SPACE TOURISM—FUTURE INDUSTRY

Ms. Priti Atrey*

Over the past few decades other forms of tourism have been becoming more popular, particularly: Adventure tourism, Agritourism, Ecotourism, Cultural tourism, Heritage tourism, Health tourism, Sport tourism, Disaster tourism, Medical tourism, virtual tourism and Space tourism. The opinion of Space Tourism has changed from being considered "science fiction" to becoming recognized as an important new target for the space industry. Space Tourism (ST) is a recent phenomenon where wealthy individuals or corporations will have the opportunity to travel beyond the Earth's atmosphere and experience orbital flights. California multi-millionaire Dennis Tito spent $20 million on space tourism to become the first paying tourist in 2001 Tito the founder of Wilshire Associates and former JPL scientist traveled aboard Russian Soyuz capsule launched by Space Adventures Ltd. U. S. company where he spent 7 days aboard the International Space Station.[1]

Apart from scientific viewpoint of space, there is an increasing interest for new ventures like space tourism. Reasonable space access is fundamental for the development of new space business, especially space tourism.[2] Among the primary attractions of space tourism is the uniqueness of the experience, the amazing and thrilling feelings of looking at Earth from space, status symbol, and various advantages of weightlessness—potential for extreme sports, health benefits, especially to older people.

Space tourism is expected to "take off" in the first quarter of the 21st century, although compared with traditional destinations the number of tourists in orbit will remain low until technologies such as space elevator make space travel cheap. Technological improvement is likely to make possible air-ship hotels, based either on solar-powered airplanes or large dirigibles. Underwater hotels, such as Hydro polis, slated to open in Dubai in 2006, will be built. On the surface of the ocean tourists will be welcomed by ever larger cruise ships and perhaps floating cities.[3]

Space

Space has been defined in many dictionaries as:

Space is the boundless, three-dimensional extent in which objects and events occur and have relative position and direction.[4]

The empty area outside the Earth's atmosphere, where the planets and the stars are.[5]

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* Ms. Priti Atrey, Assistant Prof. in Economics, M.V. (PG) College Satikund Kankhal, Haridwar. *Residence*: 231, Phase 2, Vasant Vihar, Dehradun – 248006 (UK). e-mail: (pritiatrey@gmail.com).

The infinite extension of the three-dimensional region in which all matter exists.[6]

In mathematics, a space is a set with some added structure.[7]

A-Space (est. 1991) is a collectively run anarchist community center and art gallery located at 47th St & Baltimore Avenue in Philadelphia, Pennsylvania.[8]

A boundless three-dimensional extent in which objects and events occur and have relative position and direction.[9]

So term Space can refer to various phenomena in science, mathematics, and communications. In astronomy and cosmology space is the vast three dimensional regions that begin where the Earth's atmosphere ends. Space is usually thought to begin at the lowest altitude at which satellites can maintain orbits for a reasonable time without falling into the atmosphere. This is approximately 100 kilometers above the surface of the Earth. Astronomers may speak of interplanetary the space between planets in our solar system, interstellar space between stars in our galaxy or intergalactic space between galaxies in the universe.[10]

Tourism

The terms *tourist* and *tourism* were first used as official terms in 1937 by the League of Nations. Tourism was defined as people travelling abroad for periods of over 24 hours. The word *tour* gained acceptance in the 18th century. Tour which means a journey in a circuit where the most essential word is circuit which signifies a return journey to the origin point. Tourism can be defined as the act of travel for the purpose of recreation, and the provision of services for this act. A tourist is someone who travels at least fifty miles from home, as defined by the World Tourism Organization.[11]

A more comprehensive definition would be that tourism is a service industry, comprising a number of tangible and intangible components. The tangible elements include transport systems - air, rail, road, water and now, space; hospitality services - accommodation, foods and beverages, tours, souvenirs; and related services such as banking, insurance and safety & security. The intangible elements include: rest and relaxation, culture, escape, adventure, new and different experiences. For the past few decades other forms of tourism have been becoming more popular, particularly: Adventure tourism, Agritourism, Ecotourism, Cultural tourism, Heritage tourism, Health tourism, Sport tourism and Space tourism.

Space tourism is the recent phenomenon of space travel by individuals for the purpose of personal pleasure. Among the primary attractions of space tourism are the uniqueness of the experience, the awesome and thrilling feelings of looking at Earth from space (described by all astronauts as extremely intense and mind-boggling), status symbol, and various advantages of weightlessness—potential for extreme sports, unusual sex, health benefits, especially to older

people. This service is for persons to access and experience space for adventure and recreation. Space tourist is a person who travels to experience space for adventure and recreation as space traveler, space client and space passenger. Essentially space tourism can be divided into two categories: i.e. suborbital and orbital tourism.

1. Sub-orbital Tourism

A sub-orbital spaceflight (or sub-orbital flight) is a spaceflight in which the spacecraft reaches space, but its trajectory intersects the atmosphere or surface of the gravitating body from which it was launched, so that it does not complete one orbital revolution.

For example, any object launched from Earth that reaches above sea level and then falls back to Earth, is considered a sub-orbital spaceflight. Some sub-orbital flights have been undertaken to test spacecraft and launch vehicles intended for later orbital spaceflight. Other vehicles are specifically designed only for sub-orbital flight; examples include manned vehicles such as the X-15 & Space Ship One and unmanned ones such as ICBMs & sounding rockets.

Sub-orbital spaceflights are distinct from flights that attain orbit but use retro-rockets to deorbit after less than one full orbital period. Thus the flights of the Fractional Orbital Bombardment System would not be considered sub-orbital. Instead these are simply considered flights to low Earth orbit by definition a sub-orbital spaceflight reaches an altitude higher than 100 km above sea level.[12]

2. Orbital Tourism

During freefall the trajectory is part of an elliptic orbit as given by the orbital equation. The perigee distance is less than the radius of the Earth, hence the ellipse intersects the Earth, and hence the spacecraft won't complete an orbit. The major axis is vertical; the semi-major axis is more than one half of the radius of the Earth, and almost always less than the radius. Orbital spaceflights: a low Earth orbit (LEO), with an altitude of about 300 km, needs a speed around 8 km/s, requiring a delta-v of about 10 km/s.[13]

Extensive travel by air, sea and land for pleasure and business is a commonplace fact of modern life. In contrast, travel in space has only been available essentially to a small number of highly trained government astronauts, and the public's perception is that it cannot be otherwise. In fact Public Space Travel (PST) or "Space Tourism", routinely available to the general public at affordable prices, is much closer at hand now. The period between 1957 and 1991 saw the dawn of the space age with flights to the planets, footprints on the Moon and global communications.

The development of commercial passenger travel services to space is the key innovation needed to generate an economic return on the cumulative investment made in space capabilities to date. It is technically feasible using existing technology and it is expected to grow into a much larger business than

satellite communications. In addition it will have important macro-economic impacts by helping to overcome the current global depression caused by world-wide over-capacity in older industries and insufficient innovation of new ones. Governments currently spend $25 billion/year on civilian space activities but essentially none of this is aimed at realizing passenger space transportation.

Tourism industry with receipts in excess of US $450 billion, given the generous revenues associated with tourism, public space travel represents a huge potential market. Although human spaceflight is currently the privilege of a few space-exploring nations, recent advances in space technology and entrepreneurship are about to change the status. China with the assistance of Russian technology was able to place an astronaut in space in 2003 in a fraction of the time that it took other space powers such as the USA and USSR. The first credible private space-tourist venture is already a reality. The first space tourist Mr. Dennis Tito took the first trip to the space as a tourist in 2001 in a government vehicle and his flight was privately funded.[14]

Space Tourists

1. *Dennis Tito* is the first official space tourist in history who paid $20 million for his own flight ticket. Although multimillionaire Dennis Tito doesn't like being called a space tourist, he was given this moniker by the media for his historic flight in April 2001 aboard the Russian Soyuz TM-32 to the International Space Station (ISS). Tito made arrangements with Space Adventures, Ltd., to launch into space and stay aboard the ISS for a trip that lasted almost 8 days. Dennis Tito fought bouts of motion sickness on the initial adventure and upon his 128 orbits around the earth.[15]
2. *Mark Shuttle* Worth was the first African in space and the second paying space tourist in history. Mark Shuttle worth made his fortune as an Internet tycoon in the 1990's and on April 25, 2002 made history by flying aboard a Russian Soyuz TM34 capsule as a cosmonaut to the International Space Station (ISS). He paid $20 million for the flight to Space Adventures.[16]
3. *American millionaire* entrepreneur Greg Olsen is the third paying space tourist of record flying with Space Adventures upon a Russian Soyuz TMA-7 on October 1, 2005. For a reported price tag of $20 million, Greg Olsen, Ph.D. flew to the International Space Station (ISS) for a 10-day trip as part of a regularly scheduled Russian "taxi mission" to replace crew members.[17]
4. *Anousheh Ansari* is the first female space tourist and the fourth overall to make the trip from Russia to the International Space Station (ISS). Anousheh Ansari's trip, by Space Adventures was aboard a Russian Soyuz TMA-9 spacecraft which was launched on September 9, 2006 from Kazakhstan's Baikonur Cosmodrome.[18]

5. *Charles Simonyi* is the second Hungarian in space and the fifth space tourist overall. Charles Simonyi may be best known for being the brains behind the success of Microsoft's major applications of Word and Excel. On 7th April 2007 American billionaire businessman Charles Simonyi Ph.D. commenced his 14-day mission from Space Adventures aboard a Russian Soyuz TMA-10 to the International Space Station (ISS).[19]
6. *John Glenn*, some have argued is the first space tourist, while others point to Dennis Tito. John Glenn is in fact, the first non-paying space tourist, which some have criticized as more or a far-fetched political junket while Dennis Tito is the first paying space tourist.[20]

Imagine someone in 1905 tasked with writing a survey article on 'New Commercial Opportunities in Aeronautics', he would probably have started with a review of the commercial uses of balloons. He would then have described the latest developments in lighter-than-air technology and how this would improve the capability of balloons to attract larger or new markets. We could be facing an analogous situation with regard to commercial opportunities in space. The first space plane, Space ship One (SS1), was designed for commercial use in 2004. This was the first flight to space of a fully reusable flying machine since the last flight of the X-15 in 1968.[21]

The main causes of the high cost of present space stations are low production rate, high political profile and high cost of access for repair and maintenance. None of these factors need to apply when space planes enter service and provide low-cost access. The cost per unit weight of space hotels should then become comparable to that of airliners which are orders of magnitude less than that of space stations to date. Because of their reusability space planes have a potential cost per seat to orbit roughly 1,000 times lower than today's largely expendable vehicles when used in large numbers and developed to airliner standards of maturity as measured by life and number of flights per day. Space tourism is likely to become a large enough market to provide the required funding and high traffic levels.

The model of a small orbital space plane, needed to activate this line of development could be built in about six years using existing technology at a cost equivalent to one or two flights of the Space Shuttle. It would be used mainly for launching small satellites, supplying the International Space Station and for pioneering orbital space tourism. The timescale required to advance the small prototype to mature airline operations to orbit depends mainly on how rapidly the market for space tourism grows up. If there is a 'gold rush' with major players racing to invest heavily it could possibly be achieved in as little as ten years. The pacing item is probably the development of a long-life rocket engine.

Low-cost access to orbit will lead to rapid developments in space science and exploration, and to new commercial uses of space especially manufacturing of orbit and solar power satellites. The environmental impact is likely to be

highly beneficial. Space tourism requires an aviation approach to transport to and from orbit, which will be of wide benefit to both aviation and spaceflight.

By sponsoring space plane development, governments at one stroke will not only save money on presently planned programmer but also forward a new 'space plane age' of astronautics that would be as far ahead of the present 'missile age' as the 'aero plane age' of aeronautics was from the 'balloon age'. The prototype of a small orbital space plane needed to trigger this line of development could be developed in about six years at a cost comparable to one or two flights of the Space Shuttle. It might be possible to progress from this prototype to airline operations within ten years which has given a massive development effort.[22]

Public Space Travel (PST) is sure to become a huge commercial space industry in near future which will completely change all conventional uses of space. Most government space activities are funded through national or international space agencies and which is strongly influenced by their history. The largest of these, the US National Aeronautics and Space Administration (NASA) was established during the Cold War. This activity became known as the US 'space program'. The 'Apollo project' to land two people on the Moon before the Soviet Union was effectively a strategic step in the Cold War, and in order to realize it NASA's budget grew rapidly during the early 1960s, while its employees grew from 3,000 to 30,000. Other countries governments also established 'space programs', and eventually 'space agencies', to develop space technology partly to subsidies the development of ballistic missile technology and partly to benefit from economically valuable applications which it was said would arise.

The current funding level of space agencies is approximately $25 billion/year, comprising of $14 billion for NASA; $6 billion for the space agencies in Europe, of which the European Space Agency (ESA) receives about half; some $3 billion for the various space research organizations in Japan, including the National Space Development Agency (NASDA); and several billion dollars spread between Russia, China, India, Israel, Brazil, Korea and other countries. Of this funding about 10 - 20% is spent on space science research including astronomy micro-gravity science and biology. Consequently, in round figures, the G7 countries' space agencies (i.e. USA, Europe and Japan) spend some $20 billion/year on a range of 'space development' activities in large part comprising development and operation of expendable launch vehicles satellites for various applications, and development and operation of space station equipment. In total, government space agencies have spent approximately $1 trillion (in current US$) on civilian space activities to date although it is difficult to estimate accurately due to major currency adjustments and inflation since the 1960s.[23]

However, the lack of economic benefits from the very large expenditures by government space agencies during the 30 years since Apollo 11 and more particularly since the end of the Cold War would appear to be due more to the

fact that government organizations are not primarily economically motivated. In order to understand these reasons better it is informative to identify some of the economic interests of the main interested parties following the public choice approach. Being government organizations space agencies are motivated towards self-preservation that is to ensure the continuation of their funding from governments. In order to achieve this among other things they need to avoid criticism this leads them to avoid risks that might lead to the perception of failure and to avoid innovation which inevitably involves such risks. High costs and inadequate innovation are well-known weaknesses of monopolies both private and governmental since space agencies' costs are high, they can avoid criticism by preserving the high cost of space activities, which they can do by preventing the emergence of effective competition. This motivation acts in the same direction as the fact that being monopolies, space agencies are motivated to preserve their monopoly status. Avoiding making promises that might not be fulfilled and using their public relations budgets to manage public expectations, continually emphasizing the difficulty of their work, and the need for larger budgets, etc, all work to the overall end of preserving their status. This motivation also leads to the "making mountains out of molehills syndrome" whereby every project becomes more complex than necessary and costs many times more than necessary thereby employing larger numbers of staff.

The combination of space stations, space hotels, reusable heavy lift vehicles for launching their modules, and space planes for frequent and regular supply flights will provide a low-cost orbital infrastructure of benefit to all commercial and scientific users of space. Space hotels will have a life in orbit measured in decades. The cost of launching them is therefore relatively small compared with the cost of operating them, the largest component of which is the regular supply of transport by space plane. Thus, present expendable (and therefore expensive) heavy lift vehicles, such as Ariane 5 could be used for launching their modules without greatly affecting total cost. At a later stage technology from space planes could be applied to large launchers to provide reusability and hence to reduce their cost per flight. Space planes can remove the launch cost barrier which at present prevents three commercial uses of space from developing - manufacturing solar power collection and orbital tourism. Let us consider each in turn.

Three fully reusable transportation vehicles were designed for this application sized for 20, 60, and 180 passengers' capacity per launch. A launch rate increasing from 100 to 6,000 launches per year was adopted in order to accommodate the eventual demands for the number of passengers. These vehicles do not require technologies beyond those that will be proven within 2 years on the X-33, but must be designed for high reusability and reliability a number of paper businesses were defined for PST. They showed that low enough seat prices could be offered to actually enable the large passenger rate required by the market elasticity data. An IRR of 35-55% is achievable by such businesses when carrying 1,000-10,000 persons per year. When the vehicles carried cargo as well as advertising, ticket prices were offset sufficiently that IRR levels of at least 45% were

attainable even at 1,000,000 passengers per year. What is more, these figures were achievable even when charging less than 30 $/Kg for carrying cargo into space. Thus PST could be highly synergistic with an SPS business. Thus a business can be created that generates over $30 Billion profit annually for an investment of $ 7.6 B. In addition a smaller scale business using a Kistler-type vehicle was de-signed in order to begin services incrementally, at passenger rates of 100-2,000 per year. It is shown that such smaller scale business can also be economically viable with IRR of 25-35% readily attainable with investment under $ 2 B.[24]

Although they are related, air transportation and accommodation are different industries. Likewise space transportation and accommodation is basically a different industry. In supplying the demand for space tourism, each will create business opportunities for a range of other companies. Launch vehicle manufacturer's rocket engine, component maker's propellant producers and materials companies will all participate in the cash-flow of the vehicle operating companies. Architecture, construction, component production, interior design, food and drink and entertainment companies will all participate in the cash-flows of the operators of hotels in Earth orbit. Both of these activities will also create new business for companies providing investment, insurance, leasing, banking, marketing, media and law services. And if we consider a revenue stream growing to trillions of Yen/year (tens of $ billions), it is clear that this new customer-driven industry will infuse new life into the aerospace industry which is still painfully shrinking.

The fall of the Soviet Union was fundamentally a result of the much greater creativity and productivity of free enterprise than of government-controlled activities. When the same commercial forces are applied effectively to space activities, the effects will be revolutionary. So perhaps the most important fact about space tourism is that it will be a normal commercial industry. In contrast to the situation today in which government-funded agencies and the companies to which they pass contracts are involved in a permanent effort to persuade taxpayers' to increase or even just to maintain their funding, space activities will become a race to the fastest. One of the most important lessons of business, though not a law of nature, is that being the first company to successfully provide a new service to the general public gives great advantage in dominating a new industry. Names such as Edison, IBM, Coca-Cola, Thomas Cook, are all testimony to this.

The development of this exciting and popular new industry should be financed and in turn very significant social and global benefits that can be expected. A contributing reason for the recent slow economic growth in the rich countries is that the cumulative investment of $1 trillion that has been made by governments in space technology development has yet to earn a commercial return. When put to profitable use in the way outlined in this paper it will create a lively new field for business investment and growth. But until this happens, the slow growth may be expected to continue.[25]

On this scenario, traffic of 5 million passengers per year in 2030 would imply that the cumulative number of passengers at that time would reach app. 40 million people or perhaps 3% of the middle class population of the time. However, in market research most people say that they would like to travel to space, and in addition a large proportion, particularly of younger people say that they wish to do so several times. The tourist activities described above will represent a turnover of the order of some $100 billion/year by 2030 assuming 5 million guests paying $20,000 each. Although this is far larger than space activities today it will still be only a few percent of civil aviation at that time, which is projected to exceed $2 trillion/year. Over and above the selling of travel services to customers the provision of accommodation services in addition to space transportation will create new markets in space for a wide range of products and services creating many new commercial opportunities in these fields.

It is particularly interesting to note that the activities described above will create several million permanent jobs in the aerospace, hospitality and related industries, a large proportion of them in leading industrial countries. This is in striking contrast to the effect of government space spending: the current level of $25 billion/year maintains employment at some 1/2 million - in jobs which will disappear when this taxpayer support ends.

The importance of this result is that $12 billion is less than half of one year's funding of government space agencies today and it is therefore readily affordable. The paper extrapolates the JRS scenario to the year 2030, based on market research results. By that time space tourism activities could have grown to a scale of $100 billion/year, creating several million jobs. It thereby demonstrates the very great economic value of such a development - approximately $1 trillion greater than the value of continued taxpayer funding of space agencies' activities without developing space tourism. The paper also discusses the potentially critical importance of this new industry in maintaining economic growth in the world economy against the deflationary pressures caused by excess capacity in older industries and inadequate investment in new ones.[26]

These third-world countries can send their astronauts to space only once because the high cost prevents a multiple trip. However, the rise in both educational level and economic standing of the third world has increased the awareness of the general public in the 21st century. And if a third world country has an astronaut program, it cannot send only one astronaut. Instead, it must create a program that will give its citizens the opportunity to be selected as astronauts in the near future.

Because building a space tourism vehicle will be more expensive than sending an astronaut to space, space tourism development activities do not require a third world country to build a passenger-carrying orbital vehicle. The program can consist only of activities that contribute to the development of space tourism, which involves as many of the general public as possible. The government needs only to organize public programs such as space tourism

lectures, exhibitions, and competitions and provide administrative support to space tourism activists and organizations. This is already enough to contribute to and be part of space tourism development. The program will be able to make the people feel as if they are part of a project and to provide an opportunity for them to go to space, like astronauts.

In early 2003, the Malaysian government announced its intention to send an astronaut to the ISS by 2006. Later, the government announced that it will send an astronaut to the space station by the end of 2007 via the same package offered by Roscosmos to space tourists. The astronaut program became very popular in Malaysia when the government announced in newspapers, TV, and websites that it was looking for suitable candidates of Malaysian citizenship to be trained as astronauts. By October 2003, 10,000 Malaysians applied for the astronaut candidacy, which requires the candidate a first class degree or professional pilot license as well as to be healthy. Out of the 10,000 applicants 900 were short-listed and finally by September 2006, two were selected for the training for the trip to the ISS. However, only one candidate has been selected by Soyuz launch vehicle, while the other remains as a substitute. According to the Malaysian government the astronaut was taken to the space station in October 2007.

Space tourism was first promoted in Malaysia as early as July 1999, when a public lecture on space studies organized by Perak state government with space tourism as the major content was presented by one of the authors at the School of Aerospace Engineering University of Science Malaysia. In the lecture the author stated that the management of Kuala Lumpur International Airport (KLIA) should consider the emergence of space tourism which will affect the design and operation of the airport. This statement was reported by a major English language newspaper in Malaysia a day after the lecture.[27]

The recent growth of activities towards developing passenger space travel services is very promising; however, there is a widespread but mistaken idea that space tourism will remain a small-scale activity of the very wealthy. The truth is that having been delayed for over three decades by government space agencies failure to develop more than a small fraction of the commercial potential of space the start of space travel services is long overdue and so they are capable of growing rapidly into a major new industry. That is, the technical and business know-how exists to enable space tourism to grow to a turnover of 100 billion Euros/year within a few decades if it receives public support of even 10% of space agencies' budgets. This development would sharply reduce the cost of accessing the resources of space which could prevent the spread of the "resource wars" which have begun so ominously. No activity therefore offers greater economic benefits than the rapid development of low-cost space tourism services. A range of government policies should be revised to reflect this. In recent year's business and government leaders have spent much time explaining to the public that we live at a time of rapid technological change and that we must adapt to this in many ways. Competition-driven costs are falling

continually, so companies facing global competition have to race to survive; consequently staff have to accept the need to change jobs periodically, and so on. The phrase "labor flexibility" favored by economists who support market liberalization has become infamous as a euphemism for salary reductions, longer work hours, worsening labor conditions, welfare and pension benefit reductions, dismissals, and other reductions in standards of living. However, the same policy-makers do not seem surprised when elements of the space community tell them that "Space is different". That is despite the literally uncountable technological advances in every field, including materials, computing, combustion engineering, manufacturing, electronics, robotics, simulation and many others, no-one can make rockets cheaper than the R7/Soyuz, designed 50 years ago. They add that this will not be possible for several more decades - if then. Economic policy-makers do not complain even when this is followed by the request to continue giving space agency's 20 billion USD of taxpayers' money every year in order to develop various machines for which there is little or no commercial demand.

At a time when almost no other area of government spending seems to be safe from cut-backs - education, health, pensions and environmental protection - what is the reason for this leniency towards "space policy"? Could the explanation be that the designer of the Soyuz rocket was a "Soviet Leonardo da Vinci" whose work still cannot be matched even half-a-century later? Or maybe even a century later if we are to believe space agency leaders' projections?

Developments in 2004 suggest that, excellent though the R7 designers surely were, their outstanding genius is not the explanation for the stagnation in launch costs. The successful sub-orbital flights by "Spaceship One" in June, September and October showed that it is possible to reduce the cost of getting to space today very sharply - to about 1% of the cost of Alan Shepard's 1961 sub-orbital flight using an expendable rocket. That is, the Spaceship One project does not represent a "magic solution" to the costs of spaceflight, but it demonstrates that if a focused effort is made to use existing technology to reduce the cost of traveling to space specifically by using a piloted reusable vehicle – something which space agencies have not done since the X-15 in the 1960s – a very small investment can reduce it dramatically below space agencies' costs.

As another point of comparison the total cost of the "Spaceship One" project was 20-25 million USD. By comparison the US government's space agency NASA spends some 16 billion USD/year or some 44 million USD/day; consequently the "Spaceship One" project cost the same amount as NASA spends every day before lunch. Thus, it would have been a minimal burden for NASA Esa or even Jaxa to have developed a similar vehicle during recent decades but they all chose not to do so - and they continue not to today. The reason for this is not because space agencies have any justification for believing that it is better not to develop such services for the public but because they do not want to. The first item of "invisible cost" is the cost of having delayed the

development of sub-orbital space tourism services. In 2003 NASA published its Analysis of Space Concepts Enabled by New Transportation (ASCENT) Study which included an estimate (quoted in the OECD's report) that sub-orbital travel alone could reach a turnover of 4 billion USD/year or about 5 times the current turnover of the commercial satellite launch industry. (NB the ASCENT study was not a feasibility study, but a study of potential markets for reusable launch vehicles.) It hardly needs to be pointed out that, on these grounds alone space agencies are clearly not fulfilling their legal responsibility to encourage the maximum possible commercial use of space so long as they continue not to encourage the development of passenger travel Among these benefits, providing young people with a vision of a bright future as described so excitingly by such engineer-writers as Clarke and Heinlein before governments established monopoly space agencies is highly desirable. This is clearly greatly preferable to the cultural stagnation the "dumping down" that would be inevitable under governments which based their policies on the presently dominant but erroneous "closed world" philosophy. Among many other such benefits growth of space tourism seems likely to lead to highly desirable growth in the numbers of young people choosing to study engineering and science.[28]

We can lay out a vision of space tourism activities 30 years in the future based on the provision of a growing range of commercial space travel services to the general public. Extending the JRS scenario linearly to 2020 passenger numbers would reach 1 million/year after 10 years of operation. Thereafter it seems reasonable to project continued growth both in the number of customers and in the range of services offered as this would follow the pattern seen in the travel and tourism industry on Earth. This growth would be fueled by rising incomes growing middle class populations and commercial competition between service providers to attract customers from around the world. On this basis, passenger numbers traveling to low Earth orbit (LEO) of 5-10 million/year 30 years from now would imply average growth rates of 18% - 26%/year through the decade 2020-2030, which are certainly possible.

Endnotes

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