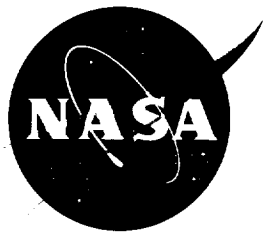

STA

General Public Space Travel and Tourism – Volume 1 Executive Summary

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Summary of a Space Act Agreement Study, including
a workshop held at Georgetown University, Washington, D.C.
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TABLE OF CONTENTS

GLOSSARY OF ACRONYMS

ASTP	Advanced Space Transportation Program
CSTS	Commercial Space Transportation Study
EO	Earth-Orbit (transportation)
HRST	Highly Reusable Space Transportation
IRR	Internal Rate of Return
ISS	International Space Station
LEO	Low Earth Orbit
NASA	National Aeronautics and Space Administration
PST&T	Public Space Travel and Tourism
R&D	Research and Development
RLV	Reusable Launch Vehicle
ROI	Return on Investment
STA	Space Transportation Association

SUMMARY

Travel and tourism is one of the world's largest businesses. Its gross revenues exceed $400 billion per year in the U.S. alone, and it is our second largest employer.

U.S. private sector business revenues in the space information area now approximate $10 billion per year, and are increasing rapidly. Not so in the human spaceflight area. After spending $100s of billions (1998 dollars) in public funds thereon, and continuing to spend over $5 billion per year, the government is still the only customer for human spaceflight goods and services.

Serious and detailed consideration was first given to the possibility of space being opened up to trips by the general public three decades ago, and some initial attempts to do so were made a dozen years ago. But the difficulties were great and the Challenger disaster put an end to them.

In recent years professional space tourism studies have been conducted in the United Kingdom, Germany and, especially, Japan. In the U.S., technological progress has been pronounced; we have had nearly a decade's experience in seeing our astronauts travel to-from low Earth orbit safely, and we expect to commence assembly of a LEO space station housing a half-dozen people this year. Too, NASA and our space industry now have new and promising space transportation development programs underway, especially the X-33 and X-34 programs, and some related, further generation, basic technology development programs. And five private companies are also working on the design of new surface - LEO vehicles.

The first professional space tourism market studies have been conducted in several countries in the past few years, especially in Japan and here. The U.S. study makes it clear that, conceptually, tens of millions of us would like to take a trip to space if we could do so with reasonable safety, comfort and reliability, and at an acceptable price. Initial businesses will address the desires of those willing to pay a greater price and accept a greater risk.

A two-year cooperative Space Act agreement study has been conducted by our National Aeronautics and Space Administration and the Space Transportation Association. It was conducted by NASA and STA study leaders drawing upon the competence, experience and hard-nosed imagination of a national Steering Group and scores of attendees at a multi-day Workshop. The study has involved scores of professionals and business people from various areas: astronauts; space booster technology and operations professionals; a hotel architect and a hotel operator; an airline planner; insurance underwriters; space sickness experts; space theme park designers; space and travel and tourism association and business executives; a space-related financier; university tourism and space policy experts; present and former space-responsible government officials; space entrepreneurs; space writers; ... .

This study concludes that serious national attention should now be given to activities that would enable the expansion of today's terrestrial space tourism businesses, and the creation of in-space travel and tourism businesses. Indeed, it concludes that, in time, it should become a very important part of our Country's overall commercial and civil space business-program structure. For it offers new personal and business opportunities that would capitalize upon our great and continuing human spaceflight public expenditures and make additional use of our reservoir of space professionals, facilities and institutions.

The study also makes specific suggestions about how our Federal government, particularly the Departments of Commerce and Transportation, and the National Aeronautics and Space Administration, should cooperate with each other and with private sector aerospace and travel and tourism business interests to hasten the creation of a sound and potentially very large space-related business. They could do so by supporting both terrestrial and space tourism merchandising; by developing early and appropriately beneficial vehicle, hotel and space trip

regulation; by seeing the best use made of our human spaceflight assets -- our professional astronaut corps, the Shuttle fleet and the International Space Station; by seeing our space leaders consider taking trips to space themselves; and by supporting research and development activities designed to increase the safety, reliability and comfort of general public passenger-carrying space trips -- both in vehicles and orbiting hotels -- and to reduce the cost per passenger -- all by several factors of ten.

Judgments must be somewhat reserved as to when a large space business can be created inasmuch as, to date, our aerospace industry has principally served human spaceflight objectives delineated and paid for by the Federal government, whereas private space travel and tourism services must be provided in a free enterprise, privately financed, fashion. That is, entrepreneurial drives and fortunes, and the true character of the marketplace, will decide how and when the general public will begin to take trips to/from space. Already, private interests are working on initial space trip vehicle designs, and travel and tourism business interests are offering initial space trip services that could begin in the next few years. The future is almost upon us -- *carpe diem.*

GENERAL

Today space travel and tourism trips are limited to on the surface opportunities and "zero-gravity" trips in aircraft. Even so, over 10 million people each year visit a space museum, a space camp, a rocket launch-recovery site and government space R&D centers -- a business estimated to approximate $1 billion per year. This business could be expanded, especially if our general public could see programs underway that specifically offer the promise of trips to/from space becoming available early in the next decade. And its expansion would attract entrepreneurs and investment attention to in-space business possibilities.

Zero-gravity aircraft trips are now becoming more widely available, and other trips using a new kind of vehicle taking people up to very high altitudes should become available within the next few years. And the Shuttle fleet, now becoming privatized, could carry a very few of our general public to orbit every year for general public space tourism research and merchandising purposes.

To move beyond this to generally available trips to orbit and week-long stays in LEO hotels now can be seen as certainly feasible, and some of the required basic space transportation and habitation technological-operational advances required to do so are already underway.

The U.S. government is committed to working cooperatively with private space transportation interests to drive down today's Shuttle costs of hundreds of millions each trip with the anticipation that, with new kinds of vehicles, this cost could be lowered to tens of millions. This translates into lowering the per person trip cost from hundreds of thousands of dollars using today's technology to tens of thousands of dollars when next generation technology becomes available, airline-like operations are adopted and very large markets are served. In parallel, safety and reliability will increase by several factors of ten. And we will begin to learn how to acquire and operate safe permanent housing for people in space with the International Space Station program.

During the cooperative NASA-STA study thoughtful space-related professionals and travel and tourism business people concluded that private, high priced "adventure" trips to space with greater than today's commercial airline risk could become possible in the next few years. Much larger scale, lower priced, orbital operations, could commence in the decade thereafter. But, in order to see this possibility realized, a number of psychological, technological, operational and institutional inhibitions must be overcome and investments of $ billions made. The study discusses this possibility in detail and suggests government and private sector courses of action that would see this possibility realized.

The Country must now move in this direction. We should begin to think out, in some detail, the public and private investment steps to be taken, always keeping in mind that the future, especially in a democratic free enterprise economy, is shaped by free choices that people will often make in unexpected ways. When truly sophisticated vehicle-fleets carry 100,000s of us to space each year, we will have created a new space business at least as large as today's satellite communications business, have changed our personal views about space profoundly, and begun the clear incorporation of space activities directly into our daily business and private lives.

INTRODUCTION

The travel and tourism business is among the largest in the world. In the United States alone, travel and tourism generate sales of more than $400 billion per year. This translates into jobs: the travel and tourism business is the second largest employer in the U.S.

Recently, the idea of extending travel and tourism beyond the surface of the Earth has been increasingly suggested -- trips by ordinary people to space, not as scientists or technologists, but for personal reasons including adventure, recreation and business. This idea is not a new one; it has been examined several times in the past 30 years and some initial abortive attempts to commence actual travel and tourism businesses took place in the U.S. a dozen years ago. Early in this decade the Japanese Rocket Society encouraged the conduct of broad space tourism studies, including market studies. In 1994, the (then) six major U.S. aerospace firms concluded in their Commercial Space Transportation Study (CSTS) that general public space travel and tourism had the potential to become a very large market if space transportation safety and reliability could be sharply increased, and per passenger costs could be reduced, substantially. (See the General References.)

The latest professional space travel and tourism market survey -- one conducted in the United States by non-space interests -- clearly suggests that very many (tens of millions) "average" American adults can envision themselves taking a trip to space (as they imagine, today, what such a future trip would be like) and, altogether, paying a great sum to do so. (See Appendix A.)

However, substantial obstacles remain that prevent the immediate creation of a large scale business.

Today, the cost of access to space for people using currently operational vehicles remains very high; a half-dozen astronauts can accompany the delivery of payloads to space on Shuttle trips that cost some $400 million each. In addition, the safety and reliability of operational space transportation vehicles is presently far too low: a risk of some 1-in-100 of failure involving fatalities may be acceptable today for government missions and for a few adventure travelers, but not for airline-like general public passenger-carrying operations which will have to be safer by several factors of ten.

Finally, there has been a persistent lack of credibility because now it is generally thought that only NASA and the Russian government can send people to space and that they must be highly trained professional astronauts. This so-called giggle factor is especially prevalent among some experienced aerospace systems engineers unfamiliar with potential new capabilities that are inherent in recent technological advances and the increased insistence of the Congress that public spending in space result in greater economic growth, especially in the human spaceflight area. And they may not recall the enormous strides made in commercial aviation over just a few decades. The general public is actually more accepting of the idea of public space travel than these engineers.

Fortunately, critical advances have been made during the past decade in many of the technologies that can enable non-astronaut human space travel to become both technically and economically feasible, and more are foreseen. As a result, the potential exists for the creation, in the next very few decades, of a $10-20 billion... per year "general public space travel and tourism" business.

Too, initial steps can be taken at the surface, then in the atmosphere and later in space so that early profitability and experience, and credibility-creating activities, can begin prior to full orbital trips and long-term stays there.

During 1996-1997, the Space Transportation Association (STA) and the National Aeronautics and Space Administration (NASA) have, through a cooperative Space Act agreement, conducted a study of the potential for future general public space travel and tourism businesses. Several important findings were made. In their light, suggestions concerning what must be done to surmount the barriers to this business creation have been formulated.

Although several significant issues were identified, consensus grew within this study that the aerospace industry and travel and tourism interests, working in partnership with each other and with the Federal government where appropriate, could overcome all identified obstacles and that a viable, and potentially very large, general public space travel and tourism business could begin to be created over the next decade or so.

The basic objective of the NASA-STA study was to determine the feasibility of a commercially viable, general public space travel and tourism business being created in the U.S. through private initiatives with private resources, along with government encouragement, cooperation, and key scientific research and technology development investments.

As indicated, it is believed that such a business could grow to have great benefits for the U.S. economy while, at the same time, substantially increasing public interest in space activities generally. For, once the sharply increased safety and reliability, and sharply decreased unit costs required for large scale space tourism businesses to succeed have been achieved, many other things could then be done in space using such markedly advanced space capabilities.

(The STA-NASA study leaders are listed in Appendix B.)

WORKING FORUMS

The National General Public Space Travel and Tourism Study Steering Group

A General Public Space Travel and Tourism National Steering Group for the NASA-STA study was formed in the Fall of 1996. This Group conducted a preliminary assessment of the opportunities and problems faced by those who could be interested in forming space travel and tourism businesses, and it found that the former are inviting and, in principle, the latter are tractable. The Steering Group outlined a framework for a General Public Space Travel and Tourism Workshop (described below), and many of its members participated personally therein. Finally, a draft of this Report (Volume One) was provided to the Steering Group by the STA-NASA study leaders and members of the Steering Group participated in its editing. (The members of the National Steering Group are identified in Appendix C.)

The General Public Space Travel and Tourism Workshop

To develop the concept of general public space travel and tourism further, and to bring together representatives from our space-related government and university interests, the travel and tourism business, the financial community and the aerospace industry, a Workshop was held during February 19-21, 1997. The primary purpose of this Workshop, which was held at the Georgetown University's Thomas and Dorothy Leavey Center, was to define what must be done in order to allow this new and potentially large space-related market to develop and to generate preliminary strategic concepts, milestones and organizational constructs toward that end. The Workshop was planned to have a relaxed, working atmosphere to encourage the flow of ideas.

Participants worked in teams to discuss the following topics:

- Space Transportation and Destination Facilities
- Passengers, Crew, Life Support and Insurance Considerations
- Regulation, Certification, Legislation, Policy and Environmental Issues
- Financial, Economic, Business Planning and Market Considerations
- Initial Ground Facilities, Space Tourism Theme Parks and other Orbital Trip "Precursor" Considerations
- Research and Technology Development Requirements, and Use of Existing Space Assets

Participants included:

- Travel and tourism business leaders
- Hotel architect, airline and business leaders
- Insurance interests
- Aerospace entrepreneurs
- Aerospace technical experts
- Space health and medical experts

The objectives of each of the several working sessions were: (a) to develop a detailed statement of the topic, (b) to identify key issues associated with general public space travel and tourism, (c) to identify opportunities to eliminate barriers, and (d) to make recommendations for future action. By the end of the Workshop, each of the teams formulated a series of findings which were captured in both a presentation to the Workshop as a whole and in white papers provided to the NASA-STA study leaders. These results were integrated with other information

sources (see, for instances, Volume Two and the General References) by these leaders to form the kernel of this NASA-STA study final Report.

The strong consensus view of the Workshop was that there is a very real potential for a large, profitable, commercially-driven general public space travel and tourism business to begin to develop beginning a very few years from now.

(A list of the Workshop participants is provided in Appendix D.)

THE PROSPECTS FOR GENERAL PUBLIC SPACE TRAVEL AND TOURISM

Space Transportation and Destination Facilities Considerations

Getting into and back from space safely and reliably, and for an acceptable price and in reasonable comfort, and having somewhere to go there, are fundamental to the concept of general public space travel and tourism. Areas for consideration are far-ranging, and include space transportation vehicles and their operation (both opportunities to use existing vehicles and the development of specialized transports) and space "habitats" and other facilities in space which will eventually serve as destinations. Some kinds of initial space transportation vehicles would likely also serve as habitats in short duration trips, while space residences would eventually develop to support longer term stays, much as in earth-bound travel.

Appropriate passenger-carrying Earth-Orbit transport vehicles are clearly essential. These may well be feasible in the relatively near future but, depending upon their size and the overall length and sophistication of the trips, required investment costs could be high -- in extreme cases, very high. At present, there are several Federal government-aerospace industry and several purely private sector programs underway that, to various extents, can be visualized as providing some initial space travel and tourism capability. Dramatic advances in propulsion systems and structures are needed to see the lowest unit cost vehicle and largest service market develop. The probable costs to develop these systems will be high and government R&D co-investments are needed.

Validation of the real market for general public space travel and tourism is going to be an essential step. A central issue will be: is it possible to get that validation with current vehicles? In principle, the Shuttle fleet and small-scale trips using vehicles now under development could explore the market incrementally.

A notional -- but not at all improbable -- concurrent market and system-service development sequence might follow a path such as:

- enlarged terrestrial space-related travel and tourism businesses
- increasingly higher altitude adventure tourist sub-orbital trips
- global sub-orbital space plane package delivery and passenger-carrying services
- short duration adventure tourist orbital trips
- longer duration orbital trips, including stays at Low Earth Orbit destinations

Eventually, supra-LEO trips would be taken, but this study is limited to the consideration of trips to no higher altitudes than LEO.

Although services could be initiated with passengers living in the transport vehicle (as current astronauts do in the Space Shuttle), destination residential facilities will eventually have to be developed. In both cases zero-gravity "sickness" problems must be solved, generally, or artificial gravity provided. Fortunately, there is much attention being paid to the former and studies have shown that the latter is possible.

LEO residential facilities will be sophisticated and expensive undertakings compared to those on the surface. Ultimately, providing levels of comfort and privacy that are comparable to very large and successful terrestrial ocean cruise lines will be a very strong driver for the acquisition of improved in-space infrastructure.

As is often the case in the creation of a new kind of business, issues and arguments tend to be circular: both markets and financing are dependent on each other already being in place. Some use of such government facilities as the Shuttle and the U.S. portion of the International Space Station (ISS) is very highly desirable inasmuch as (a) general public passenger R&D is required, (b) key technologies and subsystems operations must be demonstrated, and (c) general public merchandising demonstrations would be invaluable. Too, having the ISS close by and cooperating with early residential facility use could be comforting to architects, builders, operators and guests.

Passengers, Crew, Life Support and Insurance Considerations

The "human" issues and problems associated with public space travel and tourism are no less important than the technological challenges of getting them to/from space. There is the need to identify the accommodations that will be required to support the general public; the need for experienced crew and attendants and their likely functions; the need for life support equipment that will be required in passenger vehicles and habitats; space sickness, its effects, and its countermeasures and their implications; flight and hull insurance -- all, hopefully, at an early moment. Numerous issues must be resolved and actions taken before safe, large scale, comfortable and routine general public space travel and tourism can begin.

There appear to be a variety of options called for beyond terrestrial, and lower atmosphere space travel and tourism, including varying costs, accommodations, and levels of preparedness and acceptable risk-taking by various kinds of future passengers.

These could include:

- sub-orbital trips (lasting less than 1 hr; all in the space transportation vehicle)
- three orbit trips (lasting up to 5 hours; all in the space transportation vehicle)
- three day trips (possibly including a LEO facility)
- resort packages (with stays of 1-2 weeks at a LEO facility and possibly even extra-facility activities)

For any of these cases, the transport vehicle and any in-space facility must provide accommodations with certain minimal personal and social standards. These include: safety, privacy, baggage handling, entertainment, training and exercise facilities, and easy to operate toilets, showers, eating-drinking facilities, and medical capabilities (*in situ* plus telemedicine). For instance, gravity loads during launch and re-entry should be limited to some 2 times that of surface gravity.

One of the major issues concerning general public space travel and tourism (especially during early, relatively short duration trips) is the prevention and/or the amelioration of space sickness in "zero gravity". Nearly half of all people who have gone into space have experienced nausea and become ill because of the lack of gravity. Untreated, nausea and other effects can last for period ranging from a few hours to several days. However, there are steps that can be taken. First, medication exists which will help almost all individual travelers. Although this medication is inappropriate for a Space Shuttle pilot because of its side effect of drowsiness, there is no present reason to believe that it cannot provide relief to many/most passengers. In addition, for longer term stays, techniques exist by which artificial gravity could be created which would prevent essentially all space sickness. For the latter case, technological-operational approaches range from spinning centrifuges or turntables operating inside an

otherwise "zero-gravity" habitat for short stays, all the way to large-scale rotating habitats that could provide as much as Earth-normal gravity on long stays.

Overall, the issue of accommodations, life support and other amenities provided for the paying clients of a space travel and tourism business requires careful consideration. These can be expected to vary in scale and type depending upon the character and expectations of the travelers (especially the ones who could be identified as "adventure tourists") and on the duration of an individual's stay in space.

Another important consideration will be the size and skills of the crew providing support and personal services to the passengers. (Reflecting upon the early days of commercial aviation's passenger service accommodations could be helpful.) In order to assure confidence in comfort and safety a relatively large crew will probably be needed. Members of such crews will need exceptional people skills to handle the situations that are bound to arise in such an "alien" situation -- informing without alarming, and calming without isolating when there are problems. Some or all crew members must also have appropriate medical training. In addition, adequate medical facilities must be provided locally, commensurate with the duration of the particular services being provided. Also, for longer duration trips (e.g., for a week-long stay) and where a greater degree of physical exertion may be expected (such as in-space sports) an appropriately trained and experienced physician must be available.

Appropriate and thorough passenger preparation will be essential. This may very well include specialized training in some cases. For example, a working familiarity with the systems on board the residential facility might be a useful aspect of assuring health and safety. Rather than being a burden, it may well prove that preparation activities are a valued part of the overall public space travel and tourism experience (perhaps like attending a space camp). Broad experience in the preparation process itself could well become a terrestrial revenue-generating element of an overall general public space travel and tourism business.

Even after the technologies needed to make travel and tourism service affordable have matured and the systems have been developed, tested and deployed, uncertainties and risks will remain. This will be true for in-space facilities, but it will be especially true for EO transports. Passenger, crew and vehicle insurance could become available, but would be expensive until transports are proven to be reliable by repeated usage over time. The "third party" liability issue must be addressed by both the vehicle developers and operators, and the Federal government, and this matter is now receiving increased attention. Practices similar to those employed on other so-called "adventure travel" trips, such as mountain climbing in the Himalayas where tourists sign a waiver of liability and proceed at their own risk, may be applicable in this case as well.

Again, both transports and hotels must be designed, developed and operated with basic general public physical, psychological and social considerations in mind.

Regulation, Certification, Legislation, Policy and Environmental Considerations

A myriad of legal and regulatory aspects of public space travel and tourism must be resolved before viable large scale businesses can emerge. This is especially true of those public agencies with the responsibility to regulate in the interest of public safety. This includes identification of public policies and/or laws that exist or must be enacted to enable business formation, licensing, certification and approval processes for both passengers and vehicles, clearance and over-flight considerations, and environmental and safety issues including atmospheric pollution, solar radiation (flares) and orbital debris.

National and international regulatory issues will affect general public space travel and tourism significantly. It will be crucial to assure both the Congress and the general public that this new business is considered to be safe by reasonable standards and acceptable by those who would take space trips. For example, it might be reasonable to expect that the earliest services will be safe by the standards of sky-diving, but not by the standards of today's commercial aviation; recall that the latter required improvement over decades to reach its present high level. Whatever standards are applied, it will be important to streamline regulatory processes and to establish uniformity in those standards and their application.

Near-term Regulatory Issues

Experimental flight regulations; spaceport regulations
Waiver of liability; space traffic management

Near-term Policy Issues

Use of government assets; privatization of zero-gravity flights
Authority to license reentry vehicles

Longer-term Issues

Certification of commercial transport systems operations
Property rights: claims registry, deeds and liens, noninterference
Environment: noise and debris, overland supersonic flights
Removal or mitigation of orbital debris

Financial, Economic, Business Planning and Market Considerations

The ability to start viable businesses that offer diverse services of various scales and prices will be the ultimate test for the realization of the concept of general public space travel and tourism. Financial planning, capital needs and sources, and the creation of viable business plans are fundamental to creating a sound new business area.

This study is not recommending any specific ventures inasmuch as these remain the purview of the private sector and its judgment regarding business opportunities, but it does identify general issues and classes of opportunities.

For instance, the early years of space tourism flights should be in vehicles whose operations are licensed under the existing authority of the Associate Administrator for Commercial Space Transportation in the FAA-DOT. This office already licenses space cargo launches, and has the statutory authority to closely monitor the safety related policies, procedures, and operations and equipment of launch operators.

After some years of experience with various vehicle types and potential failure modes, the Federal government then could formulate standards for certification of passenger spaceships. This evolution to certification would free spaceship operators of the need for specific approval for each trip that is required under the licensing regime.

Major uncertainties that will affect the initiation of general public space travel and tourism business startups include: market demand and elasticity; transport vehicle acquisition and O&M costs; trip price; trip safety, reliability and comfort; and insurance and regulatory burdens. Notional business models suggest that profitability of eventually truly large scale service operation will depend on per orbital trip costs of not more than about $1-2 Million (roughly 100

times less than Space Shuttle costs and 10 times less than today's Reusable Launch Vehicle program goal). In addition, an overall safety of 0.9999+ (roughly 100 times better than Shuttle) will be needed. Vehicles should be designed able to return to Earth and land safely if required by any space trip emergency. Finally, high utilization of the space transportation vehicles will be critical -- including turnaround times of some 24 hours (roughly 100 times shorter than today's individual Shuttle experience).

As these technical-operational goals are achieved, the price per ticket could drop below $50,000 per passenger, and might eventually reach the range of $10,000-$20,000. (By that time, if U.S. economic growth continues at the same rate as the past decade, in effect prices, in 1997 dollars, could be reduced by a factor of some 1.5X, and over 10 million households could have incomes, in 1997 dollars, of over $100,000 per year.) Market forecasts all suggest large real markets, but vary significantly in their predictions of market elasticity. However, with ticket prices well below $50,000, it is believed that there could be the order of 500,000 space trip passengers/year. (Transporting these many people/year would require the carrying to/from space of hundreds of millions of pounds of payload per year -- roughly 1,000 times more than today's total U.S. civil, commercial and industry annual space trip payload, but still many factors of ten less than is carried by commercial airlines.)

Some notional business models that have been constructed suggest that, then, high annual internal rates of return may be achievable. However, it is recognized that such results are crucially dependent upon market elasticity surveys and space transportation service cost estimates that are at early stages of development. They each have major uncertainties and the general public's present trip expectations could change over a decade's time; therefore, such economic feasibility projections could be in substantial error and they should be updated every few years.

As a part of the business start-up process, incremental business formation involving niche markets will be vital. For example, poll data indicate that some people would go on very expensive "space adventure trips" now -- even at prices approaching $1 million per ticket and with substantial physical risk. As part of this process, a carefully planned public relations and merchandising campaign is needed to improve public awareness of this opportunity and to change public perceptions of risks and viability. This is essential not just from the standpoint of informing eventual clients, but also from that of satisfying the concerns of potential investors. The perceived level of risk and uncertainty in a general public space travel and tourism venture will, of course, have a direct bearing on the availability and cost of money for that venture.

Overall, the assessment to date suggests that if EO transportation system-services can be developed that demonstrate acceptable safety, reliability, comfort and affordability, and are sized to serve large enough markets, financially viable general public space travel and tourism businesses can be created by the private sector.

And it is judged that, once public in-space trips of any character commence and continue with regularity, today's terrestrial space tourism businesses would flourish.

Initial Ground Facilities, Space Tourism Theme Parks and Other Orbital Trip "Precursor" Considerations

A variety of ground facilities and activities may be called into play to support successful formation of general public space travel and tourism enterprises, especially including businesses that are formed to exploit the latent market demand even before actual in-space trips are available to the public. These facilities could include theme parks, trip training facilities, and other such public quasi-entertainment facilities that could develop around future general public space travel and tourism launch/recovery sites, and whose function it would be both to prepare the public for

the space experience and simultaneously to profit from the undertaking. The success of these businesses could be crucial in raising both public awareness and large amounts of capital for the actual public in-space travel and tourism to follow. Again, these activities would also serve as transition activities for the present terrestrial travel and tourism businesses.

As noted above, Earth-based space travel and tourism already exists and is flourishing. However, to serve as an effective "precursor" to public in-space travel, terrestrial space travel and tourism must enlarge its marketing focus from children and adolescents of the "Star Wars" approach so as to emphasize average, typically very successful, professional adults. Private business may make a lot of money on these types of facilities and entertainment activities, including those around a future commercial spaceport, as well as through training camps, space camps, theme parks, space-related merchandise, etc. Such activities may begin well before actual in-space trips occur, and they could continue growing once in-space trips become available.

A variety of information-oriented "precursor" activities will probably be needed to engender the rapid creation of a general public space travel and tourism business. For example, greatly expanded communications efforts are needed to develop space travel and tourism groups and to promote entertainment in such related applications as movies, prizes, CDs, and books. In addition, using motion picture and/or other media personalities to promote public space trips may be a sound strategy. Private, non-profit, organizations (such as the newly created Space Tourism Society) could lead these information-oriented activities and assist in the building of a consensus on various issues. This would be an important step.

For instance, a virtual reality experience could be offered -- one in which, on the surface, a person led by an astronaut could experience to some degree the characteristics of human spaceflight. Such experiences can be expected to whet the general public's appetite for "the real thing".

Too, it is now time for a few senior Federal officials who have responsibility for our civil and private sector space interests to consider taking trips to orbit. Their fundamental domain of responsibility is space itself, not the Earth's surface, and their doing so could be a graphic signal to the Country that space trips are no longer to be confined to astronauts. Certainly their personal participation in opening up space to the general public is as important as sending probes throughout the solar system. In so doing, they would simply replicate the trips of such Federal officials as the President and the Secretaries of Defense and State, who oftentimes visit dangerous areas around the globe to ensure that our Country's interests are well understood and supported.

Finally, it will be important that "precursor" activities provide early revenues to nascent general public space travel and tourism businesses and create a new public understanding that human spaceflight activities can be separate and distinct from those of NASA's.

Research and Technology Development Requirements, and Use of Existing Space Assets

There are several appropriate research and technology development activities that the Federal Government should undertake to allow the future creation of privately-funded general public space travel and tourism businesses. These include any technology developments or demonstrations that are too risky or too long term for the private sector to undertake under novel market circumstances, and any research programs, such as in life sciences -- all of which are traditional government undertakings. The Government's role in advancing our satellite communications and remote sensing business interests continues to be a useful precedent.

Government-owned space assets, such as the Space Shuttle and the U.S. segment of the International Space Station should be used for the conduct of scientific, technological and operational inquiries and, as well, for market-stimulation and initial private citizen trips. National policy regarding Shuttle fleet operations should be examined in anticipation of the desirability of allowing this latter use. The privatization of the Shuttle is proceeding well with initial operations now being conducted by the private sector -- the United Space Alliance. Analogous privatization of ISS operations should also be seriously studied.

EO transport vehicles based on current technologies and operating methods are not sufficiently safe or reliable for widespread general public transport, and they cost too much to operate. For example, a space travel and tourism business that used a current NASA Space Shuttle configured to carry 50 people would have to charge some $10 million per ticket just to cover operations and maintenance costs. In the relatively near term, improvements to the Shuttle vehicles and their enlarged operations might enable a 2-4 times reduction in these levels. At such prices, it might be possible to start a business, but it would be one which could only accommodate a few people each year at best.

To ensure that the use of costly public assets are used in a fundamentally egalitarian fashion, private sector interests could explore the use of a national lottery and/or auction with government cooperation.

A lottery would provide funds needed to work out the procedures for training and supporting non-professional space travelers. The purpose of an auction would be to determine at what price private trip services might be able to sell their initial tickets; the answer would significantly reduce the uncertainty about the initial market for space tourism, and thus improve the ability of commercial space travel companies to secure financing for private spaceships. The lottery and auction would be conducted only twice each, with a lottery and auction for Shuttle trips and again for combined Shuttle-Space Station trips. After these tests, space tourism would be conducted solely by private entities. It should be noted that the Department of State's Immigration and Naturalization Service now conducts an international visa lottery and the Federal Communications Commission (FCC) has auctioned off use of portions of the electromagnetic spectrum -- interesting and encouraging precedents.

In general, the Space Shuttle is suitable for R&D purposes, modest initial "adventure travel" public uses, and fundamental educational and merchandising activities. While some additional R&D could be conducted on the International Space Station its capability should be augmented by a private sector tourist module. Access to these systems would be very helpful in the development of general public space travel and tourism businesses.

R&D programs are underway to reduce the unit cost of space access. For example, the NASA/Lockheed Martin X-33 technology development and demonstration project -- a part of the Reusable Launch Vehicle (RLV) program -- is investing in both new technologies and operations approaches. This investment could enable the beginning of more businesses by driving the cost per ticket down to the order of $100,000 each. However, this level is still too high for the development of a truly "mass market". Perhaps a lower "loss leader" price could be charged for Shuttle and/or RLV trips with an acceptable overall profit being obtained by including that from trip-related surface business activities.

Through the Advanced Space Transportation (AST) program NASA is also pursuing the development of technologies which, eventually, could reduce ticket prices to under $50,000. The program includes:

- Highly reusable engines and vehicles

- Combination and/or combined cycle propulsion
- Off-board energy for launch assist or elimination of most propellants
- Advanced manufacturing, operations (including automation and robotics), and thrust augmentation systems (including upper stages)
- Advanced operations that enable further, dramatic, reductions in the number of ground and trip personnel

The validation of these technologies should be pursued in future successors to the X-33 technology demonstration program.

Staying at an orbital residence for as little as a week would increase the cost of this kind of general public space travel and tourism significantly. Acceptable unit costs would require more advanced technology and operating concepts than those being used for the International Space Station, and the government should initiate R&D activities to lower such infrastructure costs.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The opening of the frontier of space -- not just to government missions and astronauts, but now to private individuals and private sector businesses -- is a space challenge of overarching importance. It is especially important for the democratic United States of America. This study should play an important role in beginning, in earnest, the process of United States government and business interests recognizing and overcoming the barriers to large-scale general public access to space in the early years of the next century. This fundamentally new human experience could be much closer to being realized than most people now imagine.

The following are the specific Findings and Recommendations of the study that are expected to help make this happen.

Findings

The NASA-STA study found that:

- Professional space tourism studies have been conducted in the United Kingdom, Germany and, especially, Japan. Japanese studies have included conceptual designs for vehicles that would carry large numbers of tourists.

- In a very real sense, "space tourism" already exists in the United States. It exists in the form of millions of visitors each year to space-oriented museums, to space launch/recovery sites and space research and development centers, to a space camp, and in space-related activities generally. And zero-gravity aircraft trips are becoming available.

- Polls consistently find that public interest in actually going to space continues to be large, real and widespread. However, very few realize that it is possible (given appropriate actions) that soon ordinary people, not just highly-trained and government-paid astronauts, could be able to take a space trip -- as only a very few have since the beginning of the space age.

- Immediate steps can and should be taken to enlarge today's terrestrial space travel and tourism businesses. In addition, small scale enterprises may be able to get started using very near-term vehicles and/or technologies.

- For instance, two new companies have announced publicly that they are organized to provide space-related terrestrial and atmospheric trips and to position themselves to offer 100 kilometer altitude trips within 5 years; other companies are known to be considering offering similar space tourism services.

- Public communications and merchandising can make a significant difference in raising the level of this awareness. High profile public figures and senior space-responsible Federal officials could play a very effective role in promotion and education campaigns relating to general public space travel and tourism.

- Economic return on investment could be sufficiently high to attract capital for large-scale ventures. But the initial problems to be solved focus upon creating profitable businesses that serve small markets at high prices. As business moves to do so are successful, and if major issues are satisfactorily addressed, then the creation of financially viable high volume-low price businesses could commence.

- As a result, general public space travel and tourism has the potential to emerge as a large and growing commercial business in the early decades of the next century. Our positive economic experience in the large and rapidly growing private sector satellite communications, navigation/position-fixing and remote sensing business areas should encourage this prospect.

- The cost of a Shuttle trip to/from orbit for a half-dozen people (and upwards of 40,000 pounds of cargo) now approximates $400 million, the individual Shuttle trip turn-around time is about a half-year, and the possibility of a fatal accident about 1%. These spaceflight characteristics can be reduced by roughly a factor of ten times with a next generation of technology, and roughly another factor of ten times in a following generation, i.e., following the pattern that underlies the success of commercial aviation.

- However, to enable the development of broadly-accessible, "mass markets" for public space travel and tourism, new, much lower-cost and much higher safety/reliability transport vehicles are needed, and relatively large-scale and continuing space industry and government programs will be needed to acquire them.

- The DOD-NASA DC-X/"Clipper Graham" technology development and maturation programs, and the ongoing cooperative private sector/Federal government X-33 and X-34 programs, are most encouraging steps forward.

- NASA's 1998 Strategic Plan (NASA Policy Directive (NPD-1000 - 1000.1)) moves in the correct direction when it asks in its "Administrator's Strategic Outlook" section: "How can we enable revolutionary technological advances to provide ... space travel for anyone, anytime...?"

- We must learn how to reduce, if not eliminate, general public passenger space sickness discomfort.

- Very many more rocket launches will heighten concern about launch site noise and atmospheric pollution, and heighten concern regarding space debris collisions. These concerns must be realistically addressed.

- And recent Mir experience emphasizes the need for space hotel fire detection and suppression characteristics among other safety enhancement needs.

- The $ multi-billion per year NASA and DoD space transportation market should be looked to, as well as the satellite communications market, in considering the required rapid and confident amortization of acquisition costs of new passenger-carrying vehicle-fleets.

- Limiting the in-space experience to the transportation vehicle is acceptable for initial business (e.g., "sorties" into space for a short period of time). In this vein, early sub-orbital trips should become initial stepping stones to later orbital flights.

- However, to enable large-scale market expansion, orbital residential facilities will be needed. The technologies being developed today (i.e., for the International Space Station) represent a good starting point, but clearly more work is needed to reduce the cost of human habitation in space by a large factor.

- Regulatory, policy, legislative/statutory and insurance questions must be addressed with an eye toward balancing public safety with making higher risk adventure travel start-up businesses possible. These discussions should include several organizations within the government.

- Creation of the United Space Alliance to operate the Shuttle fleet, which should lead to the fleet's use for private as well as public use, is an important and positive institutional change. It could well become the precursor, in the human spaceflight area, of our aerospace industry looking, entrepreneurially, to the private sector marketplace as well as the Federal government, for the large new human spaceflight business opportunities.

- Long distance, very high speed sub-orbital passenger and cargo transport prospects are also emerging, and would be enhanced by any conceptually related Defense vehicle and operations development programs. These could well furnish the earliest means for expansion into large-scale space travel.

- Both existing and new non-profit organizations outside the government could play important roles in enabling public space access to develop as a major new business activity.

- It should be appreciated by all civil space leaders that a large-scale private sector space travel and tourism business would strengthen the general public constituency for the conduct of civil space science and exploration activities, which otherwise will continue to be increasingly constrained by eroding general public financial support.

- It must be appreciated that widespread space tourism services will become available only as the marketplace is positively judged by our free enterprise business community, not our Federal government, and it should also be appreciated that the realization of a large general public travel and tourism business could take longer than otherwise if one or more of the following happen(s):

    a) Another Challenger-like space accident involving loss of life;

    b) A marked and prolonged turndown in our Country's economic circumstances; and/or

    c) Insufficient appreciation of the true economic dimension of the business by related aerospace, travel and tourism, and government interests.

<u>Recommendations</u>

In order to facilitate the development of a general public space travel and tourism business, the following steps are recommended:

- Our national space policy should be examined with an eye toward actively encouraging the creation of a large general public space travel and tourism business.

- In the near term, expansion of our terrestrial space travel and tourism businesses should be encouraged; theme and virtual reality space parks; space camps; training, production and launch recovery facilities; and other money-making "precursors" to in-space trips should be considered.

- Space industry companies, space-related financing and insurance interests, theme park developers, airline and cruise ship operators, hotel architects and operators, adventure tour operators, ..., all should begin to inform themselves of general public space travel and tourism business prospects to determine their self interests therein.

- In pursuing these recommendations, it is now most important that a complete spectrum of people and businesses become engaged: financial, airline, cruise, hotel, terrestrial tourism and travel, and aerospace. Encouraging the involvement of small businesses and entrepreneurs is especially important.

- The assistance of existing and/or the creation of new not-for profit, non-government, organizations (such as a Space Travel and Tourism Association) should be sought to play a role in the needed communications efforts.

- The Aerospace Industries Association (AIA), the American Institute of Aeronautics and Astronautics (AIAA), the Institute of Electrical and Electronics Engineers (IEEE) and the Travel Industry Association of America (TIAA) should now begin to give increased business and professional attention to space travel and tourism.

- Universities that offer travel and tourism educational programs should now begin to consider terrestrial, in-atmosphere and in-space, trips and businesses.

- The Department of Commerce should focus upon coordinating general public space travel and tourism matters with those of the Departments of Transportation and Defense, NASA, and our presently evolving space travel and tourism businesses, so that the Federal civil space program will adequately encourage and support travel and tourism business interests. The Departments and NASA should also consider how to address this new and potentially large space business prospect.

- The Federal government's role should be that of cooperating closely with our private sector to reduce the latter's initial technological, operational and market risk, much as it has, with laudable success, in aviation, satellite communications and space remote sensing business development. It should:

  (a) as it does now for our private sector aviation interests, develop and demonstrate technology that would increase space trip safety, reliability and comfort, and decrease unit costs -- all by factors of ten; learn how to deal with high rocket launch rate noise, atmospheric pollution and debris collision concerns; learn how to provide low cost human habilitation facilities in orbit; and learn how to ameliorate general public passenger space sickness discomfort;

  (b) following on to the NASA Reduced Gravity Student Flight Opportunity Program precedent (in which college students performed experiments under microgravity conditions aboard a NASA KC-135 aircraft) allow the use of such public space assets as the Shuttle fleet and the U.S. portion of the International Space Station (augmented by a private module) to conduct general public tourist R&D and initial fundamental

"demonstration" merchandising activities -- much as it continues to do, effectively, for the satellite communications business area;

(c) use its own space transportation needs, costing $ multi-billions per year, imaginatively, as a market to assist the private sector to amortize, confidently, its large initial vehicle-fleet acquisition costs;

(d) inform the general public about space travel and tourism possibilities; such communications should focus on the idea that ordinary people -- not just astronauts -- should be able to go on a space trip in the relatively near future as a result of government-private sector cooperation;

(e) see senior Federal officials responsible for our civil and business space interests consider taking the lead in "opening up space to the general public" by taking trips to space themselves;

(f) balance, prudently, between regulating for public safety and encouraging business success under novel operational circumstances; and

(g) cooperate in holding an annual General Public Space Travel and Tourism Conference.

- Government-sponsored R&D investments should specifically address:

  a) Driving the per flight costs of space transportation down by 10-100 times in order to allow lower trip prices to be charged, in particular by developing and maturing technologies -- including particularly rocket engines -- that would be needed for low cost and high safety, reliability and comfortable transport vehicles;

  b) Driving down the costs of longer duration visits to LEO dramatically, i.e., for human space habitation, by developing and maturing high safety, low cost and high reliability technologies;

  c) Demonstrating ways to reduce the effects of space sickness to levels acceptable to the general public;

  d) Assuring that high quality, high reliability, "human support" capabilities (such as emergency rescue and in-space health care) can become available; and

  e) Environmental concerns, generally.

- Our X-33 and X-34 cooperative space industry-NASA program leaders should give specific attention to the prospects of general public space travel and tourism, as should the private sector space transportation activities of such companies as AeroAstro, Boeing, Kelly Space, Kistler, Lockheed Martin, Pioneer Rocketplane, Rotary Rocket, Vela Technology, and others.

- Private sector interests should consider the possibility of using lotteries and/or auctions to see that early R&D and merchandising trips involving the general public, especially those that use public assets, are conducted in an egalitarian fashion and paid for with the private funds that it/they could provide.

A FINAL OBSERVATION

In addressing, seriously, the possibility of our private sector providing space travel and tourism systems and services to the general public we should all appreciate that what is being discussed here is nothing less than a fundamental challenge to our views of, and participation in, extra-earth activities. It is not unreasonable to characterize this challenge as politically, socially and economically revolutionary.

We now see the opportunity of opening up space to the general public -- a "sea change" in our half-century sense that people in space would continue to be very few in number, would be limited to highly trained professionals who, at personal physical risk, would conduct mostly taxpayer supported scientific and technical activities there under government purview.

Now the dream of very many of us during the Apollo era that we could someday take a trip to space for our own personal reasons is finally approaching realization.

But bringing this about will require fundamental changes in the way that scientists, engineers, system-service operators, government officials, investment houses, business people, industry leaders, entrepreneurs... ., go about creating space-related infrastructure and offering space-related services.

It is hoped that this report will draw wide attention to a fundamentally new human dimension of space that can and should be created, and to suggest ways by which many of us can help to see this come about responsibly and at a relatively early moment.

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15. "Ambitious Entrepreneurs Planning to Send Tourists Into 'Astronaut Altitude'"; The New York Times; February 17, 1998; Page A-16.

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Also see:

a) The Japanese space tourism Internet Web site: http://www.spacefuture.com

b) The STA space tourism Internet Web site: http://www.spacetransportation.org

APPENDIX A

TOURISM SURVEY RESULTS

Yesiawich, Pepperdine and Brown of Florida, along with Yankelovich Partners of Connecticut, completed a 1,500 family focus inquiry in 1997 regarding the interest of the U.S. public in taking a trip to space.

The results of this study apply to the 130,000,000 million of "...all U.S. consumers who took one or more pleasure trips of 75 miles or more in 1996 that required overnight accommodations. Accordingly, the percentage of potential Shuttle travelers and potential cruise [-like space] vessel travelers can be applied to this base for purposes of estimating the [space tourism] market potential ."

Dennis A. Marzella, Senior Vice President, Research and Strategic Marketing of Yesiawich, Pepperdine and Brown, was kind enough to review the study data in some detail so as to produce the values given in the following table.

Question	Percentage (%)
Would you be interested in taking a two-week vacation in the Space Shuttle in the future?	33.9

If yes, what would you be willing to pay per person for such an experience?	Percentage (%)
Less than $500	11.7
$500 - $1,999	22.5
$2,000 - $4,999	26.7
$5,000 - $9,999	22.5
$10,000 - $24,999	9.1
$25,000 - $49,999	< 1
$50,000 - $99,999	< 1
$100,000 or more	7.5
Mean	$10,812

Question	Percentage (%)
Thinking ahead about the likely advances in space travel within the next decade, would you be interested in travel in a space cruise vessel capable of taking passengers into space which would offer similar accommodations and entertainment programs of an ocean going cruise ship?	42.2

APPENDIX B

STUDY LEADERS

NASA

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Daniel O'Neil
William Piland
Barbara Stone**

STA

Thomas Rogers
Eric W. Stallmer

Associated with the Study

David Gump
Robert Haltermann

STA Administrative Support

Bernice Coakley
Ann Pryor Spitsbergen

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* Since January, 1997, as a private consultant.
** Since November, 1996, as a private consultant.

APPENDIX C

STEERING GROUP MEMBERS

Dr. Buzz Aldrin
Astronaut -- one of the first to stand on the Moon; Chairman of the Board of Directors, National Space Society; author

Ben Bova
Author of many futuristic novels -- a recent one of which speaks to space tourism -- and non-fictional books regarding space; former Editor of Analog and Omni magazines

Robert Citron
Co-founder of Kistler Aerospace; founder of SPACEHAB, Inc.; managed space research projects for the Smithsonian Institution under contract to NASA; early "space tourism" entrepreneur

Dr. Suzanne D. Cook
Senior Vice President of Research of the Travel Industry Association of America.

Dr. Patricia S. Cowings
Head, Psychophysiological Research Laboratory, NASA Ames Research Center; principal investigator on several Shuttle missions

Duane Edelman
Manager of Future Projects, Northwest Airlines

Donald Fuqua
President of the Aerospace Industries Association of America, Inc. (AIA); former Congressman; former Chairman of the House of Representatives' Science Committee

Jake Garn
Former Senator with NASA program oversight responsibilities; one of the very few non-technical people to take a Shuttle trip

Lori Garver
Senior Policy Analyst, Office of Policy and Plans, NASA Headquarters; Formerly, Special Assistant for Communications to the NASA Administrator; former Executive Director, the National Space Society; Member of the NASA Advisory Council

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Neil Hosenball, Esq.
Former General Counsel, National Aeronautics and Space Administration

Dr. Max Hunter
President of Space Guild; aerospace engineer; leading proponent of the Single-Stage-to-Orbit (SSTO) fully reusable space transportation vehicle concept

Dr. John M. Logsdon
Professor at George Washington University; Director of the GWU Space Policy Institute; author; U.S.A. Editor of the professional journal Space Policy

Michael McCullough
Senior Chairman, Booz-Allen-Hamilton

Dr. John McLucas
Former FAA Administrator, Air Force Secretary and Head of the NASA Advisory Council; author of "Space Commerce"

G. Harry Stine (Deceased, 1997)
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Dr. Laurence R. Young
Space scientist/engineer; Apollo program Professor of Astronautics and Director of the National Space Biomedical Research Institute, Massachusetts Institute of Technology; member of the National Research Council's Aeronautics and Astronautics Board and Committee on Space Station

Ex Officio

General Daniel O. Graham (Deceased, 1995)
U.S. Army (Ret.)

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Tidal W. McCoy
STA Chairman; Vice President of Government Affairs, Thiokol

Keith Calhoun-Senghor
Director, Office of Air and Space Commercialization, Department of Commerce

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APPENDIX D

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Lawrence R. Young (MIT)
John Spencer (Design Finance International)
Harvey Wichman (Claremont McKenna College)
Howard Wolff (Wimberly, Allison, Tong and Goo)
Gordon Woodcock (Consultant)
Dr. Molly Brennan (CCI; Workshop Organizer)
Jack Pozza (CCI; Workshop Organizer)

APPENDIX E

SPACE ACT AGREEMENT

The " Space Act Agreement" between NASA and STA under which the study was conducted.

NONREIMBURSABLE SPACE ACT AGREEMENT
BETWEEN
THE SPACE TRANSPORTATION ASSOCIATION
AND
THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
TO CONDUCT A STUDY OF SPACE TOURISM

ESTABLISHING A U.S. SPACE TOURISM BUSINESS

1. BACKGROUND AND PURPOSE

The Space Transportation Association (STA) is initiating a study addressing the creation of a large U.S. space tourism business. The concept of space tourism as a business has been advanced often, especially over the last decade. Within the past two years, two national studies ("What the United States Must Do To Realize The Economic Promise Of Space" conducted by the Institute of Electrical and Electronic Engineers and the "Commercial Space Transportation Study" conducted by an alliance of six major U.S. aerospace companies with partial funding by NASA) suggested that space tourism should be given serious attention. Internationally, a professional market study completed in Japan last year convinced knowledgeable space professionals and commercial interests there that a space tourism business grossing over $ 1 0 billion annually could be created.

NASA has an X-33 space transportation development and demonstration program underway that should point the way to greatly increased space transportation safety and reliability, and sharply reduced unit cost, for passenger traffic. Since any U.S. next generation (post-Shuttle) space transportation vehicle fleet must be privately funded, it must be designed to serve commercial as well as government markets. The commercial markets must be large enough to make investment profitable; space tourism is potentially the earliest and largest of these markets.

STA is requesting NASA's assistance in the Study in technology areas for which NASA has unique experience, including human space flight and the physiology of living and working in space. In the study, STA will address the question of what specifically needs to be considered and done by the private sector to hasten the development of a large space tourism business and NASA will assess the technological or other limitations that must be reduced or removed that call for R&D activities.

2. AUTHORITY

This agreement is entered into by the Space Transportation Association (herein referred to as "STA") with place of business at 2800 Shirlington Road, Suite 405, Arlington, Virginia 22206, and the National Aeronautics and Space Administration Headquarters located in Washington, DC ("NASA"). The legal authority for NASA to enter into this

Agreement is found in the Space Act of 1958 § 203 (c) (5) and (6); 42 U.S.C. § 2473 (c), as implemented by NASA Management Instruction 1050.9A.

3. RESPONSIBILITIES

The Study will be co-directed by Mr. Thomas F. Rogers of STA and Mr. Ivan Bekey of NASA. A few additional people from each organization will be assigned to the Study. Lt. Gen. Daniel 0. Graham, USA (Ret.), Brig. Gen. Robert C. Richardson 111, USA (Ret.), and Mr. Steve McCormick of STA will participate, as will Mr. Michael Marks, a consultant to STA. STA Board Members and membership organizations will also be called upon. STA will also endeavor to have two graduate students work on the Study; one with a background in space policy and the other in travel and tourism. At NASA, Dr. Barbara A. Stone (Headquarters), Dr. William Piland (Langley Research Center) and Mr. Steve Creech (Marshall Space Flight Center) will participate. NASA will also enlist the cooperation of appropriate individuals in other Federal organizations.

A Steering Group composed of approximately 10 members and co-chaired by the two co-directors will be formed by STA to provide Study oversight. Steering Group membership will include the Study Co-directors, an astronaut, an aerospace industry executive, a space transportation vehicle design professional, a commercial airline executive, a financial authority, and a travel and tourism expert. Lt.Gen. Daniel 0. Graham, USA (Ret.) (Chairman, STA), Brig. Gen. Robert C. Richardson 111, USA (Ret.) (an STA Director), Mr. Daniel S. Goldin (NASA Administrator) and Dr. John E. Mansfield (NASA Associate Administrator for Space Access and Technology) will be invited to be *ex officio* members of the Steering Committee.

STA will also form a larger Working Group with members representing diverse technical, business and legal expertise. Members of the Working Group will prepare, review, and provide comments on draft papers which address their specific professional or business areas.

The Study will conclude with a written report prepared under the direction of the Co-Directors. The Report will be in two parts. The first part will be a relatively short subreport written so as to be readily understandable by the interested general public. This sub-report will outline the steps required to bring about a space tourism business as soon as possible. The second part of the Report will contain the separate papers that address specific professional, business and government issues relating to the development of a space tourism business.

A joint STA-NASA press conference will be held to announce the findings of the Study and to make the report available to the general public and professional and business media.

The Study is expected to take 9 months. If agreement is reached to extend the Study, a progress report briefing will be offered to the X-33 program, government, and extra-government participant organizations at the end of 9 months.

A. STA Responsibilities

- STA will prepare draft papers addressing space tourism business issues such as insurance, advertising, market studies, financial estimates, associated surface activities, in-orbit hotels and facilities, merchandising, vehicle characteristics, launch/recovery physical environment, passenger surface transportation, initial operational date estimation, international activities, federal policies, regulations, laws, international agreements, and other issues as agreed upon by NASA and STA. All Study information gathered or prepared by STA will be made available to NASA.
- STA will prepare the general public sub-report.
- STA will form the Steering and Working Groups.
- STA will endeavor to employ one or two graduate students.

B. NASA Responsibilities

- NASA will prepare draft papers addressing issues such as human space flight and the physiology of living and working in space, technology requirements, vehicle certification, space sickness, passenger physical acceptability, and other issues as agreed upon by NASA and STA. All study information gathered or prepared by NASA will be made available to STA.
- Printing and distribution of 1000 copies of the final report will be done through NASA, either in-house or by the Government Printing Office.

- NASA will lead in communicating with appropriate offices in the Executive Branch. NASA has the primary responsibility for keeping government interests informed of the conduct of the Study.

C. Joint Responsibilities

- Prepare the final Study Report.
- Prepare material for Government, space industry, and tourism business briefings.
- Communicate, as appropriate, with space industry, airline, tourism, and other business organizations.
- Communicate with the Legislative Branch.
- Prepare the final Study Report distribution list.
- Conduct press briefings.

4. FINANCIAL OBLIGATIONS

There will be no transfer of funds or other financial obligation between NASA and STA in connection with this Agreement. Each Party will fund its own participation under this Agreement.

5. OFFICIALS NOT TO BENEFIT

No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this Agreement, or to any benefit arising from it. However, this clause does not apply to this Agreement to the extent that this Agreement is made with a corporation for the corporation's general benefit.

6. FINANCIAL OBLIGATIONS

All activities under or pursuant to this Agreement are subject to the availability of appropriated funds, and no provision of this Agreement shall be interpreted to require obligation or payment of funds in violation of the Anti-Deficiency Act, 31 U.S.C. Section 1341.

7. SCHEDULE AND MILESTONES

The scheduled major milestones for the Study are contained in Attachment 1.

8. PRIORITY OF USE

The schedules and milestones are estimated based on the Parties' current understanding of their circumstances. In the event that either Party's circumstances change, the other Party shall be given reasonable notice of that change so that the schedules and milestones can be adjusted accordingly.

9. LIABILITY AND RISK OF LOSS

There is to be no use by either Party of any equipment or facilities, beyond that of meeting places, of the other Party. Therefore, neither Party expects to incur any significant liability or risk of loss,

10. INTELLECTUAL PROPERTY

Nothing in this Agreement shall be construed as granting or implying any rights to, or interest in, patents or inventions of the Parties or their contractors or subcontractors. Each Party is obligated to transfer to the other Party only the technical data necessary to fulfill the responsibilities of the transferring Party under this agreement. It is the intent of the Parties to effect such transfer without restrictions as to use or disclosure, subject to the following:

1. In the event a Party finds it necessary to transfer technical data in carrying out its responsibilities under this agreement that are proprietary, and for which protection is to be maintained, such technical data will be marked with a notice indicating that it shall be used and disclosed by the receiving Party and its contractors and subcontractors only for the purposes of fulfilling the receiving Party's responsibilities under this agreement, and that the technical data shall not be disclosed or retransfered to any other entity without prior written permission of the furnishing Party. The receiving Party agrees to abide by the terms of the notice, and to protect any such marked technical data from unauthorized use and disclosure.

2. The Parties are under no obligation to protect any unmarked technical data.

In the event reports or publications prepared in the performance of this agreement are copyrighted, the Parties shall have a royalty-free right to reproduce, use, and distribute the work for their purposes.

11. INDEPENDENCE OF CONTRACTS

There are no contracts between NASA and STA.

12. ASSIGNMENT OF RIGHTS

Neither this Agreement nor any interest arising under it will be assigned by STA or NASA without the express written consent of the officials executing the Agreement.

13. TERM OF AGREEMENT AND RIGHT TO TERMINATE

The term of this Agreement shall extend for 9 months from the last signature date below. Either Party may unilaterally and without liability terminate the Agreement prior to the expiration date, by providing a 30-day written notice to the other Party. In the event of such termination, each Party shall return to the other any data it furnished to assist the other Party in performance of this Agreement, but each Party may retain any data generated by its partial performance under the Agreement. The signatories or their designees may amend this Agreement at any time, but only by mutual agreement in writing.

14. KEY PERSONNEL

The following personnel are designated as the key officials for their respective Party. These key officials are the principal points of contact between the Parties in the performance of this Agreement.

STA	NASA
Mr. Thomas F. Rogers President Space Transportation Association	Mr. Ivan Bekey Senior Executive for Advanced Concepts Office of Space Access and Technology

Suite 405
2800 Shirlington Road
Arlington, VA 22206
Telephone 703-671-4116

Code XZ
NASA Headquarters
Washington, DC 20546-0001
Telephone 202-358-4561

15. PUBLIC INFORMATION

Release of general information to the public regarding this study may be made by the appropriate Party for its own portion of the program as desired and, insofar as participation of the other is involved, after suitable consultation.

16. APPLICABLE LAW

The Parties hereby designate the United States Federal Law to govern this Agreement for all purposes, including but not limited to, determining the validity of the Agreement, the meaning of its provisions, and the rights, obligations, and remedies of the Parties.

17. EXECUTION

THE SPACE TRANSPORTATION ASSOCIATION

Lt. Gen. Daniel O. Graham, USA (Ret.)
Chairman of the Board

Date 12 Sep 95

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. John E. Mansfield
Associate Administrator for Space Access and Technology

Date 12 Sept 95