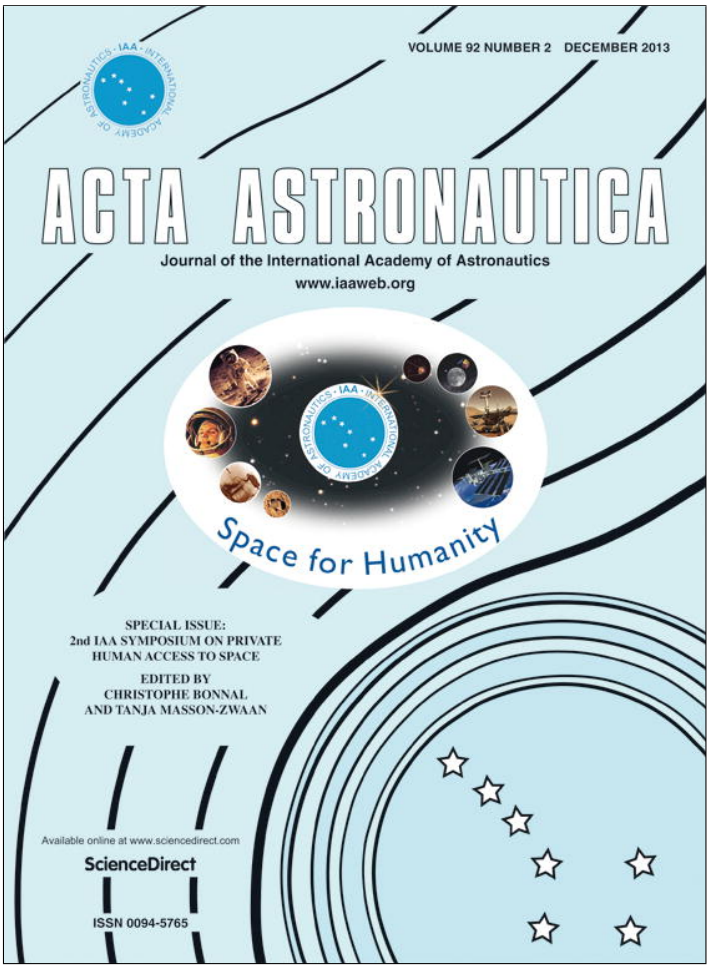

Acta Astronautica 92 (2013) 138–143

Contents lists available at ScienceDirect

Acta Astronautica

journal homepage: www.elsevier.com/locate/actaastro

Space tourism: Its history, future and importance

Derek Webber *,[1]

Washington DC Director, Spaceport Associates, Bethesda, MD, USA

ARTICLE INFO

Article history:
Received 19 February 2012
Accepted 19 April 2012
Available online 8 May 2012

Keywords:
Space
Tourism
History
Future
Importance

ABSTRACT

This paper sets space tourism in its historic setting, while looking ahead to where it may lead, and it underlines the significance of the new space tourism services to the overall future of the utilization of space, whether for commercial or governmental purposes.

1. Introduction

We are at a significant juncture between the early successes of the orbital space tourism industry, and the very near promise of the start of sub-orbital space tourism operations. Spaceports stand ready to embrace the new sub-orbital space tourism markets and their attendant economic and employment opportunities. The paper shows the parallels with early aviation and the simultaneous development of rocketry, and indicates how private access to space is a logical and inevitable next step. Finally, the paper points out that the importance of space tourism cannot be overstated. It is the means towards a future when access to space will become routine.

2. History

2.1. Aviation

The aviation era began in December 1903 when the Wright Brothers successfully flew a heavier-than-air flying machine in Kitty Hawk, North Carolina, USA. The machine (Fig. 1) does not look much like a modern aircraft, but it importantly contained all of the elements to enable controlled flight in three axes. Thus began mankind's efforts to leave the Earth, initially join the realm of the birds, and eventually venture forth into the far reaches of space. It has taken little more than a century before it became possible for passenger spaceflight to become a reality. It can be instructive to take note of the individual steps that were needed to take place throughout this century of effort. In the case of aviation, it was necessary for aircraft to travel at ever-greater speeds to ever further distances and altitudes. Pioneers led the way, and passengers soon followed.

The first passenger sat on the wing of a Wright Flyer, and it is interesting to note that the early airliners were noisy, subject to vibration, cold and very expensive. Only the rich and privileged could be airline passengers at the outset. Charles Lindbergh flew solo from New York to Paris in 1927, and by 1944, it had become possible for anyone with the money to do the trip in the comfort of airliners like the Constellation (Fig. 2). During the Second World War, the jet engine was invented, so that jet airliners subsequently made it possible for long distance air travel for all (although champagne and caviar were no longer on offer).

We note with some amazement the photo in Fig. 3 which shows Orville Wright briefly seated at the controls

* Tel.: +01 301 581 3382.
E-mail address: DWspace@aol.com
[1] Author: "The Wright Stuff: the Century of Effort Behind your Ticket to Space", Apogee Books.

0094-5765/$ - see front matter © 2012 IAA. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.actaastro.2012.04.038

Fig. 1. Wright Flyer (1903).

Fig. 2. Lockheed Constellation (1944).

Fig. 3. Orville Wright at controls of a Constellation (1944).

of a Constellation a few years before his death. How could he possibly have imagined such changes in the period after his first flights at Kitty Hawk in the primitive Wright Flyer? It is likely that 40 years on from the first space tourism flights, we shall also be amazed at how the technology will have been advanced.

The early pioneers can rarely imagine the final outcome of their endeavors and risk-taking. For example, the Wrights did not witness space travel. But Charles Lindbergh did. He even met the Apollo astronauts who walked on the Moon.

2.2. Rocketry

It was the same year of the Wright Brothers' success, 1903, when Konstantin Tsiolkovsky in Russia wrote his seminal paper "Investigation of World Spaces by Reactive Vehicles", in which he developed the rocket equations. In 1957 Sputnik 1 opened this next era in mankind's progress upwards and outwards. In April of this year (2011), we celebrated 50 years since man's first trip into space, when the Russian Yuri Gagarin completed an orbit of the Earth in the spaceship Vostok (Fig. 4). The early spacecraft, like Vostok and the US Mercury capsule, had little control once they were in orbit, and they could only carry one person at a time. As the technology developed, it became possible to maneuver in orbit and rendezvous with spacecraft which were already up there.

We can see in Fig. 5 an example of this important rendezvous process taking place between two US Gemini craft. Gemini carried a crew of two, and they proved the technology needed for the Apollo Moon landings by eventually achieving rendezvous and docking in space. Rendezvous and docking would be necessary if space tourists were ever going to be able to arrive at a space hotel. These first generation spacecraft were still too small to be used for space tourism, although the subsequent development of the Russian Vostok – the 3-person Soyuz spacecraft – has already been used for that purpose.

Simultaneously with human spaceflight developments, there was the beginning of commercial space, particularly in the form of the satellite telecommunications business. Commercial launch vehicles became available, a new set of support professionals emerged, including space insurers, space bankers and commercial space consultants,

Fig. 4. Vostok spacecraft (1961).

Fig. 5. Orbital Rendezvous–Gemini spacecraft.

whose activities would be needed later to ease the introduction of space tourism.

Soyuz continues to be used today for transfer of crews to and from the International Space Station (ISS). And nine commercial space travelers have used Soyuz for trips into orbit, starting with Toyohiro Akiyama in 1990, and ending with Guy Laliberté in 2009. One of them (Simonyi) even made two trips. So, orbital space tourism has become established fact, with journeys initially to space station Mir, and subsequently to the ISS. When Akiyama flew, it was only 29 years after Gagarin had opened up the new frontier. As with aviation, the first flights were very expensive, and ticket prices for Soyuz rides have risen from initially around $20 M to $60 M today. But a route to less expensive space tourism has opened up, following in the steps of the rocket plane test pilots.

2.3. Rocket planes

Max Valier and Fritz von Opel designed and flew the first rocket plane as early as 1929, and during the Second World War the Messerschmitt Me 163 Komet was a rocket plane which flew operationally. Then in 1947, the Bell X-1 rocket plane was the first aircraft to break the sound barrier, flown by Chuck Yeager. The experimental rocket planes pushed the envelope flying faster and higher, and the North American X-15 (one of whose pilots was Neil Armstrong) eventually reached Mach 6.7. Burt Rutan was a flight test engineer at Edwards Air Force Base, California, the home of the X-Planes, between 1965 and 1972. He used the rocket plane approach (a mother plane carries a rocket plane to about 40,000 feet, the rocket plane is dropped, fires its motor for a few minutes heading upwards, and lands as a glider when the rocket fuel has been exhausted) when he decided to compete for the $10 million Ansari X-Prize in 2004. In Fig. 6 we see Rutan's SpaceShipOne — which indeed won the X-Prize by being the first civilian space plane, going into space and returning, then repeating the feat a week later. It is now on display in the main hall at the Smithsonian Institution's National Air and Space Museum in Washington, DC. It hangs beside the Bell X-1, which opened up this new kind of transportation combining attributes of aviation and rocketry. This space architecture, using rocket

Fig. 6. Bell X-1 (1947) and SpaceShipOne (2004) at Smithsonian.

planes, has made possible space tourism for all, (or at least for millionaires, compared with the billionaires who were needed to afford the orbital tourism ticket prices!)

So, we have arrived in 2011, 108 years after the first flight of the Wright Brothers, and 50 years after the first space flight of Yuri Gagarin, at a point where two different kinds of space tourism are possible, and there could well be more in the future.

3. Future

Summing up these possible space tourism experiences, we realize that there will be competitive offerings, opening up a genuine market place which will ensure that service will improve, safety and reliability will increase, and prices will come down, exactly as has happened with aviation. The first aviation passengers would be astonished to experience the typical scene at an airport today with 400 people boarding an Airbus or Boeing 747. In this section, we look at some of the competitive space tourism offerings in order of complexity, with sub-orbital space tourism coming first.

3.1. Sub-orbital

Although orbital space tourism has already taken place, and sub-orbital space tourism is yet to start, that is due to a quirk of history, and it is far easier to provide sub-orbital space tourism than the orbital space tourism experience. The sub-orbital space tourism operators are likely to begin flying their first fare-paying passengers in 2013. A regulatory regime to support sub-orbital space tourism has been put in place in the US, with the FAA being appointed as the regulatory agency. There are likely to be a range of possible architectures for doing this, and two are described briefly below.

The Virgin Galactic sub-orbital space tourism operation will take place using the SpaceShipTwo spacecraft, released from the WhiteKnightTwo mother plane (Fig. 7). Both the spacecraft and the mother plane are developments of the architecture which Burt Rutan built in order to win the Ansari X-Prize in 2004. The SpaceShipTwo spacecraft will carry six passengers into space, and initial prices are set at $200,000 per flight. As can be seen from the image in Fig. 7, the program is well advanced, and SpaceShipTwo has been undergoing the first flights in its flight test regime. The photo was taken when the

Fig. 7. SpaceShipTwo and WhiteKnightTwo flying in 2010.

Fig. 8. XCOR Lynx simulation.

WhightKnightTwo/SpaceShipTwo combo arrived at the new spaceport in New Mexico, called Spaceport America, and landed for the dedication of its new runway.

A very different architecture for sub-orbital space tourism will be offered by the XCOR team, when they provide flights in their Lynx rocket plane (Fig. 8). The Lynx will not use a mother plane, but will use its rocket engines for the entire flight. Only one passenger will be carried, sitting next to the pilot. Prices will initially be as low as $100,000 but the first version of Lynx will not reach the full 100 km altitude line; later versions will.

Other potential providers are proposing still different architectures for sub-orbital space tourism, some which would use a combination of jet engines and rocket motors, and some of which will be wingless and complete the whole flight profile in vertical motion — straight up and down.

3.2. Orbital

We have pointed out that all the existing commercial space travelers to date have used the Soyuz spacecraft (Fig. 9) launched out of Baikonur in Kazakhstan. And it should be further noted that Soyuz is also used to transport government astronauts, including US astronauts, to the ISS. Soyuz carries three persons in exceedingly cramped conditions, but has done so reliably since the dawn of the space age. Soyuz was designed by the Russian chief space engineer Sergei Korolev as the follow-on to the Vostok spacecraft. The Russians continue to be willing to offer tourist flights in any spare seat on Soyuz, but there is a considerable supply-constraint because of the need to transport government astronauts into space. This supply constraint, together with an associated monopoly price, explains why the rate of orbital space tourism

Fig. 9. Soyuz spacecraft for orbital space tourism.

Fig. 10. SpaceX Dragon spacecraft retrieved from orbit (2010).

flights has generally not exceeded one per year (with none at all in 2010 or 2011). Although it has not been stated publicly so far, it seems apparent that once the Soyuz rocket starts to operate from the European launch site at Kourou, Guyana, at least potentially orbital space tourism could also take place from there. Then presumably French, rather than Russian, will be the language of choice for learning emergency procedures!

Possibly the first challenge to that Russian monopoly of orbital space tourism seats will come from the Dragon spacecraft (Fig. 10), which has already been launched into orbit, and successfully retrieved in 2010, by SpaceX. The spacecraft is intended to be used to provide cargo and personnel transport to the ISS, and clearly any spare seats would be potentially available for orbital space tourists. It was launched by a Falcon 9 launch vehicle, also developed by SpaceX, but could potentially be launched by other types of launch vehicle.

There could well be further offerings to provide orbital space tourism seats (including possibly spacecraft from Orbital, Boeing, Blue Origin, and Sierra Nevada corporations) but so far little is known in the public domain about space tourism resulting from these possibilities. However, quite a lot is known about possible commercial destinations for orbital space tourism flights. Bigelow Aerospace of Las Vegas, Nevada, has already placed two prototypes

Fig. 11. Bigelow Genesis prototype space hotel/station (2006).

Fig. 12. Reaction Engines Skylon.

in orbit (Fig. 11) of their eventual Sundancer habitat, which can be used as a space hotel or as an independent space station for nations which do not want to use the ISS.

In many respects, Bigelow is ahead of the game, and he awaits the regular provision of the next load of orbital space tourism passengers to his orbiting hotel porch.

3.3. Point-to-point

Even though we are still probably decades away from the commercial introduction of such a system, a great deal of work has been done, and continues to be done, on the design of possible hypersonic technologies to provide point-to-point sub-orbital space transportation. One such design is shown in Fig. 12, which shows the British Skylon of Reaction Engines. The engineering of such a vehicle is particularly challenging from the point of view of its aerodynamics, its combined cycle engine, and its reusable thermal control systems. Potential users certainly include the military, but it is far from clear whether a commercial market exists, either for cargo or passengers, who could afford the likely prices needed to recover the costs of such an exotic craft. From a potential space tourist's point of view, this class of vehicle would make it possible to fly up into space from a spaceport or airport almost reaching orbit and then return to Earth absolutely anywhere around the globe within an hour. The technology to make this possible is however much more comparable with the technology for getting into orbit, than it is to the technology for sub-orbital space tourism. And therefore, it is likely that the ticket prices would have to reflect that fact. It may therefore be that such vehicles, if built, would more likely be used as a fully-reusable delivery system of payloads (which might of course include orbital space tourists) into orbit.

Fig. 13. Apollo 8 circumlunar flight (1968).

3.4. Lunar

One space tourism operator, Space Adventures of Virginia, USA, has announced that it is ready to offer a tourist flight to the Moon and back to Earth, without landing there, using a development of the Soyuz spacecraft. If this were to take place, these tourist/adventurers would be following in the footsteps of the Apollo 8 crew (Fig. 13) who performed this feat in December 1968. Meanwhile, the Google Lunar X-Prize competition is encouraging the development and deployment of the commercial robotic pre-cursors of eventual lunar landings by space tourists.

4. Importance

The importance of space tourism cannot be overstated, partly because of the economic benefits it will bring, partly because of the new perspectives it will provide to all future space tourists, and partly because of the airline-like operating experience with reusable space vehicles, and the associated economies of scale of launch operations that will result.

Space tourism represents a new area of commercial endeavor, and has the potential to develop many billions of dollars annually in revenues, with associated benefits in employment and taxes. There will not only be employment opportunities created directly by space tourism, but also indirectly in the support industries and at the spaceports. Tourism in general is one of the largest sectors of the commercial world economy, and space tourism will provide a new exotic realm beyond the world cruise and adventure holiday domains which currently exist.

Space tourism will make all space flight eventually less risky and much cheaper. One of the reasons for this is the potential size of the market. Today, the sum total of payloads annually on all launch vehicles (government and commercial, from all over the world) amounts to 60–80 launches. This number has been constant for several decades. Because there are potentially thousands of passengers per year, and a passenger is considered as a payload, space tourism changes the economic framework of space flight, and economies of scale begin to show their

benefits. Furthermore, space tourism requires re-usable space systems, and so the existence of the space tourism market enables the development and refinement of this class of vehicle, leading to improvements in re-usability and more airline-like operations. Not only space tourists, but all users of space (government, commercial) will benefit from the advantages that will result from the creation and operation of space tourism. It will become easier, cheaper, and more routine to get payloads into space. Researchers will be able to plan, afford, and execute space experiments within the reasonable timeframe it takes to get a Ph.D, which is not generally the case today.

Finally, the tourists themselves will present a force for beneficial change. For 40 years since the Moon landings, the general public has been losing interest in space flight (as evidenced by the results of countless public opinion polls). Space tourism represents a way to make space personal to them, and therefore provide a stimulus for more public interest in space in general. This will provide a stimulus for more scientific and mathematical courses at college, reversing a downward trend at least in the US. Not many more than 500 people have followed Yuri Gagarin into space during the last 50 years. Soon, with the coming of sub-orbital space tourism, it will be possible to fly more than that number in a single year, and they will all be able to savor the same experience of America's first man in space, Alan Shepard, who in May 1961 declared: " What a beautiful view!." Almost everyone who has been into space has reported that the experience has been transforming. To see the curvature of the Earth, and the black sky, and the narrow fragile band of our atmosphere has almost always resulted in an increased awareness of the need to conserve the resources of this planet. To those twenty four men who went to the Moon in '68–72', it also underlined the realization that it will be very hard indeed to create an alternative home for man, elsewhere in the solar system. But, however hard it will be, mankind will eventually need to establish footholds elsewhere on other planetary bodies, and treat those bodies as commercial resources just as mankind has treated Earth up to the present. Space tourism is an essential building block that is needed to make that very long term future a possibility. Charles Lindbergh met both Orville Wright and Neil Armstrong within his lifetime. Burt Rutan met Wernher von Braun and built the first prototype space tourism craft, SpaceShipOne. By helping make this industry flourish, the attendees of this conference will make possible a future in space that none of us can imagine today.