Horses for Courses – Spaceport Types

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There are over 35 operational spaceports in the world today. Most of them are government owned and operated; some are now emerging which are non-Federally-owned. How do these different types of spaceport approach and appeal to the various markets? Can a single type of all-inclusive spaceport cater for the needs of all potential users? This paper provides an update on the status of spaceports today, explores some aspects of competitive advantage, and makes some comparisons and conclusions. There will be a particular focus on the requirements for public space travel. A case will be made that it is probably not a workable plan to attempt to cover all markets with a single spaceport. Instead, it will be important for the management team at a spaceport to focus on those sectors where they can bring decided competitive advantage to bear, and in this way contribute to an eventual segmentation of spaceport types; some markets will be best left to be developed at other spaceports. Each spaceport will concentrate on what it can do best – "horses for courses".

I. Introduction

There will be vastly different requirements for the future public space travelers, and their families and friends, than are normally available at the traditional launch sites built fifty years ago. Indeed, the creation of this emerging kind of facility, the commercial spaceport, is in some ways a very necessary part of the creation of the new space businesses that the twenty-first century offers. It will be essential that, while the space tourism companies are becoming established in order to provide services to the new public space travelers, suitable ground based facilities will be developed in parallel to sustain and support these operations. The paper provides an updated catalog of existing and planned spaceports, both in the US and elsewhere in the world, with comparative information that will be helpful to the range of users and planners of the new spaceports. This leads to a discussion of a probable emerging market segmentation of spaceports.

II. The Space Tourist and the Spaceport

Space tourism emerges as such an important factor in the success of the new commercial spaceports that this point deserves some elaboration. Indeed, without the tourism, it is safe to say that very few, if any, of the developing spaceports can be commercially viable.

Starting in 2001, NASA's Marshall Space Flight Center funded a 2-year comprehensive study, subsequently named ASCENT, of all potential space markets. The results of the work are now in the public domain via the Futron or MSFC web sites. It was found that, firstly, for the next twenty years there is destined to be no overall growth in traditional space launch markets globally, and the annual number of launches throughout the world will remain roughly constant at around about 50 - 80 per year. Secondly, and consequently, these traditional markets are insufficient on their own to justify the development of a fully reusable launch vehicle (RLV), even when the benefits in reduced prices to orbit, which the introduction of an RLV would bring, are taken into account. Thirdly, it was found that the only sector that can offer the possibility of steady growth in launch demand is the public space travel sector. This sector is very sensitive to price levels (it should be noted that the space tourism research that supported this conclusion was very thorough, statistically valid, and was derived from interviews of millionaires). Thus, space tourism is needed, both to give the aerospace industry future growth prospects, and as a market to enable a viable RLV development to emerge.

III. World Spaceports–a Catalog

A. Definitions

The word "spaceport" has a variety of connotations (in science fiction, for instance, it is even used to represent the port of entry and departure of future travelers at the Moon, planetary bodies, or at Lagrangian Points). At another level, it is sometimes used only to describe the new terrestrial facilities for space tourism. For this paper, I am using the label to refer to all kinds of launching site for journeys into space (including sounding rockets, human missions and all other commercial, governmental or military missions except silos and subs). Of course, there will be a difference in the level of information that can be amassed for these different kinds of facility, and for many new spaceports there is as yet nothing to show on the ground, because work is still in the planning stage.

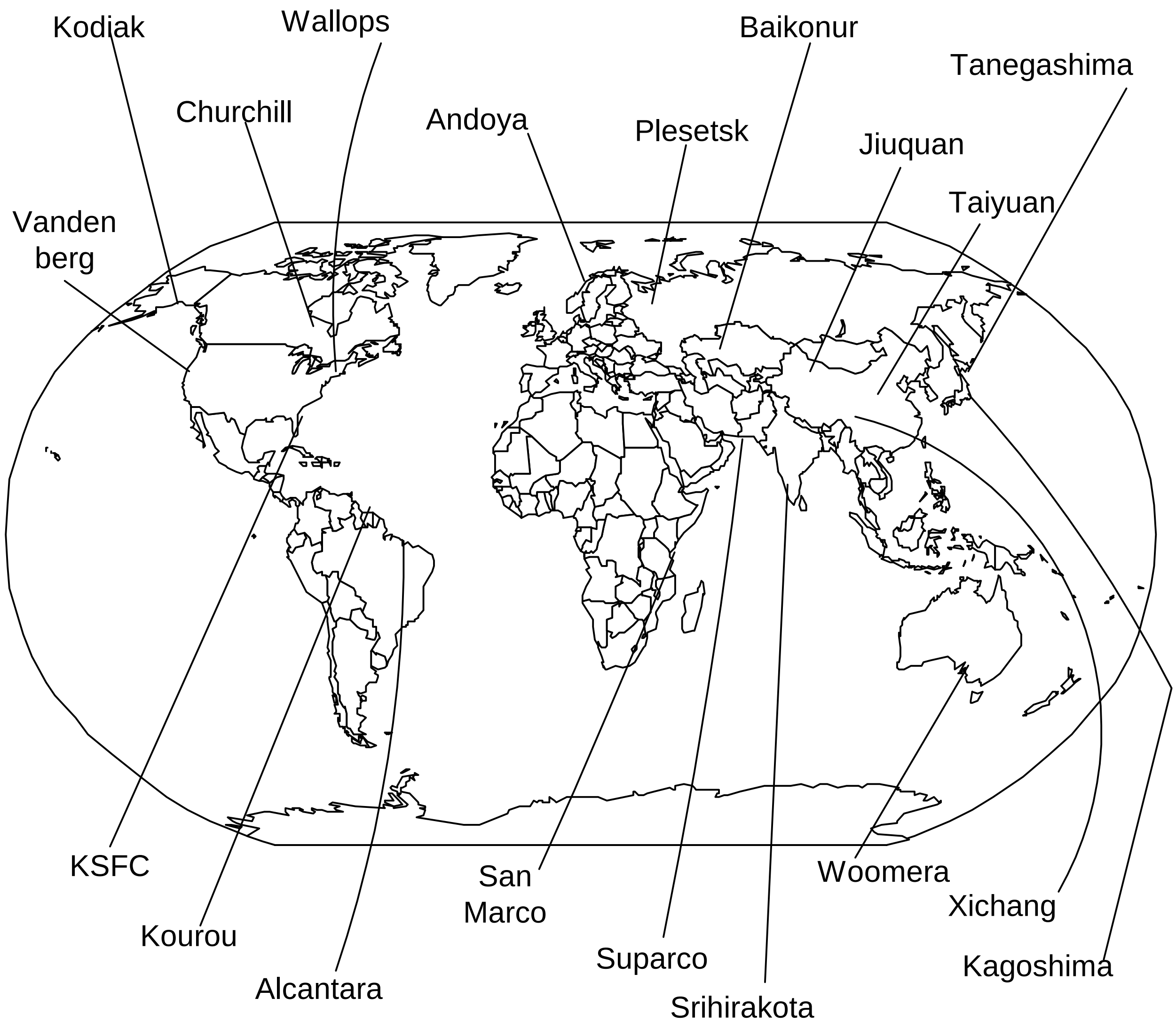
B. Overview

There is a certain advantage for some kinds of mission to having a launch site as near as possible to the equator. In particular, this applies to launches that are intended to take payloads into geo-stationary orbit. The further a launch site is away from the equator, then the more fuel that must be expended in order to remove the north-south motion of the payload once it attains geo-stationary altitude. Also, because of the rotation of the Earth, launches take advantage of Easterly azimuths, and it is therefore advantageous when a launch site has the ocean *to its East* in order to minimize the potential hazard to people on the ground from launch failure. Deserts can serve the same purpose as oceans in parts of the world where this is more feasible. Deserts are particularly useful for missile testing and sounding rocket work, where payload recovery is required. Having said this, we can expect a certain geographical layout of spaceports when we look at their location on the globe, and generally there are no surprises. Both the Kennedy Space Center, and the European Kourou launch site, are classic cases of the coastal site, and Baikonur provides a good desert site example.

However, we also must take into account the need for launches to non-geo-stationary orbits. In particular, there is a need for earth resource monitoring payloads to be placed into polar, or near-polar, orbits. Certain kinds of communications satellites also require a launch into non-geo-stationary orbits. Launch sites for these missions need to have ocean (or desert) *to the north or south* of the spaceport. So we might also expect to see such locations around the globe, and Vandenberg in California, or Woomera in Australia, are classic examples of spaceports that meet these needs. There are also some special orbits, intermediate between polar and equatorial, that are a result of historical circumstances, such as the orbit of the International Space Station (ISS) that is determined by the geographical location of the launch site for the Russian components, and for the Soyuz supply vehicles.

Finally, we need to consider any different requirements for spaceports aimed at public space travel. It seems that there will be two distinct kinds of space tourism: sub-orbital and orbital. For the orbital missions much of what appears above relating to Easterly azimuths applies. For sub-orbital missions, then the commentary on recoverable payloads such as sounding rockets in desert locations may be more relevant. However, in both cases, there will be a need for new kinds of infrastructure, and to some degree this may be in conflict with the indications of the generic launch site location criteria discussed above. This is because for space tourism to succeed there will need to be easy access both for the tourists and the public in general. And most existing spaceports today are far from easily accessible to the public. There is another variable in the equation that at present is unknowable. All of the discussion above relates to vertical launches. There is a mixture of technologies being developed to serve this market, and some require vertical take off, but others take off horizontally. Equally, there is a whole array of different techniques for landing being explored. If public space travel opts for a more airline-like business model, then the spaceports will be more like airports, with large runways being more important than launch gantries. Figure 1 provides the geographic coordinates of selected spaceports around the world.

FIGURE 1 LOCATIONS OF SELECTED SPACEPORTS



C. US Spaceports

Table 1 provides a summary status of US spaceports, and is based on data from the FAA-OST. It is known that other states beyond those indicated on the table are also in very preliminary discussions regarding the possible introduction of a spaceport within their borders. It should be noted that, until recently, only White Sands was an inland desert site in the US. All the other examples were the traditional coastal sites. Furthermore, all the non-federal licensed spaceports until recently were located at original Federal facilities. However, all that changed when Mojave achieved FAA licensed spaceport status just in time for the first flight of the Spaceship One sub-orbital space plane in June of 2004.

TABLE 1
US SPACEPORTS SUMMARY STATUS (OPERATIONAL AND PLANNED)

Class	Spaceport	Location	Status
Federal	Kennedy Space Flight Center	Cape Canaveral, Florida	Operational
	Edwards AFB	Mojave, California	Operational
	Vandenberg AFB	Lompoc, California	Operational
	Wallops Flight Facility	Wallops Island, Virginia	Air launch, maybe Falcon
	White Sands Missile	New Mexico	Operational
	Reagan Test Site	Kwajelein, Marshall Is.	Operational
Licensed non-Federal	California Spaceport	Lompoc, California	Co-located Vandenberg AFB
	Kodiak Launch Complex	Kodiak Island, Alaska	Polar launches
	Florida Space Authority	Cape Canaveral, Florida	At KSFC and Cape San Blas
	Mid Atlantic Regional Spaceport	Wallops, Virginia	At Wallops Flight Facility.
	Mojave Civ Flt Test	Mojave, California	Scaled and X-COR
Proposed non-Federal	Gulf Coast Regional	Brezoria County, Texas	Greenfield. No infrastructure
	Nevada Test Site	Nye County, Nevada	Potential Kistler launch site.
	Oklahoma Spaceport	Burns Flat, Oklahoma	Airport. Pioneer Rocketplane
	South Texas	Willacy County, Texas	No infrastructure.
	Southwest Regional	Upham, New Mexico	Future site of X-Prize Cup
	Spaceport Alabama	Alabama, Baldwin Co	No infrastructure.
	Spaceport Washington	Washington, Grant Co	STS emergency landing site.
	Utah Spaceport	Wah Wah Valley, Utah	No infrastructure.
	West Texas	Pecos County, Texas	No infrastructure.
	Wisconsin Spaceport	Sheboygan, Wisconsin	Suborbital launch pad.
	West Texas Corn Ranch	Van Horn, Texas	Suborbital, Blue Origin.

Assoc Administrator Commercial Space Transportation FAA, Jan 2005, Updated by Spaceport Associates.

D. Non-US Spaceports

Table 2 provides an equivalent summary of the non-US spaceports. It can be seen that they are a mixture of the coastal and desert-site types

TABLE 2 NON-US SPACEPORTS SUMMARY (OPERATIONAL OR PLANNED)

Country	Spaceport	Location	Status
Anguilla	Sombrero Island	18 deg N	concept only. Beal site.
Argentina	La Rioja Mar Chiquita	29 deg S n/k	Proposed Proposed
Australia	Woomera Cape York	31.0 deg S 12 deg S	former UK site(Blue Streak) Proposed
Brazil	Alcantara Barreira do Inferno	2.2 deg S 5.5 deg S	Operational Sonda sounding rockets
Canada	Churchill Range	57.7 deg N	Black Brant sounding rockets
China	Jiuquan Taiyuan Xichang Hainan Island	40.6 deg N 37.8 deg N 28.2 deg N 18 deg N	Long March Long March Long March Sounding rockets
French Guiana	Kourou	5.2 deg N	Ariane and Soyuz pads
India	Sriharikota (SHAR) Balasore	13.7 deg N 22 deg N	PSLV and GSLV n/k
Indonesia	Pameungpeuk	7 deg S	n/k
International	Odyssey Platform	Equator	Sea Launch/Zenit 3SL
Iraq	Al Anbar	n/k	n/k
Israel	Palmachim	n/k	Shavit vehicle.
Japan	Kagoshima Tanegashima Yoshinobu Osaki Takesaki	31.2 deg N 30.4 deg N 33 deg N 33 deg N 37 deg N	M5 LEO H2 GEO n/k in development Sounding rockets
Kazakhstan	Baikonur/ Tyuratam	45.6 deg N	Soyuz, Proton,Rockot, Zenit, Dnepr, etc
Malaysia	Perak/Ipoa	n/k	n/k (maybe Bristol Spaceplanes)
Marshall Islands	Kwajalein	9 deg N	Used by US for military for testing
Norway	Andoya Range	69.3 deg N	Sounding Rockets
Pakistan	Suparco/Miani	25.0 deg N	Sounding rockets
Papua New Guinea	Spaceport	8 deg S	Proposed
Russia	Kapustin Yar Svobodny Plesetsk	48.4 deg N 52 deg N 62.8 deg N	Cosmos launches START (LEO) Soyuz, Angara
South Korea	Verarodo Island	35 deg N	KSLV1 (2007).
Spain	Canaries	28 deg N	in devt for Capricornio
Sweden	Kiruna/Esrange	68 deg N	Sounding rockets
Taiwan	Ping Tung	22.5 deg N	n/k
Source: Spaceport	Associates 2005		

E. Generic Features of Spaceports

Table 3 provides a summary checklist of factors that are relevant in the location, design and functioning of spaceports. It seems probable that not all spaceports will have all types of feature. For example, some spaceports will be developed without any facilities for vertical launches, and depending on the fuel needs of clients, it may not sometimes be necessary to have facilities for storage of hazardous materials. Different kinds of potential launch service operator require different kinds of spaceport. A military focus demands security; a tourism focus needs a more open and relaxed environment.

TABLE 3 GENERIC SPACEPORT FEATURES (Source : Spaceport Associates Model)

Class	Feature Description	Class	Feature Description
Geographical/ Technical	Country Altitude deg latitude possible easterly azimuths possible southerly azimuths proximity to sea weather-humidity weather-wind weather-rain weather-lightning time-related exclusions	Local Infrastructure	Runways/runway length Port/Railhead Airliner overflight situation Road Access and condition Hotels & Restaurants Qualified local workforce Proximity to University Proximity to NASA facilities standard electric power high-tech incubators political stability
Site facilities	Pads for sounding rockets Pads for small ELV Pads for medium ELV Pads for large ELV/RLV Landing pad for RLV Horizontal takeoff/landing Multiple pads for each veh type. Fuel Handling-Solid Fuel Handling Liquid/cryo	Space Tourism Specific	Health check facilities Training facilities Simulators Space Camp/Academy Family facilities -residential Family facilities-entertainment Amateur rocketry facilities. Good P.A. systems Cruise port convenience?
	Fuel Handling - Hybrid Fuel Handling - Nucl Generators Chemical Analysis facilities Ordnance/Pyro facilities Vehicle Integration/Checkout Payload Processing-hazmats Processing - dynamic balance. Spacecraft storage facilities Engineering/Miss Mgt Offices Control facilities for LEOP, IOT Met Office/Radiosonde Range Radars, cameras Telemetry data retrieval/precise timing	Financial/Admin	Years of Operations On-time launch record Financial Incentives/trade zones Int'l facilities-customs Int'l facilities-foreign cuisines,etc Security for military users Veh manufacturer partnerships High Tech company incubators Simplified Admin (ie reg, safety, environment) Operational turnaround
	Payload processing-vibration Engine test stands/cranes/high bay Materials testing facilities Hazmat training On-site research labs Broadband access Emergency Response teams Downrange payload retrieval. Blockhouses/hangarage flame ducts/water system	Vehicle types	ELVs - payloads to LEO ELVs - payloads to GEO RLVs- uncrewed RLVs - crewed RLVs vertical launch/landing RLVs horizontal launch/landing

F. Aspects of Competitive Advantage

Some initial work has been carried out to make comparisons between the various operational world spaceports, and the resulting summary is included in Table 4. In studying the table, note that the column of data related to years of spaceport operation can sometimes mask a change in the kind of facility. The most usual is a change of role from a former sounding rocket site, by upgrade, to a satellite launching facility. Therefore, the facility may have been there for several decades as a sounding rocket range, but as yet have only little experience of satellite launching operations. Some other characteristics also become apparent. For example, only three of the spaceports are in the Southern Hemisphere. Looking at Kourou, it becomes clear, by comparison with KSFC, that the Europeans have an advantage in payload capacity as a result of the relative proximity of their spaceport to the equator. Another observation concerns the Russian and Kazakh sites. They all have a high orbital inclination, and this has resulted, through political compromise, in the International Space Station (ISS) being in a high inclination orbit. The advantage of such an orbit is that it does ensure that much of the Earth is covered under its ground track. The disadvantage, however, is that it is a less than optimum use of the Earth's rotation when it comes to getting cargoes up to the ISS. Launches from eg Kourou or KSFC destined to rendezvous with the ISS therefore need to use up fuel for orbit change that could otherwise have been used for lifting cargo. Some nations, such as Brazil and China, have a geographical advantage in that they can launch into multiple types of orbit from the same facility.

Out of this whole list, only two spaceports operating today are capable of offering space tourism, ie Mojave and Baikonur, but it seems probable that the Europeans will offer Soyuz tourist trips from Kourou once the new pad is completed, and also the Chinese may follow suit from Jiuquan.

TABLE 4 OPERATIONAL WORLD SPACEPORTS - COMPETITIVE COMPARISONS

Country	Spaceport	Deg Lat.	Easterly Azimuths	N/S Azimuths	yrs ops	Mission Types*	Launch Vehicles
US	KSFC	28.5 deg N	35 to 120	none	55	L,G,H	Atlas, Delta, Titan, STS
	Edwards	35.0 deg N	n/a	n/a	58	A	Pegasus, X-Planes
	Vandenberg	34.7 deg N	none	140 to 201	48	L,P,A	Atlas, Delta, Titan, Peg, Taur
	Wallops	37.5 deg N	38 to 60	none	60	L,S,A	Black Brant, Pegasus, Scout
	White Sands	32.5 deg N	none	0	60	S	Starchaser
	Cal Sp'port	34.7 deg N	none	147 to 220	10	S,P	Taurus, Minotaur
	Kodiak	57.0 deg N	none	125 to 235	7	S,P,L,M	Athena
	Florida S.A.	28.5 deg N	35 to 120	none	48	L,G	Athena, Microstar
	M.A.R.S.	37.5 deg N	38 to 60	none	8	S,L,A	Minotaur
	Mojave	35.0 deg N	n/a	n/a	1	H	Spaceship One, X-Cor
Australia	Woomera	31.0 deg S	none	350 to 15	59	P,S	Blue Streak, Skylark, Kistler
Brazil	Alcantara	2.2 deg S	10 to 100	10 to 100	15	S,L,G	Sonda, VLS, Cyclone 4
Brazil	Barr do Inf	5.5 deg S	14 to 145	14 to 145	40	S	Sonda, Nike-Apache
Canada	Churchill	57.7 deg N	none	yes (n/k)	48	S,P	Aerobee, Nike, Black Brant
China	Jiuquan	40.6 deg N	135 to 153	135 to 153	41	L,P,H	Long March 1, 2 and CZ2F
China	Taijuan	37.8 deg N	90 to 190	90 to 190	17	L,P	Long March 2, 4
China	Xichang	28.2 deg N	94 to 105	n/k	27	G	Long March 2, 3
China	Hainan Is	18.0 deg N	n/a	n/a	n/k	S	Sounding Rockets
Fr Guiana	Kourou	5.2 deg N	350 to 93	350 to 93	37	S,N,G,H,P	Ariane, Soyuz,Vega, Cyclone
India	Sriharikota	13.7 deg N	18-50	18-50	25	L,G,P	PSLV, GSLV
Int'l	Odyssey	0.0 deg N	any	any	10	G, P	Zenit 3SL
Israel	Palmachim	32.0 deg N	yes (n/k)	none	n/k	L	Shavit
Japan	Kagoshima	31.2 deg N	31 to 100	none	43	L	M5
Japan	Tanegashima	30.4 deg N	yes (n/k)	none	38	L,G	H2
Japan	Takesaki	37.0 deg N	n/a	n/a	37	S	Sounding Rockets
Kaz'stan	Baikonur	45.6 deg N	25 to 62	193	48	L,M,G,H	Cosm, Dnepr, Rock, Soy, Prot
Marsh Is	Kwajalein	8.0 deg N	yes (n/k)	n/k	n/k	G,L,A,S	Falcon, Pegasus
Norway	Andoya	69.3 deg N	n/a	n/a	43	S	Skylark, Black Brant
Pakistan	Suparco	25.0 deg N	none	220 to 310	45	S	n/k
Russia	Kapustin Yar	48.4 deg N	51 to 107	none	48	S,L,P	Cosmos
Russia	Svobodny	52.0 deg N	53 to 81	344-0	n/k	L	Start, Strela
Russia	Plesetsk	62.8 deg N	90	14	39	M,L,P	Cosm, Moln, Rock, Soy, Ang
Russia	Nov'skovsk	54.0 deg N	n/k	n/k	n/k	L	Shtil
Sweden	Kiruna	68.0 deg N	n/a	n/a	41	S	Skylark, Black Brant
Taiwan	Ping Tung	22.5 deg N	n/k	n/k	n/k	n/k	n/k

* GEO-G; LEO-L; POLAR-P; MOLNIYA-M; SUBORBITAL-S; HUMAN-H; AIR-LAUNCHED -A;

Source: Spaceport Associates 2005

There is a distinct range of launch markets to be considered. Each segment has its own requirements. From the point of view of requirements, the main differences are as described in Section III B above. Thus, some need eastern azimuth launches (commercial or governmental payloads into GEO); some need polar orbital launches (remote sensing spacecraft); some go into intermediate LEO or Molniya orbits, and others are destined for sub-orbital or sounding rocket uses.

IV. Special Needs of Space Tourism

Some of these aspects were included in summary on Table 3, but it is worthwhile to discuss them individually in more detail, because of the dramatically different nature of these facilities from those associated up to now with spaceports. If these features are not eventually made available at spaceports, there will be a major impact on the rate of growth of the space tourism business. The relative rate at which the facilities are introduced at rival spaceports will have a bearing on the market share of space tourism-related revenues, and therefore to the consequential benefits in terms of employment and tax revenues, that any one spaceport (or spaceport state) generates.

Let us discuss each of these in turn. As the business develops, more aspects will become obvious, but this list will serve initially.

a) *Open Access, cell-phones, etc.*

The future space tourism basis will depend upon two distinct kinds of tourist. First of all, of course, there will be those initially rich folks who can afford to go into space. But equally important are the general public who will come to share in the experience. Of course, many in the second category will themselves hope in turn to be able to afford the experience of a flight when prices come down over years of experience. The second category will come to witness the experience and will want to feel involved vicariously in the space flights. They will spend money on accommodation and food and drink and on souvenirs, etc. So the most important thing is that they are able to get there! Many existing spaceports (such as eg the Mid Atlantic Regional Spaceport – M.A.R.S.) are hard to find, and have to be entered through off-putting military security gates. Space tourists, of both categories, will want to feel relaxed and welcome when they arrive. An environment much like that at a commercial airport, or at a cruise ship terminal, will be needed. Easy communication with the outside world will be expected, and for instance there should be good reception both inside and outside the buildings for cellular phones, with good Internet access.

b) Training Facilities

The future space tourists will need training facilities, and they can be co-located at the spaceports. At present, because the industry is at an early stage the only tourist flights were conducted from Russia, and most of the training was conducted there. Again, at present, there are no specifically tourist-designed training courses, so the space tourist is treated very much like a full government astronaut and Tito and Shuttleworth both had to spend 6 months in Russia for the training. For the business to develop, the training time period will need to be reduced, and there will need to be local facilities for US tourists, with arrangements for family and friends to accompany the potential tourist during the process. The training facilities can themselves be money generators for the spaceport operators. For sub-orbital flights, it is likely that the training duration will be much reduced to only a week, or a few days.

c) Medical Facilities

Some of the training, and indeed some of the experience of space flight, will be stressful. There will need to be full medical facilities to check out the health of candidates and certify them for space flight. This is especially true in the early stages of developing the industry, because wealthy individuals, who can afford the first flights, tend on average to be older and potentially less healthy than average. There will also need to be keep-fit facilities to maintain the conditioning of candidates throughout the training process, and emergency facilities in case of accidents.

d) Residential Facilities

Hotels will often need to be built near, or attached to, the new commercial spaceports. They will have special arrangements for displaying status information on pending launches throughout the bedrooms and public areas. Hotels will be needed for the public space travelers for the duration of their training, for the family and friends who come near to launch date to share the experience and for the new workforce of the spaceport (on a permanent basis, or at least until housing becomes available).

e) Entertainment Facilities

Family and friends of the space travelers will need entertainment to occupy them during the training period. Possibly an IMAX type theater would be an attraction, and a space theme park, with rides and simulations. If well designed, these facilities will be a destination in themselves, even when there are no launches taking place. They will create an attraction for the general public to journey to the spaceport, even when they have no connection with any particular space tourist. It is even conceivable, for spaceports that are co-located with a cruise port, that an operator will market packages of events linking cruises to launches. It is also conceivable that training, especially for an orbital mission, could take place on a cruise ship, at least in part, and thus enable family to come along and join in the experience of the ultimate vacation.

f) Space Camp/Academy

There are a few examples of these facilities around the country, and it would make a great deal of sense to co-locate them with a spaceport. Then the children of the space tourist(s) will have an opportunity to learn about the experience, so preparing the next generation of travelers.

g) Simulators

These are needed for training, and could also be used as entertainment facilities, and as part of a Space Camp architecture, or space theme park experience.

h) Amateur Rocketry Facilities

There have been some early examples of this kind of activity being offered at spaceports. Indeed there is a potential to develop the idea into a fully-fledged competition that would be an event generating business, and requiring very little in capital cost outlay.

i) Extended Public Access to Launch Control

This is in many ways the antithesis of the situation at today's Federal spaceports. Currently, only a few VIP's are able to witness the unfolding events in mission or launch control. Much broader facilities will be needed, where members of the public can stroll in and out while a launch preparation is taking place, and where they can decide to sit in comfort to watch the events unfold.

j)Public Address Systems

This is an extension of the idea in i) above. Wherever a member of public may be at the spaceport, they need to be able to hear what is going on. It may be appropriate to think in terms of creating the equivalent of the old "Voice of Mission Control" of the Mercury days in the 1960's to convey the excitement of the countdown to the visiting public and families of space travelers. The P.A. system would operate at outside viewing areas, and also in selected locations within the spaceport hotel and shopping complex.

k) Restaurants, Shops

This is a natural follow-on to what has been stated above, but should not be under-estimated in its potential impact on the profitability of the spaceport venture. At venues like the public facilities at Kennedy Space Flight Center at Cape Canaveral, having large numbers of visitors each day eating franchised meals is a major source of revenues.

V. Global Space Launch Market Activity

What is the relative size of the respective space launch markets? This was discussed earlier in Section II, but it is summarized by sector in Table 5 below. We note that the potential numbers of tourism-related launches is bigger by several orders of magnitude than numbers of launches for other market segments. As the price of tourist flights comes down over time, then the contrast with the numbers of launches for traditional markets will become even more stark. In deriving the numbers used in the table, sub-orbital tourist flights were priced at $100,000, while orbital trips assume a $20M price per ticket.

TABLE 5 GLOBAL LAUNCH MARKETS DEMAND BY MARKET SEGMENT

Market Segment	Orbit Type	Yr 2001 actuals	Yr 2020 forecast
Sounding Rockets (Sub-orbital) :			
65% Research into Astro/solar/plasma	suborbital	15	9
5% Research into Microgravity	suborbital	2	2
25% Research (other)	suborbital	6	6
5% Defense payloads	suborbital	4	2
Total Sounding Rockets	suborbital	**27**	**19**
Orbital Launches :			
Telephony (Commercial)	GEO	4	5
Television and Radio(Commercial)	GEO	5	8
Data Communications (Commercial)	GEO	4	6
Military Communications	GEO	11	4
Remote Sensing (Commercial)	Polar	2	4
Remote Sensing (Civil Gvt)	Polar	5	5
Remote Sensing (Military)	Polar	6	5
Navigation/Positioning	LEO	3	1
Space Science	LEO/Interpl	5	2
International Space Station Missions	LEO	14	14
Human Exploration	LEO	1	4
Other Gvt and Military	LEO,GEO	1	2
Total Orbital Satellite Launches		**61**	**60**
Additional Space Tourism Launches :			
Sub-orbital flights	Suborbital	**0**	**13,000 pass / yr**
Orbital trips	LEO	**0**	**54 pass / yr**

Source: Spaceport Associates, from Ref 1,3,4,5,7, and ASCENT

VI. The All-Inclusive Spaceport?

There is an inherent conflict between the needs of space tourism and the needs of, say, the military space launch activities. And this is true wherever in the world we look. Military payloads require a tight exclusion area that discourages the general public, whereas the public space travel sector needs not only the tourists themselves, but also the family, friends, supporters and the day-tripping public at large, to share in the experience, and so contribute to the revenues. The terrestrial tourists of today, who come to view a tourism flight, will become potential space tourists of the future, as prices are gradually reduced through time.

This would seem to suggest that it is unlikely that an all-inclusive spaceport can be developed. Already, there have been articles in the press commenting that Florida, for example, is concerned that it may not be able to benefit from space tourism revenues, even though it contains the Kennedy Space Center. The space tourism activities seem to be going to take place instead at some of the new commercial spaceports. At places like Mojave in California (for the Virgin Galactic flights, and the XCOR trips), Oklahoma Spaceport (for Rocketplane tourism), and at the new Southwest Regional Spaceport in New Mexico (for the X-Prize Cup competitions, and the UK Thunderbird rocket company), there is evidence of this trend.

So, there is emerging a polarization of spaceport providers. Throughout the world, the already established government spaceports are likely to continue to provide ELV services to government, military and some commercial users. Meanwhile, new commercial spaceports are emerging that will focus primarily on space tourism (both sub-orbital and orbital), and which will thereby support the development of the RLV mode of spaceflight.

Some spaceport planners at the existing government launch sites continue to monitor developments in the potential new growth area of space tourism, and to try to find ways to integrate this into their existing mix of governmental and military work with its less exciting growth prospects. Only time will tell whether this will prove to be possible. Meanwhile, there is a competitive battle shaping up between the various potential future commercial spaceports, to determine which ones are funded to completion and success. At present, the leading contenders in the US seem to be Mojave, Oklahoma and New Mexico. As for the rest of the world, Virgin Galactic is considering an Australian location for some of its offerings, and we shall need to continue to monitor developments in Russia and China and also in Kourou, French Guiana.

VII. Conclusions

This paper has described the importance of the development of public space travel, both as an end in itself, and as an enabler for the launch industry in general, as a consequence of the associated development of safe and reliable RLV’s with markets sufficient to make them viable.

The importance of designing a new kind of spaceport, which caters to the needs of space tourists and their families and friends, has been demonstrated. It has been made clear that the space tourism business, with its many advantages, will not be able to get fully under way without a parallel effort at building the spaceport architectures to support the business terrestrially.

It seems unlikely that a single all-inclusive type of spaceport will emerge that is capable of handling satisfactorily all the diverse kinds of spaceport business. Commercial spaceports will tend to focus on space tourism; the remaining business will be handled by existing government spaceports. Horses for courses.

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