P Collins & A Autino, 25 May 2008, "What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace", Originally presented at Plenary Session of the International Academy of Astronautics' 1st Symposium on Private Human Access to Space, held at Arcachon in France, 25-28 May 2008..
Also downloadable from http://www.spacefuture.com/archive/what the growth of a space tourism industry could contribute to employment economic growth environmental protection education culture and world peace.shtml

Bibliographic Index

References and Referring Papers Printable Version

Originally presented at Plenary Session of the International Academy of Astronautics' 1st Symposium on Private Human Access to Space, held at Arcachon in France, 25-28 May 2008. Revised and updated 11 June 2009

*Life & Environmental Science, Azabu University, 1-17-71 Fuchinobe, Sagamihara, Kanagawa 229-8501, Japan
** Andromeda Inc., Italy

WHAT THE GROWTH OF A SPACE TOURISM INDUSTRY COULD CONTRIBUTE TO EMPLOYMENT, ECONOMIC GROWTH, ENVIRONMENTAL PROTECTION, EDUCATION, CULTURE AND WORLD PEACE

Patrick Collins* & Adriano Autino**

Abstract

The authors argue that the creation of a popular new industry of passenger space travel could be economically and socially very beneficial in creating new employment in aerospace and related fields in order to supply these services. In doing so, the application of nearly a half-century of technological development that has yet to be used commercially could create many new aerospace engineering business opportunities. In addition, by growing to large scale, space tourism has unique potential to reduce the cost of space travel sharply, thereby making many other activities in space feasible and profitable. The paper discusses the scope for new employment, stimulating economic growth, reducing environmental damage, sustaining education particularly in the sciences, stimulating cultural growth, and preserving peace by eliminating any need for "resource wars".

1. Introduction: potential growth of space travel industry

ARCHIVE

There are currently **222** documents in the archive.

Bibliography List

KEY DOCUMENTS

Here are some key documents from the archive to get you started:

1. What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace
2. Space Tourism Market Demand and the Transportation Infrastructure
3. General Public Space Travel and Tourism
4. Artificial Gravity and the Architecture of Orbital Habitats
5. Prospects of Space Tourism

More Documents

Images of rockets launching satellites and crew into orbit, like the idea of space travel, are widely treated as "futuristic" in the media. However, it is noteworthy that such rockets are not only not futuristic, they are very old technology, developed in Germany during WW2. The first successful spaceflight was achieved on October 3, 1942, after which the project leader Walter Dornberger held a party for the team, who toasted the future of space flight with him:

> *We have proved rocket propulsion practicable for space travel. This 3rd day of October, 1942, is the first of a new era in transportation, that of space travel.*

- Walter Dornberger, after the first successful space flight [1].

If German rocket development had continued as Dornberger envisaged, the V2 (of which a winged version reached Mach 4) and the Messerschmidt 163 piloted rocket-plane projects could well have led to the start of sub-orbital passenger space flights, using fully reusable, piloted spaceplanes, by 1950. In this case, passenger travel services to and from low Earth orbit (LEO) would presumably have started during the 1960s.Instead of this possible scenario, rocket development was dominated by the cold war competition between the USA and USSR, which led to the production of tens of thousands of longrange missiles. As a result, launch vehicles were derived from missiles, rather than being designed ab initio as passenger vehicles as aircraft had been, decades before. Government space agencies have continued to develop expendable rockets, of which the safety and cost/passenger are inevitably much closer to those of missiles than to passenger vehicles. (The space shuttle, as well as being partly expendable, was designed primarily to launch the "Big Bird" satellite and land within the continental USA after one orbit—not to achieve low-cost space travel.) As of mid-2009, sub-orbital passenger space flight services are expected to start in 2011: there has thus been more than a half-century delay in developing passenger space travel.In view of this history, the rockets used to launch satellites today, rather than being considered "futuristic" can reasonably be described as "obsolescent". That is, they could have been replaced by reusable launch vehicles several decades ago if policy-makers had so chosen, and they would have been if space technology investment was intended to earn commercial profits. This is because market research strongly suggests that there is much greater potential demand for reusable launch vehicles carrying fare-paying passengers than for expendable rockets.This is well exemplified by the study performed by Futron Inc. as part of NASA's "ASCENT" study (Analysis of Space Concepts Enabled by New Transportation) to identify and quantify possible uses of reusable launch vehicles [2]. Having considered numerous possibilities, it concluded that sub-orbital travel services in the USA alone might grow several times larger than world-wide commercial satellite launch services [3].It is not possible to accurately predict future orbital travel growth rates even before sub-orbital passenger services begin, but the potential scale to which orbital passenger space travel might grow, based on market research, is discussed in [4,5]. For modeling sales of new services, the family of sshaped "Gompertz curves" uses estimates of what percentage of households will eventually buy a new product or service, and how long it will take for a certain percentage of households to adopt it, in order to generate consistent scenarios of annual sales.An interesting precedent of rapid growth of a new service was the explosive growth of the mobile phone industry in Japan from 1994 through 1996. Starting from almost zero, new customers reached 40 million within 3 years, and the largest service supplier grew into a 50 billion dollar company. Some $30 billion were invested by the service providers during those 3 years, at a time during Japan's deepest post-war recession. All of the participating companies greatly underestimated how fast sales would grow. Another interesting precedent was the rapid growth of airline passenger traffic, sometimes called the "Lindberg Boom", which took place during the 1930s world depression. This was aided by a number of effective government policies designed to encourage passenger air travel.In 2008, the Tauri Group studied the personal spaceflight industry, and estimated total revenues of some $200 million in 2006 and $300 million in 2007 [6]. Although promising, this amount is barely 1% of what governments give to space agencies. Consequently additional investment of even several times this amount would be a trivial cost to governments—and utterly negligible compared to the trillions that they have given to banks during 2008–9. Consequently, if governments are sincere in their claims that they are trying to aid innovation and growth of new

WHAT'S NEW

29 July 2012
Added "Space Debris and Its Mitigation" to the archive.

16 July 2012
Space Future has been on something of a hiatus of late. With the concept of Space Tourism steadily increasing in acceptance, and the advances of commercial space, much of our purpose could be said to be achieved. But this industry is still nascent,

industries, then it is not only easy, but it would cost very little to accelerate the growth of passenger space travel services.Cost estimates by the Japanese Rocket Society [7], Bristol Spaceplanes [8], Bekey [9] and others, corroborated by the very low cost of "SpaceShipOne", indicate that once space travel grows to 1 million passengers/year, prices could fall to 5000 Euros for sub-orbital flights, and 20,000 Euros for orbital flights [7–9]. The latter is equivalent to some 200 Euros/kg or about 1% of launch costs today. We can estimate that if sub-orbital passenger travel had started in 1950, orbital travel could have grown to perhaps several million passengers/year by 2000, as shown in Fig. 1.

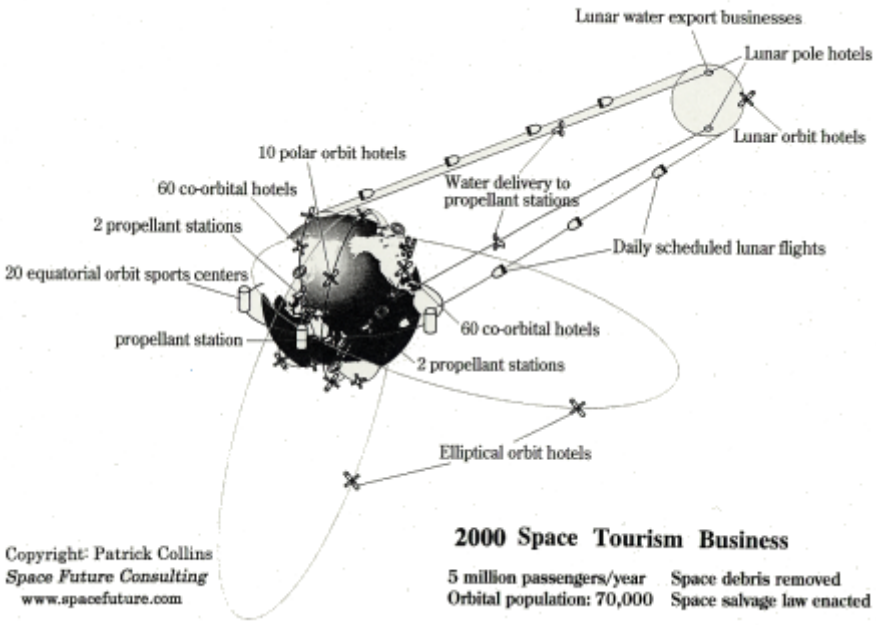

Fig. 1. Year 2000 space tourism industry if sub-orbital tourism had started in 1950 (adapted from [10]).

Costs for the development of low-cost orbital passenger transportation systems are of the order of 10 billion Euros [7–9]. Even 10 times this amount would be less than 5 years of space agencies' current budgets. The economic benefits seem sure to greatly outweigh the cost, due to the much larger commercial markets that would be created as a result, in contrast to the very small markets created with 1 trillion Euro-equivalents invested in satellite and launch vehicle manufacturing to date.That is, there seem to be no technical reasons why rapid growth of space travel services could not be realised: the technology has existed for decades, and companies wishing to develop vehicles are hampered by only one obstacle, which is the easiest for governments to solve—lack of funds. Hence the rest of this paper assumes that over coming decades households will start to purchase space flight services, which will grow to reach 5 million passengers/year, out of a worldwide middle-class population of more than 2 billion people, a few decades from now.Starting from today, in order to achieve the scale of activity shown in Fig. 1 over the next 30 years, government funding equivalent to about 10% of space agencies' budgets, or some 2 billion Euros/year would probably suffice to stimulate private investment in reusable orbital passenger vehicle manufacturing and operations. Thereafter most of the funding would come from private companies, just as airline and hotel companies finance their own growth today.

and there's much to do. So...watch this space.

9 December 2010
Updated "What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace" to the 2009 revision.

7 December 2008
"What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace" is now the top entry on Space Future's Key Documents list.

30 November 2008
Added Lynx to the Vehicle Designs page.

More Subscribe

SFJ TOP STORIES

- How Much Do You Know About Space
- Space Future Editor Wins NewSpace Journalism Award
- China's First Manned Docking of Space Module Is a Success
- Five Horrifying Facts
- NASA Will Pay You to Eat Astronaut Food

1.1. Implications of launch cost reduction

Reducing the cost of space travel to 1% of existing launch vehicles' costs, in combination with the growth of a new consumer service market in space, would greatly aid the growth of many commercial space activities, thereby creating numerous new business opportunities both on Earth and in space. This process is already at work on a small scale in relation to sub-orbital flight services: in addition to a large number of travel companies acting as agents for sub-orbital flights (including JTB, the largest travel company in Japan), Zero-G Corporation supplies parabolic flight services, Bigelow Aerospace is developing the first space hotel, Spaceport Associates advises on spaceport design, Orbital Outfitters Inc. supplies customised flight suits, spaceports are being developed in several places, and several support organisations have been established. All of this activity is occurring some years before the first high-priced services even start, so a much wider range of different space travel-related businesses are sure to grow in future.

In the case of orbital services there will be an even wider range of companies with much larger revenues, including companies supplying various services to orbiting hotels. These will include services which terrestrial hotels typically purchase today, such as catering, cleaning, accounting, entertainment, plus such additional services as space-based window maintenance, air supply, solargenerated electricity, water supply, waste disposal services, and others.

As activities in orbit expand progressively, they could grow to include use of materials extracted from the Moon and near-Earth asteroids and cometoids, of which the potential has been researched for several decades [11]. Due to the much higher cost of activities in orbit than on the surface of the Earth, orbiting hotels seem likely to create the first market for non-terrestrial materials like ice, water, oxygen and hydrogen, as discussed in [12].

Another potentially major space-based industry, which has been held back for 40 years by high launch costs, is the supply of solar power from space to Earth. Although the potential of this system was recognised in studies by the US Department of Energy in the late 1970s, and confirmed in the 1990s [13], total funding has remained minimal. However, progress could be rapid once launch costs fall to a few percent of ELV costs [14]. Hence, as passenger space travel activities expand to large scale, a growing range of manufacturing activities in Earth orbit, on the lunar surface and elsewhere could develop spontaneously, driven by entrepreneurial effort to exploit new business opportunities opened up by the growth of new commercial markets in Earth orbit. These will in turn open the door to the large-scale space activities described in [11].

The growth of orbital passenger space travel to several million passengers/year over a few decades would represent a direct commercial turnover of some 100 billion Euros/year. In such a scenario of rapid growth, annual investment in new facilities, research and development might add the same amount again. Indeed, having reached such a scale, there would be no foreseeable limit to further growth—in particular it need not be limited, like terrestrial activities, by environmental or political constraints. Quite apart from the numerous opportunities which such a scenario offers for growth of the space industry, it also offers great potential benefits for humanity, in several different fields, as discussed in turn in the following.

2. Employment

In most countries, most of the population do not have economically significant land holdings, and so employment is the economic basis of social life, providing income and enabling people to have stable family lives. The high level of unemployment in most countries today is therefore not only wasteful, it also causes widespread poverty and unhappiness, and is socially damaging, creating further problems

Attention Teachers: If You Don't Apply to This Workshop
Space Is Dirty
The Film That NASA Banned
SRI holds Inaugural Conference
Zubrin's Proposal to Fund "Pathway to the Stars"
More Articles

for the future. One reason for investing in the development of passenger space travel, therefore, is that it could create major new fields of employment, capable of growing as far into the future as we can see.

As of 2001, the hotel, catering and tourism sector was estimated to employ 60 million people world-wide, or 3% of the global workforce, and 6% of Europeans [15]. Hence we can estimate that the passenger air travel industry, including airlines, airports, hotels and other tourismrelated work, indirectly employs 10–20 times the number of people employed in aircraft manufacturing alone. Likewise, passenger space travel services could presumably create employment many times that in launch vehicle manufacturing—in vehicle operations and maintenance, at spaceports, in orbiting hotels, in many companies supplying these, in services such as staff training, certification and insurance, and in a growing range of related businesses.This possibility is particularly valuable because high unemployment, both in richer and poorer countries, has been the major economic problem throughout the world for decades. Consequently the growth of such a major new market for advanced aerospace technology and services seems highly desirable, as discussed further in [16].

By contrast, in recent years employment in the traditional space industry in USA and Europe has been shrinking fast: a 2003 report by the US Federal Aviation Administration stated that employment in launch vehicle manufacturing and services fell from 28,617 in 1999 to 4828 in 2002, while employment in satellite manufacturing fell from 57,372 to 31,262 [17]. Likewise, European space industry employment fell by 20% from 1995 to 2005; the major space engineering company Astrium cut 3300 staff from 2003 through 2006; and in 2005 alone, European prime contractors cut 13.5% of their staff or some 2400 people [18]. Unfortunately, the probability of space industry employment recovering soon is low, because satellite manufacturing and launch services face both low demand and rapidly growing competition from India and China, where costs are significantly lower.

It is therefore positively bizarre that government policy-makers have declined to even discuss the subject of investing in the development of passenger space travel services, and have permitted no significant investment to date out of the nearly 20 billion Euro-equivalents which space agencies spend every year! This is despite the very positive 1998 NASA report "General Public Space Travel and Tourism" [19], and the NASA-funded 2002 "ASCENT" study referred to above [2,3].

In the capitalist system, companies compete to reduce costs since this directly increases their profits. However, reducing the number of employees through improving productivity raises unemployment, except to the extent that new jobs are created in new and growing industries. In an economy with a lack of new industries, increasing so-called "economic efficiency" creates unemployment, which is a social cost. In this situation, governments concerned for public welfare should either increase the rate of creation of new industries, and/or slow the elimination of jobs, at least until the growth of new industries revives, or other desirable counter-measures, such as new social arrangements, are introduced. These may include more leisure time, job-sharing, and other policies designed to prevent the growth of a permanent "under-class" of unemployed and "working poor"—a development which would pose a major threat to western civilisation.

One of the many ill effects of high unemployment is that it weakens governments against pressure from corporate interests. For example, increased restrictions on such undesirable activities as arms exports, unfair trade, environmental damage, corporate tax evasion, business concentration, advertising targeted at children, and anti-social corporate-drafted legislation such as the "codex alimentarus", "tort reform" and compulsory arbitration are socially desirable. However, when unemployment is high, corporations' arguments that government intervention would "increase unemployment" have greater influence on governments.

As outlined above, the opening of near-Earth space to large-scale economic development, based initially on passenger space travel services, promises to create millions of jobs, with no obvious limits to future growth. At a time when high unemployment is the most

serious economic problem throughout the world, developing this family of new industries as fast as possible should be a priority for employment policy. To continue economic "rationalisation" and "globalisation" while not developing space travel is self-contradictory, and would be both economically and socially very damaging.

3. Economic growth

The continuation of human civilisation requires a growing world economy, with access to increasing resources. This is because competing groups in society can all improve their situation and reasonable fairness can be achieved, enabling social ethics to survive, only if the overall "economic pie" is growing. Unfortunately, societies are much less robust if the "pie" is shrinking, when ethical growth becomes nearly impossible, as competing groups try to improve their own situation at the expense of other groups. Continued growth of civilisation requires continual ethical evolution, but this will probably be possible only if resources are sufficient to assure health, comfort, education and fair employment for all members of society.

The world economy is under great stress recently for a number of reasons, a fundamental one being the lack of opportunities for profitable investment—as exemplified by Japan's unprecedented decade of zero interest-rates. This lack of productive investment opportunities has led a large amount of funds in the rich countries to "churn" around in the world economy in such forms as risky "hedge funds", causing ever greater financial instability, thereby further weakening economic growth, and widening the gap between rich and poor.

Increasing the opportunities for profitable, stable investment requires continual creation of new industries [16]. Governments today typically express expectations for employment growth in such fields as information technology, energy, robotics, medical services, tourism and leisure. However, there are also sceptical voices pointing out that many of these activities too are already being outsourced to low-cost countries which are catching up technologically in many fields [20]. Most of the new jobs created in the USA during the 21st century so far have been low-paid service work, while the number of US manufacturing jobs has shrunk rapidly [21]. It is thus highly relevant that aerospace engineering is a field in which the most technically advanced countries still have a substantial competitive advantage over later developing countries. Hence, if a commercial space travel industry had already been booming in the 1980s, the shrinkage in aerospace employment after the end of the "cold war" would have been far less. Consequently it seems fair to conclude that the decadeslong delay in developing space travel has contributed to the lack of new industries in the richer countries, which is constraining economic growth and causing the highest levels of unemployment for decades.

The rapid economic development of China and India offers great promise but creates a serious challenge for the already rich countries, which need to accelerate the growth of new industries if they are to benefit from these countries' lower costs without creating an impoverished under-class in their own societies. The long-term cost of such a socially divisive policy would greatly outweigh the short-term benefits of low-cost imports. The development of India and China also creates dangers because the demands of 6 billion people are now approaching the limits of the resources of planet Earth. As these limits are approached, governments become increasingly repressive, thereby adding major social costs to the direct costs of environmental damage [22]. Consequently, as discussed further below, it seems that the decades-long delay in starting to use the resources of the solar system has already caused heavy, selfinflicted damage to humans' economic development, and must be urgently overcome, for which a range of policies have been proposed in [23,24].

3.1. Popular demand is the basis of economic growth

The continuing heavy dependence of the space industry on taxpayer funding, despite cumulative investment of some 1 trillion Euro-equivalents, is due to the simple fact that those directing the industry have chosen not to supply services which large numbers of the general public wish to buy. Yet it is elementary that only by doing this can the space industry grow into a normal commercial activity. Doing so will create an industry which raises private investment to develop new, better and larger facilities in order to sell better services to ever-more customers—in the familiar "virtuous circle" of business growth. Eventually this activity may even reach a scale sufficient for the tax revenues it generates to repay the public investment to date.

In successful companies, investment is skillfully judged so as to produce goods and services for which there will be large commercial (i.e. non-governmental) demand. If this earns sufficient profits, then the activity will continue to grow spontaneously for decades or more, like manufacturing of cars or airliners. If, instead, funds intended for investment are spent on developing non-commercial products, such as expensive surveillance satellites or a space station for which the only significant customer is government, then clearly the space industry is doomed to remain forever a small, taxpayer-funded activity—a hindrance rather than a help to economic growth.

Economic policy-makers responsible for deciding the public budget for space development must no longer rely exclusively on the advice of the space industry itself, which ever since its origin has had different objectives than the economic benefit of the general public. That is, economic policy-makers, who are responsible for tens of trillions of Euros of activity, must take the initiative to ensure that passenger space travel services are developed as soon as possible. There are many ways in which private investments in this field can be facilitated and supported, without governments themselves either planning or managing the projects.

Among other steps, this will require the important institutional innovation of collaboration between civil aviation and civil space activities. Since, even with today's knowledge, researchers foresee the possibility of economic development in space growing to a scale similar to terrestrial industry [11]. This field of industry must be considered as having the potential to become a major new axis for economic growth—equivalent in importance to the aviation industry, but with minimal environmental impact, as discussed below—and therefore deserving of the most serious and urgent attention by economic policymakers.

4. Environmental protection

Economic development in space based on low launch costs could contribute greatly, even definitively, to solving world environmental problems. As a first step, substantially reducing the cost of space travel will reduce the cost of environment-monitoring satellites, thereby improving climate research and environmental policy-making.

4.1. Space-based solar power supply

A second possibility, which has been researched for several decades but has not yet received funding to enable testing in orbit, is the delivery of continuous solargenerated power from space to Earth. Researchers believe that such space-based solar power (SSP) could supply clean, low-cost energy on a large scale, which is a prerequisite for economic development of poorer countries, while avoiding damaging pollution. However, realisation of SSP requires much lower launch costs, which apparently only the development of a passenger space travel industry could achieve. Hence the development of orbital tourism could provide the key to realising SSP economically [14].

4.2. Carbon-neutral space travel

Clean energy produced by SSP could eliminate the environmental impact of space travel, and even make it "carbon neutral" if this is considered desirable [25]. Moreover, SSP has a much shorter energy pay-back time than terrestrial solar energy, due to the almost continuous supply of power which it can generate, rather than only in day-time during clear weather. Some critics claim that space travel will become a significant environmental burden [26]. However, while superficially correct in the short term, this is the opposite of the truth over the longer term. It would be a dangerous error to prevent the growth of space tourism in order to avoid its initial, minor environmental impact, since this would prevent a range of major benefits in the future, including the supply of lowcost, carbon-neutral SSP, and other space-based industry.

4.3. Space-based industry

If orbital travel grows to a scale of millions of passengers/year -- as it could by the 2030s, with vigorous investment -- it will stimulate the spontaneous growth of numerous businesses in space. These will grow progressively from simple activities such as maintenance of orbiting hotels, to in-space manufacturing using asteroidal minerals. For example, the development of SSP would enable a range of industrial processes using the advantages of space, including high vacuum, weightlessness, low-cost electricity and sources of both minerals and volatile chemicals in shallow gravitational wells.

If SSP grows to supply a significant share of the terrestrial energy market, more and more industry would operate outside the Earth's ecological system. While most industries cause growing damage to the Earth's environment as they grow in scale, industrial activities which are outside the Earth's ecosystem need not cause any such damage. Hence the growth of space-based industry to large scale offers the longer-term possibility of decoupling economic growth from the limits of the terrestrial environment. Indeed, it has been convincingly argued that only the use of space resources, including especially SSP, offers the possibility of protecting the Earth's environment while enabling sufficient economic growth to preserve civilised society [22,27].

4.4. Severe weather amelioration and climate stabilisation

The use of solar power satellites for reducing the severity of hurricanes and typhoons, and/or ameliorating severe snow conditions has been discussed for some years. In the extreme case this application of SSP might even include a role in the stabilisation of climate. Earth's climate system is extremely complex, and is the subject of a great deal of ongoing scientific research, including collection of an ever-wider range of data, and ever-more detailed analysis of climate change in the past.

A positive-feedback cycle causing sudden onset of the cooling phase of the long-term cycle of "ice ages" has been hypothesized, whereby a winter with unusually low temperatures and/or unusually widespread and/or longlasting snow cover would increase the probability of the following winter being even more severe [28,29]. The beginning of such a trend would be similar to the sharply more severe winters seen over the two last years in North America (as well as the unusually cool 2009 summer).

Consequently, although such a possibility may seem remote, and although there are thorny legal problems concerning deliberate weather modification, it is nevertheless noteworthy that satellite power stations may be the only practical means of selectively melting snow over areas of thousands of square kilometres, possibly sufficient to prevent such a vicious circle, even in the event of terrestrial energy shortages.

4.5. Ethical consumption

Passenger space travel and its numerous spinoff activities have the important potential to escape the limitations of the "consumerism" which governments in the rich countries have encouraged in recent decades in order to stimulate economic growth, defined as GDP.

Researchers now understand that this is resulting in "excess consumption" which causes unnecessary environmental damage [30], while reducing rather than increasing popular satisfaction [31]. That is, "first world" citizens are increasingly trapped in a culturally impoverished "consumer" lifestyle which reduces social capital, social cohesion and happiness, while damaging the environment. By contrast, expenditure on the unique experience of space travel promises to play a more positive role in the economy and society, enriching customers culturally without requiring mass production of consumer goods and corresponding pollution. As such it could be a harbinger of a future "open world" economy [27].

5. Education

The educational value of space activities is well known: children and young people find the subject of space and space travel uniquely fascinating. A number of spacebased, science-fiction films and television series have achieved extraordinary popularity, extending over decades. As a result, various organisations have created space-related educational programmes involving satellite design, small rockets and simulation of space flights. Unfortunately, while these activities are popular with the participants, it has to be recognised that they are not effective in increasing young people's scientific education overall, which continues to decline in most countries. That is, children who enjoy science classes find satellite projects inspiring, but these classes do not prevent the "flight from science" seen in rich countries, which is so dangerous for the successful continuation of civilisation.However, the possibility of being able to travel to space themselves at an affordable price is of much greater interest to young people than watching videos of other people traveling to space, or than simulating traveling to space. Hence the start of low-cost passenger space travel services holds unique promise for education in fields related to space travel. In particular, the expectation that the price of a sub-orbital flight could fall as low as just a few thousand Euros [8,32] as the service grows to millions of passengers/year, offers the possibility of almost all children being able to take a flight sometime. This possibility can be used as a uniquely stimulating teaching tool. In addition, a scenario like that shown in Fig. 1 will employ tens of thousands of staff in orbit within a few decades -- a uniquely exciting goal for young people to aim for.

6. Culture

The history and artefacts of the European Renaissance are still the subject of world-wide admiration today. One reason for this unique flowering—such as in 14th century to 16th century Firenze—was that there was a social ethic whereby the successful and wealthy had a sufficiently strong sense of civic duty that they used part of their wealth to enrich the community, particularly by building inspiring civic spaces—libraries, galleries, palazzi and other buildings—and by commissioning works of art and scholarship, with results which still inspire us 600 years later [33]. Such an ethic requires that those who are materially successful, however "self-made" and praiseworthy they may be, recognise that they are also all beneficiaries of good fortune—to have been born in a country, an era, a locale, and a family in which they have opportunities to learn language and manners, to accumulate formative experiences, to obtain useful knowledge, and then opportunities to exercise their talents and grow into a great career. In a successful society, people who are blessed with such good fortune accept that they have a social duty to repay this—by creating a similarly nurturing environment for future generations. The enduring popularity of the achievements of the Renaissance surely illustrate the enormous value of such a deep ethical sense in society, and especially among its leaders.

6.1. The need for a new world-wide renaissance

By contrast, as societies became richer over the following centuries, they were increasingly disfigured by becoming more materialistic, a trend accompanied by more and more destructive and barbarous wars, including the horrific "world wars" and communist revolutions. This trend has continued with the recent shocking decline in ethics of the US and UK governments openly flouting national and international law—and even the Geneva Conventions, once seen as a bulwark of European civilisation by making war less inhumane through banning torture and the killing of civilians, inter alia.

The way of thinking of Renaissance leaders was strikingly different from today when the wealthy are encouraged to follow the rubric: "If you've got it, flaunt it", or appear to follow the frankly psychopathic: "Everything for us—and nothing for anyone else." In the USA since 2000, "yall of the real gains in national income, total net worth and overall growth in financial worth have gone to the top 1%" [34]. The result of this is that the gap between rich and poor has widened sharply so that the top 1% of the US population now holds more than twice as much wealth as the bottom 80% of the population [34].

The futility of such behaviour is well-known throughout the ages, as expressed in such sayings as: "You cannot take it with you when you die," or "There are no pockets in a shroud". The great universalist religions of Buddhism, Christianity and Islam are in agreement that material wealth is transient and acquisitiveness is not the path to happiness: to the contrary, having gratitude for good fortune, and making efforts to help others less fortunate than oneself are extolled. The reason why these teachings have lasted for millenia is because they help people to live satisfying lives, to raise healthy children, and to maintain stable, resilient societies. They are the basis of true civilisation.

Thus, while societies have grown far richer since the Renaissance, the way of thinking of the rich today seems far poorer. Despite almost unlimited opportunities for creativity and cultural contribution, most of the rich today leave behind little or nothing that will be remembered. They typically use their money to buy large numbers of possessions, which are redistributed on their death. Of course many people, including the wealthy, give generously to charitable organisations, many of which do very valuable work for numerous socially beneficial causes. However, much of this work does little more than offset some of the worst effects of the policies followed by the rich countries which are in fact rapidly widening the gap between rich and poor.

We can judge this behaviour. The great universalist religions as well as secular humanism would agree: the great benefactors of the Renaissance were more admirable human beings. Unless corrected soon, this futile materialism of "modern" societies seems likely to destroy civilisation. Yet under "neo-liberal" or "neo-con" dogma, instead of using the opportunity provided by wealth to contribute culturally to society, the already rich nowadays exert pressure on governments to reduce their taxes further, to remove remaining restraints on monopolies and illegal surveillance of the general public, while falsely blaming already deteriorating welfare systems for governments' fiscal crisis. The lack of new industries described above weakens governments against such pressures via the threat of increased unemployment, which is electorally unpopular. Such psychopathic greed and dishonesty among the upper levels of a society are surely the prelude to its destruction, and represent the most serious challenge to western civilisation. A new world-wide "Renaissance" is urgently needed, especially among the rich of the world.

6.2. "The Earth is not sick -- she's pregnant"

Healthy societies can revitalise themselves. An interesting explanation of the potential of space travel and its offshoots to revitalise human civilisation is expressed in the idea that "The Earth is not sick: she's pregnant" [35]. Although this idea may seem strange at first sight, it is a surprisingly useful analogy for understanding humans' current predicament. According to the "Pregnant Earth" analogy, the darkening prospect before humanity is due to humans' terrestrial civilisation being "pregnant"—and indeed dangerously overdue—with an extra-terrestrial offspring. Once humans' space civilisation is safely born, the current stresses on the mother civilisation will be cured,

and the new life may eventually even surpass it's parent. This idea not only illuminates many aspects of humans' present problems described above, it also provides detailed directions for how to solve these problems, and explains convincingly how successfully aiding this birth will lead to a far better condition than before the pregnancy. A young couple may be happy in each other's company, but their joy is increased by the birth of children and life with them, from which many new possibilities arise.

Likewise, the birth of humans' coming extra-terrestrial civilisation will lead to a wide range of activities outside our planet's precious ecosystem. This evolution will solve not just our material problems, by making the vast resources of near-Earth space accessible, but it will also help to cure the emptiness of so-called "modern" commercial culture -- including the "dumbing down" by monopolistic media, the falling educational standards, passification by television, obesity, ever-growing consumption of alcohol, decline in public morality, pornography, narcotics, falling social capital, rising divorce rates, and youths' lack of challenge and lack of "dreams". It will do this by raising humans' sights to the stars, and showing that the door to them is unlocked, and has been for decades—we have only to make a small effort to push it open forever.

In addition, re-opening a true geographical frontier, with all its challenges, will in itself be of inestimable value for the cultural growth of modern civilisation. The widespread sense that we live in a closed world which is getting more and more crowded will be replaced by an open-ended, optimistic vision of an unlimited future. Access to the cornucopia of space resources that await humans' exploitation can clearly make a unique contribution to this. To the extent that leaders of major industries are motivated by ambition in business competition, they will welcome this opportunity to extend their activities to new fields in the far wider arena of space. However, to the extent that they are motivated by the attempt to achieve monopolistic control and profits, they may try to hinder development in space, even at the cost of preventing its wide benefits, since this could be more profitable to them. Implementing the "Pregnant Earth" agenda can prevent this cultural regression and start a true world-wide Renaissance, an unprecedented flowering of civilisation of which human culture has been in need ever since the inspiration of the Italian Renaissance was followed by a decline into progressive materialism and war-mongering [35].

In pursuit of this goal, a growing number of spacerelated organisations are joining the Space Renaissance Initiative" [36] started by the authors in June 2008. This has a programme to accelerate the expansion of human activities into space by advocating investment to specifically reduce the cost of space travel. That is, supporters recognise that space activities could contribute far more to economic growth than they have to date if even a small fraction of annual funding of space activities was targeted at making access to space much cheaper. At a time when the world economy is in the worst state it has been for more than half a century, the possibility of creating large numbers of jobs in commercially profitable, space-related work is very attractive, and should receive the attention of policy-makers world-wide.

7. World peace and preservation of human civilisation

The major source of social friction, including international friction, has surely always been unequal access to resources. People fight to control the valuable resources on and under the land, and in and under the sea. The natural resources of Earth are limited in quantity, and economically accessible resources even more so. As the population grows, and demand grows for a higher material standard of living, industrial activity grows exponentially. The threat of resources becoming scarce has led to the concept of "Resource Wars". Having begun long ago with wars to control the gold and diamonds of Africa and South America, and oil in the Middle East, the current phase is at centre stage of world events today [37]. A particular danger of "resource wars" is that, if the general public can be persuaded to support them, they may become impossible to stop as resources become increasingly scarce. Many commentators have

noted the similarity of the language of US and UK government advocates of "war on terror" to the language of the novel "1984" which describes a dystopian future of endless, fraudulent war in which citizens are reduced to slaves.

7.1. Expansion into near-Earth space is the only alternative to endless "resource wars"

As an alternative to the "resource wars" already devastating many countries today, opening access to the unlimited resources of near-Earth space could clearly facilitate world peace and security. The US National Security Space Office, at the start of its report on the potential of space-based solar power (SSP) published in early 2007, stated: "Expanding human populations and declining natural resources are potential sources of local and strategic conflict in the 21st Century, and many see energy as the foremost threat to national security" [38]. The report ended by encouraging urgent research on the feasibility of SSP: "Considering the timescales that are involved, and the exponential growth of population and resource pressures within that same strategic period, it is imperative that this work for "drilling up" vs. drilling down for energy security begins immediately" [38].

Although the use of extra-terrestrial resources on a substantial scale may still be some decades away, it is important to recognise that simply acknowledging its feasibility using known technology is the surest way of ending the threat of resource wars. That is, if it is assumed that the resources available for human use are limited to those on Earth, then it can be argued that resource wars are inescapable [22,37]. If, by contrast, it is assumed that the resources of space are economically accessible, this not only eliminates the need for resource wars, it can also preserve the benefits of civilisation which are being eroded today by "resource war-mongers", most notably the governments of the "Anglo-Saxon" countries and their "neo-con" advisers. It is also worth noting that the $1 trillion that these have already committed to wars in the Middle-East in the 21st century is orders of magnitude more than the public investment needed to aid companies sufficiently to start the commercial use of space resources.

Industrial and financial groups which profit from monopolistic control of terrestrial supplies of various natural resources, like those which profit from wars, have an economic interest in protecting their profitable situation. However, these groups' continuing profits are justified neither by capitalism nor by democracy: they could be preserved only by maintaining the pretence that use of space resources is not feasible, and by preventing the development of low-cost space travel. Once the feasibility of low-cost space travel is understood, "resource wars" are clearly foolish as well as tragic. A visiting extra-terrestrial would be pityingly amused at the foolish antics of homo sapiens using longrange rockets to fight each other over dwindling terrestrial resources—rather than using the same rockets to travel in space and have the use of all the resources they need!

7.2. High return in safety from extra-terrestrial settlement

Investment in low-cost orbital access and other space infrastructure will facilitate the establishment of settlements on the Moon, Mars, asteroids and in man-made space structures. In the first phase, development of new regulatory infrastructure in various Earth orbits, including property/usufruct rights, real estate, mortgage financing and insurance, traffic management, pilotage, policing and other services will enable the population living in Earth orbits to grow very large. Such activities aimed at making near-Earth space habitable are the logical extension of humans' historical spread over the surface of the Earth. As trade spreads through near-Earth space, settlements are likely to follow, of which the inhabitants will add to the wealth of different cultures which humans have created in the many different environments in which they live.

Success of such extra-terrestrial settlements will have the additional benefit of reducing the danger of human extinction due to planet-wide or cosmic accidents [27]. These horrors include both man-made disasters such as nuclear war, plagues or growing pollution, and

natural disasters such as super-volcanoes or asteroid impact.It is hard to think of any objective that is more important than preserving peace. Weapons developed in recent decades are so destructive, and have such horrific, long-term sideeffects that their use should be discouraged as strongly as possible by the international community. Hence, reducing the incentive to use these weapons by rapidly developing the ability to use space-based resources on a large scale is surely equally important [11,16]. The achievement of this depends on low space travel costs which, at the present time, appear to be achievable only through the development of a vigorous space tourism industry.

8. Summary

As discussed above, if space travel services had started during the 1950s, the space industry would be enormously more developed than it is today. Hence the failure to develop passenger space travel has seriously distorted the path taken by humans' technological and economic development since WW2, away from the path which would have been followed if capitalism and democracy operated as intended. Technological know-how which could have been used to supply services which are known to be very popular with a large proportion of the population has not been used for that purpose, while waste and suffering due to the unemployment and environmental damage caused by the resulting lack of new industrial opportunities have increased.

In response, policies should be implemented urgently to correct this error, and to catch up with the possibilities for industrial and economic growth that have been ignored for so long. This policy renewal is urgent because of the growing dangers of unemployment, economic stagnation, environmental pollution, educational and cultural decline, resource wars and loss of civil liberties which face civilisation today. In order to achieve the necessary progress there is a particular need for collaboration between those working in the two fields of civil aviation and civil space. Although the word "aerospace" is widely used, it is largely a misnomer since these two fields are in practice quite separate. True "aerospace" collaboration to realise passenger space travel will develop the wonderful profusion of possibilities outlined above.

8.1. Heaven or hell on Earth?

As discussed above, the claim that the Earth's resources are running out is used to justify wars which may never end: present-day rhetoric about "the long war" or "100 years war" in Iraq and Afghanistan are current examples. If political leaders do not change their viewpoint, the recent aggression by the rich "Anglo-Saxon" countries, and their cutting back of traditional civil liberties, are ominous for the future. However, this "hellish" vision of endless war is based on an assumption about a single number—the future cost of travel to orbit—about which a different assumption leads to a "heavenly" vision of peace and ever-rising living standards for everyone. If this cost stays above 10,000 Euros/kg, where it has been unchanged for nearly 50 years, the prospects for humanity are bleak. But if humans make the necessary effort, and use the tiny amount of resources needed to develop vehicles for passenger space travel, then this cost will fall to 100 Euros/kg, the use of extra-terrestrial resources will become economic, and arguments for resource wars will evaporate entirely.The main reason why this has not yet happened seems to be lack of understanding of the myriad opportunities by investors and policy-makers. Now that the potential to catch up half a century of delay in the growth of space travel is becoming understood, continuing to spend 20 billion Euro-equivalents/year on government space activities, while continuing to invest nothing in developing passenger space travel, would be a gross failure of economic policy, and strongly contrary to the economic and social interests of the public. Correcting this error, even after such a costly delay, will ameliorate many problems in the world today.

As this policy error is corrected, and investment in profitable space projects grows rapidly in coming years, we can look forward to a growing world-wide boom. Viewed as a whole, humans' industrial activities have been seriously underperforming for decades, due to

the failure to exploit these immensely promising fields of activity. The tens of thousands of unemployed space engineers in Russia, America and Europe alone are a huge waste. The potential manpower in rapidly developing India and China is clearly vast. The hundreds of millions of disappointed young people who have been taught that they cannot travel in space are another enormous wasted resource.

We do not know for certain when the above scenario will be realised. However, it could have such enormous value that considerable expenditure is justified in order to study its feasibility in detail [5]. At the very least, vigorous investment by both private and public sectors in a range of different sub-orbital passenger vehicle projects and related businesses is highly desirable. Fortunately, the ambitious and rapid investment by the Indian and Chinese governments in growing space capabilities may finally jolt the space industries of Russia, America, Europe and Japan out of their long economic stagnation, and induce them to apply their accumulated know-how to economically valuable activities—notably supplying widely popular travel services to the general public.

Acknowledgements

The authors would like to thank the anonymous referees for their detailed comments which have considerably improved the paper.

References

1. *T Burnett, 2005, " Who Really Won the Space Race?", Collins & Brown, p 16.*
2. *Futron Corporation, 2003, " Analysis of space concepts enabled by new transportation", Analysis Study for NASA Marshall Space Flight Center.*
3. *D Webber, 2003, " Public space markets—what we know and what we don't know", STAIF 2003 Albuquerque; also at http://www.spacefuture.com/archive/public_space_markets_what_we_know_and_what_we_dont_know.shtml*
4. *P Collins, 2007, " Economic benefits of space tourism to Europe", Journal of British Interplanetary Society 60 (11) (2007) 395–400 (also at www.spacefuture.com).*
5. *P Collins, 2006, " The economic benefits of space tourism", Journal of British Interplanetary Society 59 (11) (2006) 400–410 (also at www.spacefuture.com).*
6. *Tauri Group, 2008, "Personal spaceflight industry summary", http://www.commercialspaceflight.org/pressreleases/PSF%20Presentation%20Summary.pdf.*
7. *K Isozaki et al, 1998, " Status report on space tour vehicle Kankoh-Maru of Japanese Rocket Society", IAF paper no. IAA-98-IAA.1.5.06; also at http://www.spacefuture.com/archive/status_report_on_space_tour_vehicle_kankoh_maru_of_japanese_rocket_society.shtml.*
8. *D Ashforo, 2003, "Spaceflight Revolution", Imperial College Press.*
9. *I Bekey, 1998, " Economically viable public space travel", in: Proceedings of the 49th IAF Congress, also at http://www.spacefuture.com/archive/economically_viable_public_space_travel.shtml.*
10. *P Collins, 1999, " Space activities, space tourism and economic growth", in: Proceedings of the Second ISST, also at http://www.spacefuture.com/archive/space_activities_space_tourism_and_economic_growth.shtml.*
11. *J Lewis, 1996, " Mining the Sky: Untold Riches from the Asteroids, Comets and Planets", Addison Wesley.*
12. *P Collins, 1998, " Tourism in low earth orbit: the trigger for commercial lunar development?", in: Proceedings of the Space '98, ASCE; also at http://www.spacefuture.com/archive/tourism_in_low_earth_orbit_the_ trigger_for_commercial_development.shtml, pp 752–756.*
13. *J Mankins, 1997, " A fresh look at space solar power: new architectures, concepts and technologies", IAF paper no. IAF-97-R.2.03, in: 38th International Astronautical Congress, also at http://www.spacefuture.com/archive/a_fresh_look_at_space_solar_power_new_architectures_concepts_and_technologies.shtml.*
14. *M Nagatomo, P Collins, 1996, "A common cost target of space transportation for space tourism and space energy development", AAS paper no. 97-460, AAS vol. 96, pp 617–630; also at*

http//www.spacefuture.com/archive/a_common_cost_target_of_space_transportation_for_space_tourism_and_space_energy_development.shtml.

15. International Labour Organisation Human Resources Development, 2001, " Employment and Globalization in the Hotel, Catering and Tourism Sector", ILO, Geneva, 2001.
16. P Collins, 2002, " Meeting the needs of the new millennium: passenger space travel and world economic growth", Space Policy 18 (3) (2002) 183–197 (also at www.spacefuture.com).
17. FAA, 2003, " The economic impact of commercial space transportation on the US economy: 2002 results and outlook for 2010", FAA, Associate Administrator for Commercial Space Transportation.
18. P deSelding, 2006, "Industry, ESA air grievances during space days meeting", Space News 17 (23) (2006) 4.
19. D O'Neil et al, 1998, " General public space travel and tourism volume 1 executive summary", NASA/STA, NP-1998-03-11-MSFC; also at http://www.spacefuture.com/archive/general_public_space_travel_and_tourism.shtml.
20. J Rifkin, 1996, "The End of Work", Putnam.
21. P Roberts, 2008, "The fading American economy: government is the largest employer"; http://www.counterpunch.org/roberts04092008.html.
22. M Bernasconi, C Bernasconi, 2004, " Why implementing the space option is necessary for society", Acta Astronautica 54 (2004) 371–384; also at http://www.spacefuture.com/archive/why_implementing_the_space_option_is_necessary_for_society.shtml.
23. A Autino, 1999, " A plan for the mercantile astronautics", Paper presented to International Symposium on Space Travel, Bremen.
24. A Autino, 2000, " New credit tools and tax concepts for the opening of the space frontier", IAF paper no. IAA-2000-IAA.1.4.05; also at http://www.spacefuture.com/archive/new_credit_tools_and_tax_concepts_ for_the_opening_of_the_space_frontier.shtml.
25. P Collins, 2004, " Synergies between solar power supply from space and passenger space travel", in: 4th International Conference on Solar Power from SPACE, SPS '04, Granada; also at http://www.spacefuture.com/archive/synergies_between_solar_power_supply_from_space_and_passenger_space_travel.shtml.
26. http://www.publications.parliament.uk/pa/cm200607/cmselect/cmsctech/66/7022101.htm.
27. A Autino, 2002, " The Copernican evidence-requirements for a space age philosophy", IAF paper no. IAC-02-P-P.23, also at http://www.spacefuture.com/archive/the_copernican_evidence_requirements_for_a_space_age_philosophy.shtml.
28. http://www.climatecooling.org.
29. J Gribbin, M Gribbin, 2003, "Ice Age: How a Change of Climate Made us Human", Penguin Press Science.
30. J Schor, 2005, "Prices and quantities: unsustainable consumption and the global economy", Ecological Economics 55 (2005) 309–320.
31. R Sato, 14 November 2007, "The consumer paradox: scientists find that low self-esteem and materialism goes hand in hand", The Daily Galaxy.
32. D Ashford, 2009, " The aviation approach to space transportation", Aeronautical Journal of the Royal Aeronautical Society 113 (1146) (2009).
33. A Sapori, 2007, "Economic life", in: The World of Renaissance Florence, Giunti.
34. M Whitney, 2009, "Drifting downwards: the deflating economy", Counterpunch, A Autino, 2008, " La Terra non e malata: e incinta! (Earth is Not Sick: She's Pregnant!)", Arduino Sacco Editore, Roma.
35. http://www.spacerenaissance.org
36. M Klare, 2002, " Resource Wars: The New Landscape of Global Conflict", Owl Books.
37. http://www.acq.osd.mil/nsso/solar/SBSPInterimAssesment0.1.pdf.

P Collins & A Autino, 25 May 2008, "What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace", Originally presented at Plenary Session of the International Academy of Astronautics' 1st Symposium on Private Human Access to Space, held at Arcachon in France, 25-28 May 2008..
Also downloadable from http://www.spacefuture.com/archive/what the growth of a space tourism industry could contribute to employment economic growth environmental protection education culture and world peace.shtml

Bibliographic Index References and Referring Papers Printable Version

Home	What's New	Topics	Journal	Directory	Information	Lists	About SF