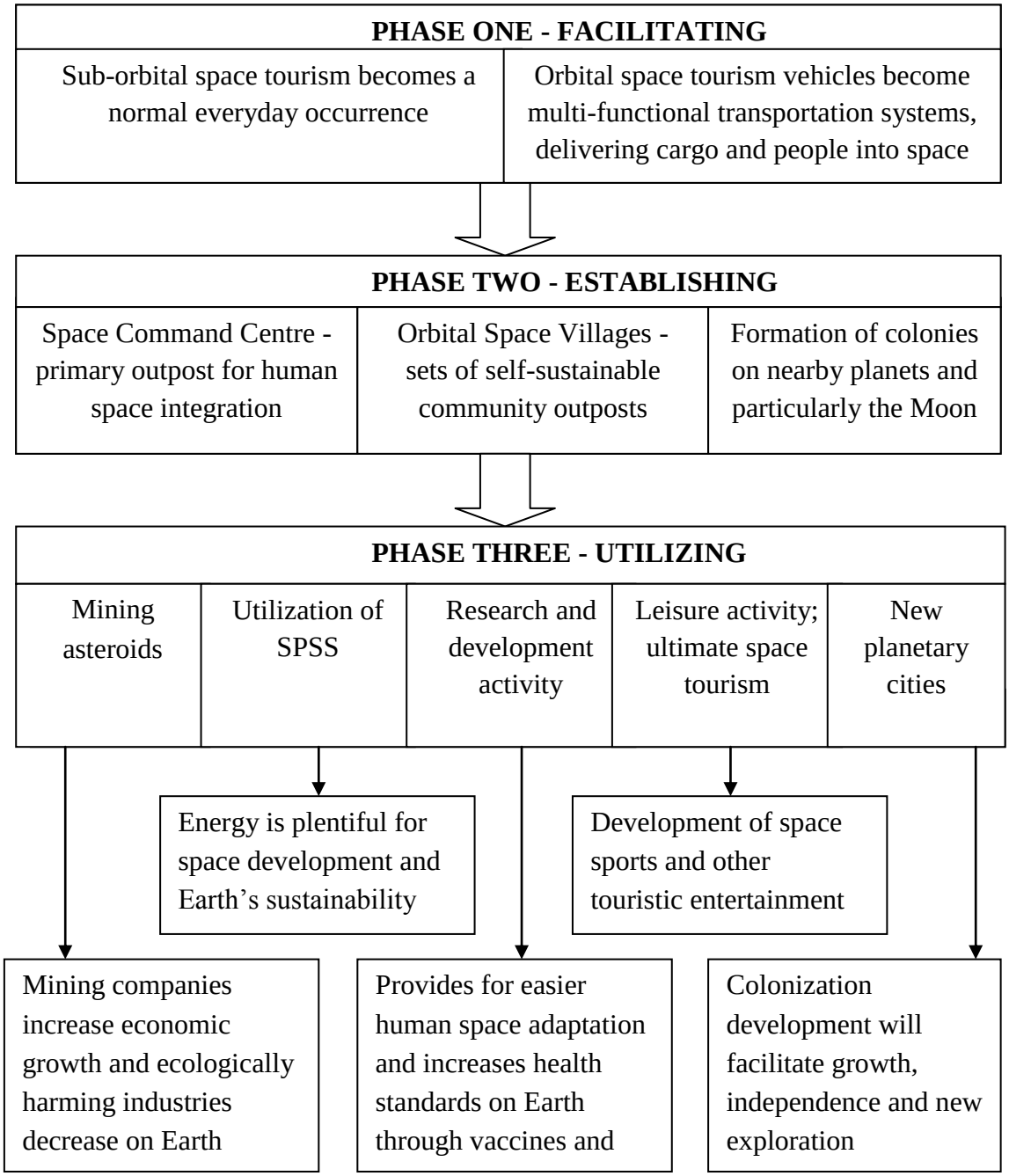
and other needs. Space tourists will enjoy the view of Earth, as well as the microgravity environment; however, with a long stay they might become bored. Various new sports and activities will be created to take full advantage of the weightless environment. First time space tourists will have to learn how to behave in such an environment and former astronauts will surely have many ideas for such games Zero gravity basketball, dodge ball and different races will keep everyone amused. Sites of the previous astronaut missions to the Moon will draw interest, while there might be lunar golf courses and complimentary spacewalk paths.

Upon achieved growth and proper exploration of the environment, colonies will be the means to acquire more resources and provide for greater entertainment and profitable business operations. Colonisation of nearby planets will have to be carefully planned and will necessitate transportation systems that are docked to the space village. To properly set up a colony, there will have to be a small fleet of spacecrafts that can transfer the needed equipment. The primary colonization area will be on the Moon. It has favourable mineral resources for exploitation, is relatively close by and it also has proper surroundings for the creation of entertainment facilities that can be used by the incoming tourists. Sites of the previous astronaut missions to the Moon will draw interest, while there might be lunar golf courses and complimentary spacewalk paths.

The Moon will be an attractive source for space tourism, yet problems might arise regarding property rights. According to present day legislation the space and its objects cannot be claimed, which will surely pose conflicts as different corporations try to build a hotel, entertainment area or even mining facility (Helmore, 2013). To solve such future conflicts, resolutions must be already thought out, at least to a certain extent regarding property rights. As there will be many mining and space tourism companies it would be highly obstructive to future development of any industry if there would not be a consensus reached regarding this issue. UNCOPUOS should act accordingly.

Figure 15 describes the comprehensive process of creating the space society. As mentioned space tourism is the driving force behind creating a sturdy link between Earth and Space. Upon creating space villages and regulating activity with the command centre, many businesses as well as the general society would benefit. A surplus in energy production, resource cultivation, new technological breakthroughs, pastime entertainment and creation of new living environments will enhance economical, social and environmental performance. Although it will take some decades, space tourism will bring forward a new era of social development, business activity and environmental sustainability.

*Figure 15*. Comprehensive space expansion model




## CONCLUSION

This master's thesis has confirmed the hypothesis that space tourism is a viable future prospective; moreover the time for sub-orbital space tourism is overdue. It will be a profitable and successful future tourist niche, especially as orbital tourism establishes its regularity and continuity. Moreover, the thesis set out to evaluate the framework of space

tourism, its strategies, management, and liabilities, and explore how these concepts will play out in establishment of space tourism.

It has been shown that there is significant demand, even though ticket prices will be extremely expensive in the early stages of space tourism operations; the popular interest and pioneering effect of a suborbital trip will outweigh the price at the beginning, while with time the price will become reasonable for potential customers. There is considerable demand for sub-orbital space tourism to establish itself as a dominant tourism niche, while at the same time paving the way for the development of orbital tourism and many other parallel activities along with it, such as space hotels. It has been found that investments in space tourism, transportation, space dangers and regulation of space tourism presents the biggest challenges in establishing a vital business; however they are not significant impediments to the progression of such business practices and are already in the works of being overcome.

It has been shown that there is great interest in developing space tourism from the private sector. Virgin Galactic and SXC are leading the way, while EADS Astrium and others may follow them sooner rather than later. While the initial investments are a heavy load to lift, in the long run the ventures will bring massive returns, particularly in the orbital space tourism segment. As space tourism trips begin and marketing campaigns get underway, one can be assured that the amount of public interest will tremendously increase, and many would be willing to spend a few months' income to participate in space flight. In turn, much needed investors would surface. Promotional and marketing campaigns would further support the business through reality TV shows, media days and public presentations, in addition to endorsements of celebrities.

It is undoubtedly true that the first participants of space tourism will be limited to high-net worth individuals, yet according to the latest reports this is an advantage, as they have had a recording breaking year in 2013, and there are now an estimates 12 million millionaires in the world. It should also be noted that the financial crisis did not have a negative impact on the image of space tourism and willingness of consumers to participate. It is also reassuring that with time ticket prices will decrease and demand will increase, making the business venture sustainable. Nevertheless, there is still great concern among passengers about the safety of these spacecraft, which will further influence demand, as well as regulation procedures and investor confidence. The aforementioned depends on the success and safety record of the future voyages.

The positive consequences of space tourism are numerous, as there would be greater employment in a variety of fields, an increase in the standard of living of society as a whole and many technological innovations would take place. Space tourism would lead to much advancement in fields from engineering and medical science to political and social

stability. While there are environmental concerns, after establishing orbital tourism the burden on Earth's resources and environment would be lifted off in many ways. The creation of solar energy production units and exploitation of mineral resources would decrease these same activities on Earth, making it environmentally more stable. Technological progress would be seen as a result of space tourism's potential effect on terrestrial air transportation, as well as being used as a shuttle service to space hotels. Many future developments would ease human adaptation to space, while the same advances could easily be used to improve everyday life on Earth.

It is vital to understand that at present human civilization is making one of its great evolutional leaps and space tourism is the main facilitator for that first step. Human civilization is at a precipice of becoming an everyday space venturing civilization, in addition to being only a step away from becoming an interplanetary one. In hopes of these developments being successful, terrestrial civilisation will experience not only new environments and knowledge, but greater awareness of itself, as well as easing the present day burden on terrestrial industry. Therefore, the master thesis advices that albeit there will be risks in space tourism activity, they should be nevertheless taken for the greater prosperity of contemporary civilization and progression thereof.

## REFERENCE LIST


1. *About Blue Origin*. Retrieved December 17, 2013, from http://www.blueorigin.com/about/
2. *About company.* Retrieved November 8, 2013, from http://www.atlasaerospace.net/eng/about.htm
3. *About Lynx.* Retrieved February 15, 2014, from http://www.xcor.com/lynx/
4. *About SpaceX*. Retrieved January 15, 2014, from http://www.spacex.com/about
5. *Airbus Defence & Space*. (2010, May 24). Spaceplane: heading for the stars. Retrieved February 13, 2014, from http://www.astrium.eads.net/en/news2/space plane-heading-for-the-stars.html
6. Al Khan, M. N. (2013, November 12). Out-of-the-world experience for space tourists willing to part with US$100,000. *The National.* Retrieved November 22, 2013, from http://www.thenational.ae/uae/science/out-of-the-world-experience-for-space-tourists-willing-to-part-with-us-100-000
7. Alfonso, A. (2013, April 10). NASA is on Hold, but These 7 Space Contractors Might Still Soar. *KapitallWire*. Retrieved February 12, 2014, from http://wire.kapitall.com/investment-idea/investing-space-government-shutdown/
8. Andreeva, N. (2013, September 25). Sony Pictures TV Sets Travel Series As Space Heats Up As Reality Frontier. *Deadline Hollywood*. Retrieved December 15, 2014, from http://www.deadline.com/2013/09/sony-pictures-tv-sets-space-travel-series-as-space-heats-up-as-reality-frontier/
9. Annear, S. (2013, December 10). BioSuit: The Future of Space Gear Is Being Built Out of MIT. *Boston Magazine*. Retrieved December 17, 2013, from http://www.bostonmagazine.com/news/blog/2013/12/10/mit-biosuit-system-dava-newman/
10. *Baikonur Cosmodrome*. Retrieved December 20, 2013, from http://www.nti.org/facilities/466/
11. *BEAM*. Retrieved December 12, 2013, from http://www.bigelowaerospace.com/beam_media_brief.php
12. Beery, J.J. (2012). State, capital and spaceships: A terrestrial geography of space tourism. *Geoforum, 43*(1), 25–43.
13. Bensoussan, D. (2010). Space tourism risks: A space insurance perspective. *Acta Astronautica, 66*(11/12), 1633–1638.
14. Bergin, C. (2013, January 3). Golden Spike contract Northrop Grumman for Lunar Lander. *NASA Spaceflight*. Retrieved January 18, 2014, from http://www.nasaspaceflight.com/2013/01/golden-spike-northrop-grumman-lunar-lander/
15. Bhasin, K. (2012, November 2). Elon Musk's "Grasshopper Project" Could Revolutionize Rocketry. *Business Insider*. Retrieved January 12, 2014, from http://www.businessinsider.com/elon-musk-rocket-2012-11
16. Booster Space Industries. (2012, February 27). *Actively Flying a High Quality Microgravity Trajectory in the BOOSTER Sub Orbital Aircraft*. Retrieved January

13, 2014, from http://boosterindustries.eu/media/748/A40288-NSRC-2012-BOOSTER-Presentation-20120227.pdf
17. *Business Objectives.* Retrieved January 2, 2014, from http://goldenspikecompany.com/our-business/business-objectives/
18. *Capabilities & Services*. Retrieved January 7, 2014, from http://www.spacex.com/about/capabilities
19. *Centrifuge*. Retrieved December 21, 2013, from http://www.spaceadventures.com/index.cfm?fuseaction=Other_Spaceflight_Experiences.Centrifuge_Training
20. *CHI Straightener.* Retrieved February 27, 2014, from on http://www.chistraightener.us/
21. Collins, P. (2006). Space tourism: From Earth orbit to the Moon. *Advances in Space Research, 37*(1), 116–122.
22. Collins, P., & Autino, A. (2010). What the growth of a space tourism industry could contribute to employment, economic growth, environmental protection, education, culture and world peace. *Acta Astronautica*, *66*(11/12), 1553–1562.
23. *Company.* Retrieved January 25, 2014, from http://masten.aero/company/
24. *Cosmonaut Overview Training*. Retrieved December 21, 2013, from http://www.spaceadventures.com/index.cfm?fuseaction=Other_Spaceflight_Experiences.Cosmonaut_Overview_Training
25. Croucher, M. (2013, May 14). Christmas Day lift-off into space for Virgin Galactic and Abu Dhabi. *The National*. Retrieved December 28, 2013, from http://www.thenational.ae/news/uae-news/christmas-day-lift-off-into-space-for-virgin-galactic-and-abu-dhabi
26. D'Orazio, D. (2013, October 22). Latest space tourism trip uses balloon to take passengers 100,000 feet up. *The Verge*. Retrieved December 5, 2013, from http://www.theverge.com/2013/10/22/4866026/paragon-world-view-space-tourism-balloon-trip-announced
27. De Selding, P. B. (2013, July 5). Russia Boosting Space Budget To Surpass China, Equal Europe. *Space News*. Retrieved February 19, 2014, from http://www.spacenews.com/article/civil-space/35638russia-boosting-space-budget-to-surpass-china-equal -europe
28. *ESA Budget 2014*. Retrieved February 18, 2013, from http://www.esa.int/For_Media/Highlights/ESA_budget_2014
29. Excell, J. (2009, July 13). Space tourism boosts research agenda. *The Engineer*. Retrieved February 18, 2013, from http://www.theengineer.co.uk/in-depth/the-big-story/space-tourism-boosts-research-agenda/312243.article.
30. *The Experience*. Retrieved February 15, 2014, from https://www.gozerog.com/index.cfm?fuseaction=Experience.welcome
31. *Experience*. Retrieved November 17, 2013, from http://www.virgingalactic.com/overview/experience/

32. Fairchild, C. (2014, January 14). Meet the travel agent to the stars – literally. *CNN Money*. Retrieved on January 19, 2014, from http://tech.fortune.cnn.com/2014/01/14/meet-the-travel-agent-to-the-stars-literally/
33. Farivar, C. (2013, August 3). John Carmack's $8M pipe dream meets reality: Armadillo Aerospace on life support. *Ars Technica*. Retrieved January 9, 2014, from http://arstechnica.com/science/2013/08/john-carmacks-8m-pipe-dream-meets-reality-armadillo-aerospace-on-life-support/
34. *Fly Mig-29 in Russia*. Retrieved January 25, 2014, from http://www.migflug.com/en/jet-fighter-flights/flying-with-a-jet/mig-29-fulcrum-in-russia.html?gclid=CM3n5Z3fur0CFenjwgod340A-w
35. Foust, J. (2011, April 25). Paul Allen's past (and future) in space. *The Space Review*. Retrieved December 20, 2013, from http://www.thespacereview.com/article/1829/1
36. Gibson, D. C. (2006). Outer Space Tourism Public Relations Purposes, Practices and Problems. *Public Relations Quarterly*, *5*(1), 29–34.
37. Gibson, D. C. (2012). *Commercial Space Tourism: Impediments to industrial development and strategic communication solutions.* [Oak Park, III]: Bentham Science Publishers Ltd.
38. Goehilch, R. A. (2005). A Ticket pricing strategy for an oligopolistic space tourism market. *Space Policy*, *21*(4), 293–306.
39. Goehlich, R. A., Anderson, J. K., Harrold, N. N., Bemis, J. A., Nettleingham, M. T., Cobin, J. M., Zimmerman, B. R., Avni, B. L., Goyea, M. D., & Ilchena, N. Y. (2013). Pilots for space tourism. *Space Policy*, *29*(2), 144–153.
40. Golden Spike Company. (2013, December 10). *Golden Spike Partners With Honeybee Robotics to Design Unmanned Lunar Rovers*. Retrieved February 13, 2014, from http://goldenspikecompany.com/wp-content/uploads/2012/02/GSC-Honeybee_NR-FINAL.pdf
41. Goodman, M. (2013, July 5). A record breaking number of millionaires in the world. *The Telegraph*. Retrieved December 3, 2013, from http://www.telegraph.co.uk/finance/personalfinance/expat-money/10158420/A-record-breaking-number-of-millionaires-in-the-world.html
42. *Graphics and Illustrations.* Retrieved March 1, 2014, from http://www.virgingalactic.com/multimedia/album/graphics-and-illustrations/
43. Halverson, N. (2012, February 25). Space Elevator, Going Up. *Discovery News*. Retrieved February 27, 2014, from http://news.discovery.com/tech/space-elevator-120225.htm
44. Harwood, W. (2014, March 5). SpaceX, ULA spar over military contracts for rocket launches. *CBS News*. Retrieved March 9, 2014, from http://www.cbsnews.com/news/spacex-says-it-could-launch-military-rockets-for-less-than-ula/

45. Heath, N. (2012, July 13). Farnborough air show: Satellites, space planes, and more (pictures): EADS Astrium space plane. *Cnet*. Retrieved on December 20, 2013, from http://news.cnet.com/2300-11386_3-10012931-3.html
46. Helmore, E. (2013, September 26). Who owns the moon? Time to call in the 'space lawyers'. *The Telegraph*. Retrieved December 13, 2013, from http://www.telegraph.co.uk/science/space/10318077/Who-owns-the-moon-Time-to-call-in-the-space-lawyers.html
47. *Incredible Adventures.* Retrieved February 4, 2014, from http://www.incredible-adventures.com/
48. Juan, D. (2014, January 13). Ground control to Major Tang. *China Daily*. Retrieved January 16, 2014, from http://usa.chinadaily.com.cn/china/2014-01/13/content_17231292.htm
49. Kester, J. G. C. (2014, January 20). 2013 International Tourism Results and Prospects for 2014. *United Nations World Tourism Organization News Conference*. Retrieved February 24, 2014, from http://dtxtq4w60xqpw.cloud front.net/sites/all/files/pdf/unwto_fitur_2014_hq_jk_1pp.pdf
50. Klemm, G., & Markkanen, S. (2011). In A. Papathanassis (Ed.), *The Long Tail of Tourism* (pp. 95–103). Weisbaden, Germany: Gabler Verlag, Springer Fachmedien Wiesbaden GmbH.
51. Koebler, J. (2012, June 25). Space: New Frontier for Medical Breakthroughs. *US News*. Retrieved Feburary 20, 2014, from http://www.usnews.com/news/articles/2012/06/25/space-the-new-frontier-for-medical-breakthroughs
52. Lam, T. (2011, August 18). Russians unveil space hotel. *CNN Travel*. Retrieved December 10, 2013, from http://travel.cnn.com/explorations/life/russians-unveil-space-hotel-678591
53. Landau, E. (2013, December 10). 200,000 people apply to live on Mars. *CNN.* Retrieved December 20, 2013, from http://edition.cnn.com/2013/12/10/tech/innovation/mars-one-plan/
54. Le Goff, T., & Moreau A. (2013). Astrium Suborbital Spaceplane Project: Demand Analysis of Suborbital Space Tourism. *Acta Astronautica, 92*(2), 144–149.
55. Lendon, B. (2013, November 8). 'Son of Blackbird': Plan for a new spy plane. *CNN News*. Retrieved December 10, 2013, from http://edition.cnn.com/2013/11/05/tech/ innovation/new-spy-plane/
56. Leonard, D. (2007, July 27). Explosion Kills Three at Mojave Air and Space Port. *Space.com*. Retrieved December 8, 2013, from http://www.space.com/4123-explosion-kills-mojave-air-space-port.html
57. Luke, M., & Mukuno, J. (2014, January 7). Max Luke and Jenna Mukuno: Boldly Going Where No Greens Have Gone Before. *The Wall Street Journal*. Retrieved January 7, 2014, from http://online.wsj.com/news/articles/SB10001424052702304325004579296781320668314

58. Room with an intergalactic view: Russia firm reveals plans for space hotel (but you might need a good book). (2011, August 16). *Daily Mail*. Retrieved on January 14, 2014, from on http://www.dailymail.co.uk/sciencetech/ article-2026534/Commercial-SpaceStation-Russian-firm-Orbital-Technologies-rev eals-hotel-plans.html
59. Malik, T. (2010, September 29). World's First Commercial Space Station Planned in Russia. *Space.com*. Retrieved December 5, 2013, from http://www.space.com/9223-world-commercial-space-station-planned-russia.html
60. Marshall, B. (2011, April 4). How Stuff Works: How space tourism works. *McClatchy - Tribune New Service*. Retrieved December 2, 2013, from http://search.proquest.comnukweb.nuk.uni-lj.si/docview/859999467?accountid=16468
61. McDermott, N. (2011, June 20). London to Tokyo in two hours: Blueprints for 3,000 mph hypersonic plane are unveiled... but it will take 40 years to build. *Daily Mail*. Retrieved February 13, 2014, from http://www.dailymail.co.uk/sciencetech/article-2005513/London-Tokyo-2-hours-Blueprints-3-000mph-hypersonic-plane-unveiled.html
62. McKinley, J. (2012, September 7). Space Tourism Is Here! Wealthy Adventurers Wanted. *The New York Times*. Retrieved December 14, 2013, from http://www.nytimes.com/2012/09/09/travel/space-tourism-is-here-wealthy-adventurers-wanted.html?_r=0
63. Messier, D. (2011, May 31). NASA Analysis: Falcon 9 Much Cheaper Than Traditional Approach. *Parabolic Arc*. Retrieved December 21, 2013, from http://www.parabolicarc.com/2011/05/31/nasa-analysis-falcon-9-cheaper-traditional-approach/
64. Moseman, A. (2011, April 26). Just One ($150 Million) Seat Remains on Space Adventures' Lunar Flyby. *Popular Mechanics*. Retrieved on February 23, 2014, from http://www.popularmechanics.com/science/space/rockets/just-one-150-million-seat-remains-on-space-adventures-lunar-flyby
65. National Aeronautics and Space Administration. (2014a). *Handheld Diagnostic Device Delivers Quick Medical Readings*. Retrieved February 3, 2014, from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20140000080.pdf
66. National Aeronautics and Space Administration. (2014b). *Bioreactors Drive Advances in Tissue Engineering*. Retrieved February 3, 2014, from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/201300 09008.pdf
67. National Aeronautics and Space Administration. (2014c). *Telescope Innovations Improve Speed, Accuracy of Eye Surgery.* Retrieved February 3, 2014, from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20120001891.pdf
68. National Aeronautics and Space Administration. (2014d). *Ventilator Technologies Sustain Critically Injured Patients*. Retrieved February 3, 2014, from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20120001890.pdf

69. National Aeronautics and Space Administration. (2014e). *NASA-Enhanced Water Bottles Filter Water on the Go*. Retrieved on February 3, 2014, from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/2014 0000091.pdf
70. National Aeronautics and Space Administration. (2014f). *Thermal Materials Protect Priceless, Personal Keepsakes*. Retrieved February 3, 2014, from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20140000093.pdf
71. National Aeronautics and Space Administration. (2014g). *Home Air Purifiers Eradicate Harmful Pathogens*. Retrieved February 3, 2014, from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/201400 00094.pdf
72. National Aeronautics and Space Administration. (2014h). *Thermal Materials Drive Professional Apparel Line.* Retrieved February 3, 2014, from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/201400 00095.pdf
73. National Aeronautics and Space Administration. (2014i). *Nanomaterials Transform Hairstyle Tools*. Retrieved February 3, 2014, from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20110000758.pdf
74. National Aeronautics and Space Administration. (2014j). *Light Source*. Retrieved January 6, 2014, from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20020080942.pdf
75. National Aeronautics and Space Administration. (2014k). *Infrared Thermometer*. Retrieved January 6, 2014, from http://ntrs. nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20020086347.pdf
76. National Aeronautics and Space Administration. (2014l). *FY 2014 Budget Request*. Retrieved February 25, 2014, from http://www.nasa.gov/pdf/740427main_NASAFY2014SummaryBriefFinal.pdf
77. *New York Angels*. Retrieved February 19, 2014 from http://www/newyorkangels.com
78. Obayashi Corporation. (2012). *Obayashi Corporate Report 2012 Financial, Social and Environmental Performance*. March 31, 2012. Retrieved on February 14, 2014, from on http://www.obayashi.co.jp/english/ir/corporate_report/ir2012en.pdf
79. Onuki, M. (2013. December 9). Profile Naoki Okumura, President, Japan Aerospace Exploration Agency. *SpaceNews*. Retrieved on February 5, 2014, from on http://www.spacenews.com/article/features/38565profile-naoki-okumura-president-japan-aerospace-exploration-agency
80. *Opportunities and pricing*. Retrieved December 12, 2013, from http://www.bigelowaerospace.com/opportunity-pricing.php
81. *Our Story: About Space Angels Network.* Retrieved February 1, 2014, from http://www.spaceangelsnetwork.com/about/
82. Paramaguru, K. (2013, January 13). Deep Space Industries: the Company that Wants to Mine Space. *Time*. Retrieved February 14, 2014, from http://newsfeed.time.com/2013/01/23/deep-space-industries-the-company-that-wants-to-mine-space/

83. *Partner.* Retrieved on February 27, 2014, from http://www.spaceadventures.com/index.cfm?fuseaction=suborbital.Providers
84. *Partners.* Retrieved on January 24, 2014, from http://www.spacexc.com/en/about-us/partners/
85. Plaehn, T. (2013). Corporate Pilot Salary Range. *Global Post*. Retrieved January 20, 2014, from http://everydaylife.globalpost.com/corporate-pilot-salary-range-35136.html
86. Rees, M. (2003). Mars Needs Millionaires. *Foreign Policy*, No. 137, pp. 90–91
87. *Rocketplane Kistler assets to be auctioned on November 11*. Retrieved January 14, 2014, from http://www.hgpauction.com/2028rocketplane-kistler-assets-to-be-auctioned-on-november-11/
88. *Rocketplane*. Retrieved December 2, 2013, from http://www.rocketplane.com/
89. Rosenblum, A. (2013, May 16). Space Tourism's Black Carbon Problem. *Popular Science*. Retrieved January 29, 2014, from http://www.popsci.com/science/article/2013-05/space-tourism-experiment-geo-engineering
90. Schilling, G. (2013, September 16). Lynx Space Plane Taking Off: Q&A with Xcor Aerospace CEO Jeff Greason. *Space.com*. Retrieved on January 20, 2014, from http://www.space.com/22820-lynx-private-spaceship-jeff-greason.html
91. Schultz, C. (2014, January 21). Virgin Galactic Started Selling Tickets to Space Before Getting Permission to Take People There. *Smithsonian Magazine*. Retrieved February 20, 2014, from http://www.smithsonianmag.com/smart-news/virgin-galactic-never-actually-got-permission-take-people-space-it-started-selling-tickets-180949409/
92. Seedhouse, E. (2008). *Tourists in Space*. Chichester, UK: Springer Praxis Publishing.
93. Shiga, D. (2010, October 26). Space tourism could have big impact on climate. *New Scientist*. Retrieved January 29, 2014, from http://www.newscientist.com/article/dn19626-space-tourism-could-have-bigimpact-on-climate.html#.UxY69vldV5Y
94. *Shop.* Retrieved on March 1, 2014, from http://www.okoh2o.com/shop.php
95. Shubber, K. (2013, August 12). Skylon: Alan Bond's mission to replace space rockets with spaceplanes. *Wired*. Retrieved January 15, 2014, from http://www.wired.co.uk/news/archive/2013-08/12/skylon-alan-bond
96. Sierra Nevada Corporation Enters Dream Chaser Critical Design Review. (2014, January 30). *Sierra Nevada News & Press Release*. Retrieved February 26, 2014, from http://www.sncspace.com/press_more_info.php?id=383
97. Sloan, J. (2012, October 18). Introduction to FAA Office of Commercial Space Transportation (AST) and International Outreach. *Space Policy Institute George Washington University*. Retrieved January 23, 2014, from http://www.gwu.edu/~spi/assets/docs/John%20Sloan%20charts.pdf

98. *Soyuz Simulator*. Retrieved December 21, 2013, from http://www.spaceadventures.com/index.cfm?fuseaction=Other_Spaceflight_Experiences.Soyuz_Simulator_Training
99. *Space Adventures.* Retrieved January 12, 2014, from http://www/spaceadventures.com/
100. *Space Expedition Corporation*. Retrieved February 10, 2014, from http://www.spacexc.com/en/home
101. *Space Flight.* Retrieved on February 27, 2014, from http://www.missionmassimo.com/?page_id=1390
102. *Space flight*. Retrieved on January 10, 2014, from http://www.atlasaerospace.net/eng/spacefl.htm
103. *Spaceflight*. Retrieved on January 20, 2014, from http://www.spacexc.com/en/space-program/spaceflight/
104. *The Spaceship Company.* (2012, October 8). Retrieved November 5, 2013, from http://www.virgingalactic.com/news/item/the-spaceship-company-2/
105. *Spaceship*. Retrieved on February 27, 2014, from http://www.spacexc.com/en/space-program/spaceship/
106. *Spacewalk Training*. Retrieved on December 21, 2013, from http://www.spaceadventures.com/index.cfm?fuseaction=Other_Spaceflight_Experiences.Neutral_Buoyancy
107. SpaceX launches its first commercial satellite. (2013, December 4). *The Telegraph.* Retrieved November 30, 2013, from http://www.telegraph.co.uk/science/space/10493366/SpaceX-launches-its-first-commercial-satellite.html
108. Sunseri, G. (2012, October 3). Singer Sarah Brightman Outbids NASA for Space Tourist's Seat. *ABC News*. Retrieved February 10, 2014, from http://abcnews.go.com/Technology/space-tourist-sarah-brightman-buys-seat-russian -soyuz/story?id=17384120
109. Sutherland, P. (2013, October 2). Japan aims to beam solar energy down from orbit. *Wired*. Retrieved February 10, 2014, from http://www.wired.co.uk/news/archi ve/2013-10/02/japan-solar-energy
110. Tandy, J. (2008, July 17). Air hostess picks up chocolate bar, wins space trip. *Reuters*. Retrieved December 13, 2013, from http://www.reuters.com/article/2008/07/17/us-space-odd-idUSN1641363920080717
111. Tate, K. (2013, February 28). SpaceX's Dragon Space Capsule Explained (Infographic). *Space.com*. Retrieved December 13, 2013, from http://www.space.com/15429-spacex-dragon-space-capsule-manned-infographic.html
112. Tsukayama, H. (2013, 27. June). PayPal Galactic looks to corner the space payments market. *The Washington Post*. Retrieved January 28, 2014, from http://www.washingtonpost.com/business/technology/paypal-galactic-looks-to-corner-the-space-payments-market/2013/06/27/ceb9fb24-df2a-11e2-963a-72d740e88c12_story.html

113. *Uniktour*. Retrieved on February 27, 2014, from http://www.uniktourspace. com/en/
114. United Nations World Tourism Organization. (2013, December 3). International tourism an engine for the economic recovery. Retrieved December 15, 2013, from http://media.unwto.org/press-release/2013-12-12/international-tourism-engine-economic-recovery
115. *The Virgin Galactic Experience*. Retrieved January 23, 2014, from http://www.travelexperts.com/space-tourism/the-virgin-galactic-experience.aspx
116. Virgin Galactic. (2013, November 8). NBCUniversal announces exclusive partnership with Sir Richard Branson's Virgin Galactic to televise first commercial flight to space. Retrieved January 28, 2014, from http://www.virgingalactic.com/news/item/nbcuniversal-announces-exclusive-partnership-with-sir-richard-bransons-virgin-galactic-to-televis/
117. *Virtuoso*. Retrieved January 17, 2014, from http://www.virtuoso.com/
118. Von Der Dunk, F. (2012). The integrated approach – Regulating private human spaceflight as space activity, aircraft operation, and high-risk adventure tourism. *Acta Astronautica*, *92*(2), 199–208.
119. Wall, M. (2014, February 5). Virgin Galactic's Billionaire Founder Sir Richard Branson Takes Zero-G Flight. *Space.com*. Retrieved February 8, 2014, from http://www.space.com/24574-richard-branson-zero-gravity-flight.html
120. Webber, D. (2012). Space Tourism: Its history, future and importance. *Acta Astronautica*, *92*(2), 138–143.
121. Wethington, N. (2009, November 4). Masten Wins $1 million X-Prize on Last Day Possible. *Universe Today*. Retrieved December 23, 2013, from http://www.universetoday.com/44083/masten-wins-1-million-x-prize-on-last-possible-day/
122. White, F. (2012, February 1). Space Tourism: Enlightenment from the Final Frontier. *World Policy Blog*. Retrieved December 14, 2014, from http://www.worldpolicy.org/blog/2012/02/01/space-tourism-enlightenment-final-frontier
123. Whittington, M. (2013, January 13). Run down Oklahoma space port still lacks a tenant 13 years later. *Examiner*. Retrieved December 3, 2013, from http://www.examiner.com/article/run-down-oklahoma-space-port-still-lacks-a-tenant-13-years-later
124. Woollaston, V. (2013, November 21). Billionaire Dennis Tito plans manned mission to Mars that could launch as early as Christmas Day 2017. *Daily Mail*. Retrieved December 22, 2013, from http://www.dailymail.co.uk/sciencetech/article-2511219/Billionaire-Dennis-Tito-plans-manned-mission-Mars-launch-early-Christmas-Day-2017.html
125. XCOR Aerospace. (2012, June 7). XCOR Aerospace Announces Space Expedition Corporation (SXC) As General Sales Agent For Space Tourism Flights, 2014. Retrieved November 30, 2013, from http://www.xcor.com/press/2012/12-06-07_XCOR_announces_SXC_as_general_sales_agent.html

126. *XPrize Foundation*. Retrieved January 13, 2014, from http://space.xprize.org/ansari-x-prize
127. *Zero-Gravity USA*. Retrieved January 6, 2014, from http://www.incredible-adventures.com/zero-gravity-usa.html
128. Ziliotto, V. (2009). Relevance of the futron/zogby survey conclusions to the current space tourism industry. *Acta Astronautica*, *66*(11/12), 1547–1552.

# APPENDIX

## TABLE OF APPENDICES

**APPENDIX A: List of Abbreviations**

| | |
|---|---|
| AvH | Alexander von Humboldt |
| CHI | Cationic Hydration Interlink |
| CNN | Cable News Network |
| COAS | Complete Ophthalmic Analysis System |
| DSI | Deep Space Industries |
| EADS Astrium | European Aeronautics Defence and Space Company Astrium |
| EASA | European Airspace Safety Agency |
| ESA | European Space Agency |
| EVA | Extra-vehicular activity |
| FAA | Federal Aviation Administration |
| FDA | Food and Drug Administration |
| Gs | Gravitational force |
| GEO | Geosynchronous orbit |
| GPS | Global positioning system |
| HEO | High Earth orbit |
| ISS | International Space Station |
| JAXA | Japan |
| JSPS | Japan Society for the Promotion of Science |
| KLM | Koninklijke Luchtvaart Maatschappij N.V. |
| LED | Light-emitting diodes |
| LEO | Low Earth orbit |
| LTM | Lightweight Trauma Model |
| MEO | Medium Earth orbit |
| MOS | Ministry of Supply |
| NASA | National Aeronautic Space Administration |
| RCCS | Rotary Cell Culture Systems |
| rHEALTH | Reusable Handheld Electrolyte and Lab Technology for Humans |
| RKA | Roscosmos, Russian Federal Space Agency |
| SABRE | Synergistic Air-Breathing Rocket Engine |
| SNC | Sierra Nevada Corporation |
| SpaceX | Space Exploration Technologies Corporation |
| SPSS | Space Solar Power System |
| SS1 | SpaceShipOne |
| SS2 | SpaceShipTwo |
| SXC | Space Expedition Corporation |
| TBS | Tokyo Broadcasting Service |
| U.A.E. | United Arab Emirates |
| UNCOPUOS | United Nations Committee on the Peaceful Uses of Outer Space |
| UNWTO | United Nations World Tourism Organization |

| | |
|---|---|
| WK1 | WhiteKnightOne |
| WK2 | WhiteKnightTwo |
| ZEHTS | Zero Emission Hypersonic Transportation |