When will we see a Golden Age of Spaceflight?

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Introduction

The period of time between the World Wars is often referred to within the flying community as the "Golden Age of Aviation." During this period of time, aviation changed from a largely experimental activity to a widely accepted means of transportation. Public attitudes towards flying also changed dramatically. Towards the end of this period aircraft such as the DC-3 were developed and deployed. The foundations of the present air traffic control system also were created during this time. In short, aviation began to be a commercially sustainable industry.

Human spaceflight marks its 40th anniversary in 2001. It is clear that spaceflight and in particular, human spaceflight have not yet achieved the same large-scale commercial advances in their first 40 years as were seen in aviation. This paper considers the contrasts and parallels between aviation and spaceflight and explores whether some of the same factors that advanced aviation might lead to a Golden Age of Spaceflight in the near future.

Parallels between Aviation and Space

A customary lament among space advocates is that commercial spaceflight has failed to develop at the pace experienced by aviation. Wildly inappropriate parallels have often been drawn between space developments and aviation history. One example is the reference to the Space Transportation System (the Space Shuttle) as "the DC-3 of space."

Yet there clearly are parallels between spaceflight and aviation. Both human flight and spaceflight were considered unattainable. Both contained inherent risk. Both were greatly accelerated as the result of governmental requirements due to war. Both also were dramatically accelerated by competition (though in different ways as we shall see.) Yet aviation's growth occurred at a much faster pace than spaceflight. The degree of technical difficulty alone is insufficient to account for the different pace of advancement.

As we mark the 40th anniversary of Yuri Gagarin's flight into space, approximately 500 men and women have experienced spaceflight. Two nations,

the United States and Russia, have demonstrated the ability to fly people into space. China has made several test flights of a vehicle capable of piloted spaceflight which is reported a derivative of Soyuz technology. They are expected to orbit a human in the near future.

Counting the new Chinese system there are now 3 different piloted space vehicles in present use. Historically the US has developed 5 manned spacecraft systems, the X-15, Mercury, Gemini and Apollo systems and the Space Shuttle. The USSR has demonstrated 2 manned vehicle systems, the Vostock/Voshkod and Soyuz vehicles and in 1988 flew a Buran spaceplane in an unpiloted automatic test. All of these systems were either developed directly by government agencies or under government contracts.

By contrast, there were almost 200 different makes of airplane available worldwide by 1912, the year the US Government first appropriated money for military aviation.[2] Between 1908 and 1910 there were approximately 1,000 new pilots trained worldwide.[3] By 1910 there were 70 different airplane powerplants available to designers.[4]

Key differences between early spaceflight and early aviation are summarized below:

Early Aviation	Early Spaceflight
Private experimentation	Government experimentation
Many experimenters	Few experimenters
Many small incremental steps	Rapid escalation of technical goals
Many customers	2 customers (US and USSR)
Private Risk-taking	Government-assumed risks
Little or no regulation	Some regulation

Table 1.

Public Expectations Hypotheses

After examining the early history of flight and spaceflight I suggest that the most important difference between spaceflight and aviation has to do with the *public expectations* formed during the early years of both activities.

Because the first well-known and dramatic forays into space were accomplished directly by government projects, the public expectation was established that spaceflight was the sole province of governments. The era in which the first space flights were accomplished (the 1940's for missiles and the 1960's for human suborbital and orbital flight) was characterized by the first ultralarge government research and development projects. The most notable examples of these were the Manhattan Project and the Apollo program itself. NASA's own spectacular successes (and those of its various Soviet counterparts) and NASA's

unique role in space exploration led the public to the expectation that government space agencies would be forever in charge of spaceflight. Ironically this expectation born of early success now impedes new commercial space markets.

By contrast, the first experiments in flight were largely the result of private experimenters working with very modest budgets. By the time that governments began to support aviation at a large scale, there was a global tradition of private experimentation in aviation. Although there are examples of initial private experimentation in rocketry in the US, Europe, and to a limited extent the former Soviet Union, in each case the leading experimenters sought and ultimately received government support. Although Goddard did not survive to see the fruits of his initial research, his Russian and German counterparts projects were completely adopted by their (and other) governments due to the exigencies of World War II and the Cold War.

A related factor contributing to the differences between aviation and space development was that the superpower competition that accelerated spaceflight quickly led to competitive targets that were well beyond the technical and financial reach of individuals or private companies. For example, the launch of Sputnik established Low Earth Orbit as the competitive goal. The Soviets quickly selected the Moon as a target and succeeded in obtaining photos of Lunar farside. Kennedy's famous pre Apollo decision memo sought a space goal which the US could attain prior to the Soviets. Indeed manned lunar activity proved to be such a daunting challenge that only one nation has accomplished it to date.

In opting to race the Russians in human spaceflight, the US made a conscious decision to concentrate on the use of ballistic space capsules launched on ICBMs rather than on a more incremental approach which might have built upon aircraft technology.[5] There was an unforeseen consequence of the decision to use missile technology (and to aim for orbital instead of suborbital activity) rather than to incrementally develop aircraft technology. That consequence was that spaceflight was channeled in such a way as to make satellite communications the only reasonable commercial application of spaceflight. By contrast, aviation's most common commercial payload in its early years was the human passenger interested in either experiencing spaceflight for fun and adventure, or later the person interested in rapidly getting from one point on the Earth to the other.

Expectations regarding spaceflight

The public expectation that spaceflight is the province of governments is nearly universal, and tends to frame the entire discussion of the future of space activities. Surprisingly, this is true even within the pro space development community. Although we have seen dramatic proof that markets have replaced governments as the principal engines of technological change, space advocates remain amazingly fixed on finding *policy* solutions to what are essentially *market* issues.

Every day millions of people fly in aircraft that contain technical improvements such as airfoils, avionics and control systems developed originally by NASA or other government agencies. None of these people expect to see NASA operate as an air carrier. Yet on almost a daily basis when I speak with reporters in the US and around the world about the advent of public spaceflight I'm asked, "When will NASA sell tickets?"

The so-called issue of "Civilians in Space," is another result of this widespread public expectation that governments are the sole legitimate spacefarers. The artificial dichotomy between people who are directly paid by governments and all other citizens has been most pronounced lately in discussions of the propriety of permitting citizens to visit the International Space Station.[6]

Another result of this public expectation is the notion that the rest of the universe should be treated as Antarctica rather than as an analog of the New World in stark contrast to all of human history. The Antarctic or "Flags and Footprints" model of space exploration remains ascendant in space agencies though some have expressed hope for a change in this regard.[7]

A interesting corollary to the public expectation that spaceflight is the sole province of governments was observed by Bill Haynes of SAIC in the 1980's. In an article entitled *The Issue is Cost*,[8] Haynes considered the fundamental reasons for the high cost of space hardware development. Haynes' observations resulted from his attendance at a NASA Headquarters meeting which was considering the development of an initial version of the 2001: A Space Odyssey "Space Pod' for orbital construction. The consensus of the meeting was that the development effort for such a system would cost in excess of $1 Billion. Haynes, however, had, just prior to the conference, spent some time with the developer's of the submersible work vehicle Deep Rover. Deep Rover had been developed and tested for about $ Million. As he contemplated the reason for the factor of 1000 increase in the cost of space hardware vs. terrestrial hardware, he attempted to fit all the traditional arguments to the problem. He discovered that the 'harsh environment' of space was less harsh than that imposed by the ocean on the submersible. The argument that space equipment

requires greater reliability than terrestrial equipment quickly fell apart in light of the fact that the designers of Deep Rover are also the pilots of Deep Rover and thus are especially interested in safety and reliability.

Haynes finally concluded that there is a widespread expectation that space is exotic and difficult and thus that the development costs for space hardware will be much larger than for terrestrial systems and that *this expectation itself* causes costs to remain high.

My own experience in working with young engineers trained in the international aerospace industry over the last dozen years is that they are almost unique among engineers in their concentration on performance rather than cost parameters.[9] I believe that this is the result of the early history of space hardware development during the cold war when government cost-plus contracts dominated the field.

An additional expectation shared by space agencies and advocates alike is that technology improvements will have a dramatic impact on costs. But in other areas of human endeavor it is market demand and the engineering and operations innovations that take place in response to demand that most impact costs. As Freeman Dyson observed in 1979, we do not need new *technology* for space as much as we need a new [operational] *style* of spaceflight.[10]

To summarize, there is a widespread belief that only governments have the capacity to operate in space. Related notions are that space is intrinsically expensive and difficult. A more subtle but equally prevalent idea is that since governments (and a handful of large companies) operate systems in orbit, that to the extent that there are commercial markets in space they are only for orbital products and systems.

Opportunities and limitations

Ultimately our species will open space. Whether this happens in the near or far future is the question of interest to us today.

In the long term, the sheer abundance of environmentally benign solar energy in space as well as lunar and asteroid materials are likely to prove essential to our economy. This is particularly true if we hope to raise living standards in an equitable manner without damaging the Earth's biosphere. The history of human expansion shows that the desire for personal freedom had been an even more powerful force for exploration than the quest for physical resources. However the visions of Tsiolkovsky and O'Neill of the expansion of the human species into the cosmos are greatly hampered by the present high cost of spaceflight[1112] No viable business plans for space power or habitation exist at existing launch costs.

These costs will remain high unless the demand for spaceflight increases significantly. But it is becoming obvious that the traditional commercial space market (communications satellites) will not require much more than the present launch rate to service world demand for telecommunications in the predictable future.[13]

There is one promising new market that could drive launch demand and lower costs by order of magnitude. That market is public spaceflight, or as it is more commonly known today, space tourism.

Research conducted by the Japan Rocket Society and the National Aerospace Laboratory of Japan showed that in that nation, 80% of the population under the age of 40 would like to take a trip into space.[14] Further research in the United States, Canada and Europe indicates that in the developed world, at least 6 out of every 10 people have a personal interest in taking a flight into space.

It is easy (especially for those of us who have been engaged in such serious pursuits as traditional satellite telecommunications or defense applications) to dismiss the notion of 'joy-rides' into space as trivial. But an examination of aviation's history indicates that to do so would be a serious mistake.

After the enormous upsurge in aviation caused by the development of military aircraft and military pilot training of World War I, there was an almost immediate slump in postwar activity. One activity served which served as an essential commercial stepping stone to air mail and later scheduled commercial passenger routes was the provision of airplane rides and exhibitions to members of the general public by itinerant flyers known as barnstormers.

The most famous example of a flyer who learned his craft and earned a living by barnstorming was none other than Charles A. Lindbergh. Lindbergh dropped out of college at the University of Wisconsin to take flying lessons at a commercial school, the Nebraska Aircraft Corporation. Unlike many other barnstormers, Lindbergh was not trained by the Army but rather made his first flight on April 9, 1922 at the age of 20.[15] He had only eight hours of flight instruction and had never soloed (due to his inability to provide insurance for the school aircraft) when he purchased his first airplane, a surplus Curtis Jenny. After some free training from a pilot who took pity on his first attempts to operate his new plane, he began his commercial flying career by providing airplane rides in the South.

Giving the public a chance to directly experience flight served several essential functions. First and foremost it provided a living to much of the pilot population and allowed new pilots to learn the art of flying. Many of these pilots were later to matriculate to air mail service, general aviation and scheduled passenger work. It also introduced much of the general population to airplanes and flying.

If even a few percent of the population of the developed world desires to personally experience spaceflight, the market for space transportation would be increased exponentially beyond the ~30 commercial launches per year required by the satellite industry. Such passenger flights would require reusable vehicles to be economical.

Although the public is most familiar with orbital flight, initial results indicate that there is a market for suborbital spaceflight as well. In fact, the airplane rides offered by early barnstormers are much more analogous to suborbital flights than to orbital activities. An orbital space flight requires about 25 times more energy than a suborbital trip to space altitude. By providing a technically achievable and commercially viable human market, suborbital barnstorming could lead to fast point to point carriage of high value cargo and rapid long-distance passenger travel. Either of these markets for large scale suborbital activities could also dwarf present demand for orbital space transportation and could serve as a commercial bridge to later more challenging forms of orbital space commercialization.

A realistic view of the present situation requires us to acknowledge that there are at least two major barriers to commercial personal spaceflight at the present time. The first of these is that unlike the post WW I period, there is not a family of WW III surplus space vehicles available to meet the latent demand. The second is the pervasive public expectation that spaceflight is solely for governments.

The good news is that there is a lesson to be learned by the space community from the history of aviation. A tool exists that may serve to both change public expectations and provide an incentive for the development of the vehicles needed for commercial human spaceflight. That tool, absent until recently from the space arena, is the concept of prizes.

The vital missing piece of the historical mix

A key factor in the development of aviation prior to WWI was the creation of a considerable array of prizes, primarily in Europe, which provided the incentive for many of the aviation advancements of that era. Looking back from the vantage of the 21st century when we take for granted the utility of aviation, it is difficult to appreciate how difficult and improbable were the feats accomplished in pursuit of these prize incentives. Until recently prizes were completely missing from the space arena.

Table 2 summarizes aviation prizes prior to the start of the first World War.[16] For a more anecdotal description of many of the early aviation prizes the reader is encouraged to visit the History of Prizes section of the X PRIZE Foundation's web site at www.xprize.org.

Year	Task	Offered by	Won by	Amount
1901	Airship flight around Eiffel Tower	Deutsch de la Meurthe	Alberto Santos-Dumont	100,000 FF
1904	Various tasks for airships	Louisiana Purchase Exhibition	Mostly unclaimed	$150,000
1906	25 meter flight	Archdeacon	Santos-Dumont	3,000 FF
1908	1 kilometer public flight	Scientific American		Trophy
1908	220 meter flight	Aéro Club de France	Alberto Santos-Dumont	1,500 FF
1908	1 kilometer closed course	Archdeacon-de la Meurthe	Henri Farman	50,000 FF
1908	15 minute sustained flight	Jules Armengaud	Henri Farman	10,000 FF
1909	Duration (2.3 hrs)	Michelin	Wilbur Wright	$3,000
1909	Altitude (100 meters)	Aéro Club de la Sarthe	Wilbur Wright	1,000 FF
1909	Crossing of English Channel	Daily Mail	Louis Blériot	£1,000
1909	41 km course to Orléans with 1 stop	Aéro Club de France Prix du Voyage	Louis Blériot	unstated
1909	Speed (2 km in 2 mins. 29 seconds)	Mathieu	Louis Blériot	unstated
1909	24 times around closed course in 50 minutes at height of 40 meters	Madame Ernest Archdeacon (wife of 1908 offeror)	Louis Blériot	unstated
1909	Coupe International d'Aviation for speed records	James Gordon Bennett, Editor of Paris Herald		25,000 FF
1909	Rheims Grand Semaine d'Aviation at Rheims	French champagne industry	Various winners	200,000 FF
1909	Frankfurt am Main		Pierre de Caters of Belgium	$10,000
1910	Los Angeles		Louis Paulhan	$10,000
1910	Heliopolis, Egypt		Various	+$35,000
1910	Nice, France		Various	+$30,000
1910	London-Manchester (offered in 1908)	Daily Mail	Claude Grahame-White	£10,000
1910	New York City-Albany	New York *World*	Glenn Curtis	$10,000

Year	Task	Offered by	Won by	Amount
1910	Greatest Number of Flights in a 12 month period	Daily Mail	Louis Paulhan	£5,000
1910	unstated	Ruinart champagne firm and Daily Mail	Jacques de Lesseps	£600
1910	Ten day aerial tour of Paris	Le Matin	various	20,000 FF main prize
1910	Crossing of the Alps	Milan Committee	Georges Chavez of Peru	160,000 lire
1910	Various including Boston Globe prize of $10,000 for a 33 mile race around the Boston Light	Harvard Aeronautical Society	various	$100,000 in total
1910	3 nation air tournament in New York at Belmont Park		various	$72,000 total
1910	Flight across La Plata River from Argentina to Uruguay and back		Cattaneo of Italy	$20,000
1910	Transcontinental US Flight	William Randolph Hearst	Prize was not won-but Calbraith Rodgers accomplished the trip (outside of the time limit)	$50,000
1910	Flugwoche (Flying Week) contests	Near Berlin	various	159,000 DM
1911	Paris to Puy-de-Dôme		Eugène Renaux	100,000 FF
1911	Distance award	Quentin-Bauchart	Eugène Renaux	30,000 FF
1911	Paris to Madrid flight	Le Petit Parisien	Jules Védrines	150,000 FF
1911	Paris to Rome flight	Petit Journal		300,000 FF for first place with additional 200,000 in prizes
1911	Circuit of Europe	Journal		~500,000 FF
1911	Circuit of Britain	Daily Mail		~500,000 FF

Year	Task	Offered by	Won by	Amount
1911	Longest flight in a British machine	Baron de Forest	Tom Sopwith	£4000
1911	Munich-Berlin Kathreiner prize		various	~$12,500
1911	Flugwoche (Flying Week) contests	Near Berlin	various	70,800 DM
1912	Chicago International Meet		Glenn Curtis won $4,854 in prizes	
1912	Circuit of Anjou 157 km triangular course race	René and Pierre Gasnier	Roland Garros took first place	120,000 FF
1912	Collier Trophy first presented	Aero Club of America	Glenn Curtis	
1912	Flugwoche (Flying Week) contests	Near Berlin	various	82,000 DM
1912	Berlin-Vienna Race		various	77,000 DM
1912	Circuit of Berlin		various	60,000 DM
1912	Monaco Hydroplane Meet	International Sporting Club of Monaco	Jules Fischer	
1912	Russian Military Competition		Igor Sikorsky took top prize of 30,000 rubles	
1913	Schneider Trophy	Jacques Schneider	Maurice Prévost	
1913	Pommeroy Cup for greatest distance flown between sunrise and sunset		Marcel Brindejon des Moulinais for a 1450 km flight from Paris to Warsaw	
1913	Manhattan Aerial Derby of the Aeronautical Society of New York	New York Times	various	$2250 total
1913 offer	First Transatlantic Crossing	Lord Northcliffe of the Daily Mail	Alcock and Brown in 1919	£10,000

Table 2. Summary of Early Aviation Prizes

The sheer audacity of many of these prizes is not evident today. The aerial feats required of the winners were often considered to be (or were in fact) utterly impossible at the time that the prizes were offered. For example, Villard reports:

> Nobody had belied, two years earlier in 1908, that the biggest prize of all, the *Daily Mail's* dazzling offer of £10,000 for a flight from London to Manchester within 24 hours-would ever be won. It was in fact openly mocked by the rival *Star*: "Our own offer of £10,000,000 to the flying

> machine of any description whatsoever that flies five miles from London and back to the point of departure still holds good. One offer is as safe as the other: The magazine *Punch* joined in the laughter with an offer of £10,000 to the first "aeronaut to fly to Mars and back within a week.[17]

The amount of prize money was significant as well. It was estimated that more than $1,000,000 in prize money was earned by aviators during the 1911 flying season.[18] Villard observed that prizes were a vital spur to European innovation. He noted:

> "In the United States where meets were fewer and prizes less attractive, aviation continued to expand during 1911-but at a much slower pace than in Europe."[19]

> "by the beginning of 1912, all the important records were held by the French…there were relatively few cash incentives in the United States, and certainly much less patriotic initiative than in France, to encourage research or competition."[20]

The progress of European aviation due to prizes and competitions became troubling to US observers. Dr. Albert F. Zahm, head of the revived Smithsonian aeronautical laboratory originally founded by Samuel Pierpoint Langley, was dispatched to Europe along with Dr. Jerome C. Hunsaker of MIT to study the situation there. Zahm's report, issued in 1914 emphasized the disparity between European progress and American inertia.[21] The report led to the creation of the Advisory Committee for Aeronautics (later known as the National Advisory Committee for Aeronautics or NACA), the predecessor of NASA.

It is also interesting to note that the amount of prize money offered to accomplish 'the impossible' stayed more or less constant despite the absolute magnitude of the distances involved. For example, the Daily Mail's London to Manchester prize was the same £10,000 later offered for the first transatlantic crossing.

The Golden Age of Aviation

Although the First World War led to a dramatic increase in the worldwide population of pilots and aircraft, the post war period that followed was initially more leaden than golden. For example in 1921 the US Air Service numbered about 3000 planes, half of which were JN-4 (Curtis Jenny) trainers. By 1924 the number of planes had dwindled to 754 commissioned aircraft.[22]

By the mid 1920's the beginnings of serious air mail operations were beginning to take root, particularly in America and France. Air mail proved to be a dangerous business. By 1925 only 9 of the original 40 pilots hired to fly US air mail had survived the experience.[23] However, flying was still generally perceived to be a

stunt or adventure rather than a viable form or transportation or the foundation for a profitable business.

A single aviation prize was about to ignite the world's imagination and lead to the widespread acceptance of flight. In May, 1919 President Alan Hawley of the Aero Club of America in New York City received the following letter from the Hotel Lafayette:[24]

> **Gentlemen,**
>
> **As a stimulus to courageous aviators, I desire to offer, through the auspices of the Aero Club of America, a prize of $25,000 to be awarded to the first aviator of any Allied country crossing the Atlantic in one flight, From Paris to New York or New York to Paris, all other details in your care.**
>
> **Sincerely,**
>
> **Raymond Orteig**

Raymond Orteig had emigrated to New York from France in 1912. He worked as a bus boy and café manager and eventually acquired two New York Hotels which were popular with French airmen assigned to duty in the United States during the Great War. Orteig's prize was to prove the most influential prize in the history of aviation.

The Orteig prize was the incentive for the 1927 New York to Paris flight of the Spirit of St. Louis by Charles A. Lindbergh. Lindbergh was one of 9 competitors who in aggregate spent 16 times the $25,000 prize purse. Interestingly, Lindbergh and Chamberlin, the two Orteig Prize competitors who actually performed the flight (or in the case of Chamberlin, its equivalent) were the two competitors who planned to complete the undertaking for less than the prize purse amount.

The Lindbergh Boom

It is difficult today to fully appreciate the impact of Lindbergh's flight on aviation. The following facts indicate the way that this single prize changed American and world perceptions of aviation. [25]

- The *Spirit of St. Louis* aircraft was personally viewed by a quarter of all Americans within a year of Lindbergh's 1927 flight.

- The number of US Airline Passengers flown went from 5,782 in 1926 to 173,405 in 1929.

- US Air cargo flown went from 45,859 lbs. in 1927 to 257,000 lbs. in 1929.
- US Air Mail increased from 97,000 lbs. in April to 146,000 lbs. in September of 1927.
- There was a 300 percent increase in applications for pilot's licenses in US in 1927.
- There was an increase of more than 400 percent in the number of licensed aircraft in America in 1927
- The number of airports in the United States doubled within 3 years of Lindbergh's feat.

Overall there was an Internet like boom in the aviation business. Companies were known to change their names to include the words 'airplane' or 'aviation' in their corporate names much like the rush to establish the early dot.coms. Unlike the (first) Internet boom, aviation has continued to grow in the nearly 75 years since the Spirit of St. Louis flight. In short, this happened because the Spirit of St. Louis flight caused people to believe that aviation was relevant to them. They knew that if they wanted to they could fly. Flying was no longer something done by someone else. The result was increased demand, lower prices and greater performance.

The personal computer boom of recent memory offers another example of how a rapid change in public expectation causes a large commercial impact. In 1975 "everyone knew" that computers were for governments, banks and other large institutions. Thanks to Jobs, Wozniak and the other pioneers of the personal computer revolution, within a decade the cost per computing cycle had plummeted, performance leaped and a new global industry had been born. Note that in both the case of Lindbergh and the Apple computer, the breakthrough was largely sociological rather then technical. Both Spirit and the Apple II employed the current state of the art…but neither exceeded it. The 'sea change' was the result of a change in expectation.

Can prizes still work today?

Lest one think that the ability of prizes to motivate people to accomplish the impossible has diminished, consider the Henry Kremer prize for human powered flight. Motivated by this prize, the AeroVironment team led by Dr. Paul MacCready accomplished the age-old dream of human powered flight in 1977. A second Kremer Prize was also won by the same team for the much more difficult English Channel crossing only two years later[26]

The power of prizes to redefine the word impossible is not limited to aviation. Nor are prizes off-limits to governments. The development of a means of

determining longitude through accurate timekeeping was once considered as impossible as perpetual motion.[27] The Longitude Act, issued by Parliament in 1714 created a series of large cash prizes for a means of determining time with the precision required for ocean navigation. English clockmaker John Harrison submitted the first working marine chronometer in 1735.[28] Although he ultimately was granted the prize he so justly deserved for his feat, it took decades and Royal intervention before he gained his reward.

A prize of 100,000 francs was offered by the French Academy during the 18th century for the production of soda from seawater. Nicholas Leblanc's resulting process became the basis of the modern chemical industry and is considered one of the key chemical engineering inventions of all time.[29]

A prize for human spaceflight

In 1995, Dr. Peter H. Diamandis, inspired by the *Spirit of St. Louis* saga, began an investigation of the history of aviation prizes and their economic impact. In 1996, Dr. Diamandis announced the formation of the X PRIZE, a $10 Million prize for the first private team to fly a reusable three person spacecraft to 100 km altitude and repeat the feat within two weeks. To date, over half of the prize purse has been raised through commercial sponsors and the St. Louis community. Prior to the X PRIZE there were no organizations known to be developing vehicles suitable for the space equivalent of barnstorming. As of this writing 21 teams in the United States, the United Kingdom, Canada, Argentina and Russia have registered to compete. Prizes continue to have a marked impact on human behavior.

Conclusions:

The fundamental difference between early aviation and early spaceflight is that the public acquired the **expectation** that space was the sole province of governments. Ironically, the same cold war competition that accelerated the early development of spaceflight fostered this belief which now impedes sustainable commercial space development. The belief that government should be the lead player in space remains all-pervasive and continues to frame the discussion of commercial space even among space development advocates.

In aviation by contrast, thousands of private experimenters and pilots had experienced flight prior to the first large-scale infusion of government support in the WWI era. Aviation prizes played a very significant role both in advancing the technology of flight and in generating widespread excitement about the new technology among the general public.

The golden age of aviation required both technology and acceptance of that technology to create a market for flight. A commercially viable market for the

most numerous foreseeable space payload, namely humans, requires a breakthrough in public expectation more than technological advancement.

Although governments are perhaps less relevant to the fundamental market problems facing commercial space than the public believes, governments can play an important role in changing the perception created by their historical involvement in space flight. In addition to offering prizes of their own, they can remove obstacles to commercial efforts. Examples include creating experimental spaceflight operating areas similar to existing Military Operating Areas to provide safe testing opportunities. Permitting informed individuals to make their own risk decisions would also remove the specter of litigation and perhaps certification from early commercial operators. Proposals for creating the space passenger equivalent of 'accredited investors' should be examined.[30] Governments should welcome early personal spaceflight adopters such as Dennis Tito in order to test the viability of this potentially vast market.

Commercial space has not yet entered its equivalent of the golden age of aviation because people have not experienced the kind of direct personal involvement promised by Lindbergh and other pioneers and later delivered by aviation advances. When the public understands that they have a real opportunity to personally experience spaceflight the result will be our own golden age.

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[1] ©2001 Gregg E. Maryniak, printed with permission of the author. Maryniak@aol.com
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[3] Ibid., p. 240.
[4] Ibid., p 125.
[5] Personal communication with Dr. Paul Cszysz, Parks College of St. Louis University, February 2001.
[6] Europe's Space Station Chief Blasts Tourist Trips, Space News, Feb 5, 2001 p.1.
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[8] Haynes, William, *The Issue is Cost*, Space Studies Institute, Princeton, NJ.
[9] Indeed it is often said that engineers are people "who can do for a dollar, what any dang fool can do for ten dollars."
[10] Dyson, Freeman J, Video interview at the May 1979 Princeton Conference on Space Manufacturing produced by the Chicago Society For Space Studies, 1980.

[11] Dyson observed that the cost per family of the Mayflower expedition was of the order of $1Million per family-far lower than what would be possible with present launch systems. See Dyson, Freeman J, Disturbing the Universe, Basic Books, 1979.
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