A New “Old Way” to Space:
Taking the Best from the Past to Forge Ahead Into the Future.

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The next step in space exploration must be on a scale that has never been experienced before. In order to construct a fully functioning spaceport, tremendous amounts of cargo and materials as well as large numbers of people will have to be transported into orbit. The size of the program and the spaceport that will have to be built will be orders of magnitude greater than anything yet accomplished.

Unlike ISS Alpha, the spaceport will have to support more than just research. For it to be economically feasible, it must provide space and services to a number of different operations. Manufacturing, tourism, research, construction, commerce and exploration are just some of the activities that will take place on or from the spaceport. These requirements dictate that the spaceport be able to provide space and services for over 300 people to live and work. If the spaceport is assumed to be a circular design providing artificial gravity such as the one proposed by von Braun and exemplified in 2001: A Space Odyssey it could easily exceed 500 meters in diameter.

The effort to lift the amount of material needed to construct a spaceport of this size is staggering. Current vehicles and methods will be unable to achieve the needed volume or launch frequency. A new set of systems and vehicles must be developed. The lessons of the past must be re-evaluated and integrated into the new program. By combining methods developed for Apollo, SkyLab, Mars Pathfinder and the Space Shuttle with modern materials and technology a new “old way” to lift mass into space becomes possible.

This paper will explore this new “old way” and how the achievements of the past will help illuminate the way into the future.

Introduction

Sometime in 2012, if SFO’s current plans come to fruition, the space base shown in Fig.2 will become operational.

When SFO first started to look at the problems associated with long term manned operations in space they found it necessary to view the space exploration paradigm from a different angle.

Space exploration is a human endeavor and as such, the tools, facilities and processes used have to accommodate the vagaries of human nature. One of these is that humans function best in relatively benign environments that may be described as “livable”. This idea leads to “human sized” systems and naturally large structures. Such structures require that real heavy lift vehicles, (HLV) and robust manned systems exist.

The original idea for the Space Exploration Plan is adequately described in Clark, (Ref. 1) and consists of three basic parts; Space Exploration Base (SEB), Heavy Lift Vehicle (HLV) and the Manned Vehicle (MV). None of these ideas are new! Many have been around for nearly a century. We will now show how our proposal for a Space Exploration Plan can trace its lineage from the very start of space exploration.

SEB

The idea of a rotating space station goes far back into space exploration history. In 1929 Herman Potocnik published a work called *The Problem of Space Travel,The Rocket Motor* in which he laid out detailed engineering diagrams showing a rotating space station shaped like a wheel, or, as Potocnik named it, a "Habitat Wheel." The book explained all aspects of the station, including how the station was constructed of modules fabricated on earth then lifted into orbit for final assembly and how the rotation of the station would provide artificial gravity.

Then in 1952 the wheel shaped station concept was popularized by *Collier's* magazine in a series of articles written by Dr. Wernher von Braun. In the articles von Braun described a 76.2 m diameter, inflated rotating station made of reinforced nylon with a pressurized volume of approximately 57,000 cubic meters. Inside the wheel, three decks would provide room for the communications equipment, earth observatories, military control centers, weather forecasting centers, navigational equipment, living space and mercury-vapor power generating turbines that would facilitate the many functions that von Braun imagined the station would perform.

Von Braun, along with many in NASA believed that a space station was a prerequisite to traveling to the moon, Mars or beyond. Their reasoning was simple; by using the space station as a waypoint, vehicles could be specialized. Rockets traveling from the Earth's surface to the station would be built to withstand launch shock and aerodynamic drag, while craft traveling to the Moon or Mars would be optimized for the space environment.

The difference between SFO's SEB and the structures proposed by Potocnik and von Braun is one of size (Chart 1 for other comparisons). At completion the SEB will be over 500 meters in diameter and have a pressurized volume of approximately 597,000 cubic meters making it significantly larger than anything previously proposed, however the concepts are the same.

The SFO SEB, as shown in Fig. 1, is made up of individual modules attached in a dual ring structure. The primary modules, which make up the arms and habitat rings, are cylinders 24 m long and 15 m in diameter. The interconnect nodes, which connect the arms to the rings, are cubes approximately 15 m on a side. Each module is constructed and outfitted on the ground and then attached together in orbit.

Once the SEB reaches Initial Operational Capability, (IOC) (Fig. 2) the entire structure will be rotated at approximately 1.3 rpm. This will produce a force equal to .22 G at the inner ring and 1 G at the outer ring, which should be sufficient to counteract the health problems associated with weightlessness.

HLV

In 1960, as the USA engaged the USSR in the space race, the space station concept was shelved in favor of going directly to the moon. After much debate the lunar orbit rendezvous model was chosen as NASA believed that this was the only way they could meet the deadline in President Kennedy's mandate of putting a man on the moon before the turn of the decade. Unlike the station model, the lunar orbit rendezvous model requires a rocket that can lift the Apollo spacecraft from the planet surface and place it in the proper trajectory for Moon rendezvous, thus the Saturn V was born.

The Saturn V was the largest launch vehicle ever built by the United Sates, weighing in at over 3,000,000 kg at liftoff - it truly was a Heavy Lift Vehicle. A three stage expendable rocket designed to put the Apollo spacecraft into translunar trajectory it was capable of lifting over 118,000 kg. to LEO. At the end of the Apollo program the remaining Saturn Vs were given a new mission, that of placing an U.S. space station into orbit.

Upon the completion of the Apollo program NASA turned it's attention back to earth and the original plan of orbiting a permanently manned space station. The Skylab project was born out of this desire to have a space station. Skylab was developed in an era of ever shrinking budgets, an unfriendly political environment and spare Apollo hardware, which resulted in a simple concept; convert a Saturn third stage, (S-IVB) into a habitable station and lift it into orbit using a Saturn V rocket. Skylab was designed to be a precursor to a long-term space station, and one of its purposes was to prove that humans could live and work in space for extended periods of time.

Skylab was placed in orbit on May 14, 1973 and despite some problems during launch was able to successfully play host to 3 crews for a total of 121 manned days. It met or exceeded all mission parameters and as such proved that man could inhabit space long-term, albeit with problems associated with weightlessness.

Again, the only difference between what NASA built in the 1970s and what SFO is doing today is size (Chart 2). SFO's HLV will consist of a two-stage core vehicle with two liquid boosters. The liftoff weight will be no greater than 4,700,000 kg and it will have a payload capacity of 170,000 kg to LEO.

As with Skylab, each module of the SEB will be an integral part of the HLV. With a diameter of 15 m each module will be integrated directly into the HLV stack.

Lessons learned from other successful programs such as Space Shuttle and Mars Pathfinder can also be applied to the HLV. As with the Space Shuttle boosters the liquid boosters will be recoverable at sea, but instead of using bulky and heavy parachutes they will use air bags similar to what was employed on the Mars Pathfinder. Partially inflated bags along the length of the boosters will provided sufficient drag to slow the descent after separation and just before splash down air bags very much like those used in automobiles will deploy cushioning the impact. The air bags will then provide flotation for the booster easing the recovery.

MV

In the late 1950's both NASA and the USAF were engaged in the development of lifting body spacecraft to move people to and from space. NASA's concept evolved into the HL-10, a twelve passenger lifting body craft capable of safely carrying people to and from orbit. Originally designed to be launched on top of a Saturn IB and to make glider like landings at standard airports it was suppose to become the people mover of space. The prototype was delivered in 1966 and was used for flight test by dropping it from a B-52 bomber. Flight testing of the prototype proved that the lifting body concept was sound and that large manned spacecraft could perform unpowered landings. The entire lifting body concept was shelved in the early 1970's in favor of the Space Shuttle.

After President Reagan's mandate for a US space station, NASA began the design process for Space Station Freedom. In the early 1990's it was realized that a supplementary vehicle to the Shuttle was going to be needed to move people to and from the station, bringing about the concept of the Personnel Launch System, (PLS).

The PLS was to be a reusable vehicle for the purpose of moving personnel to and from Space Station Freedom. It was based on the earlier designs of the HL-10 and the Russian BOR-4, christened the HL-20 (Fig. 3) it was to carry 8 passengers and two crew. As with the HL-10 it was to be launched on top of an expendable vehicle, such as a Titan III or NLS (Fig. 4), and make unpowered gliding landings at a standard airport. Extensive design work was done on the HL-20 but the project was eventually cancelled as Space Station Freedom costs escalated.

SFO will also need a vehicle for the movement of personnel and high value payloads to and from the SEB. Based on the HL-20 design (Chart 3) the Manned Vehicle (MV) will have a crew of three and be able to carry up to 4500 kg of cargo either as 20 passengers or as a combination of passengers and cargo. Just as the HL-20 it will be launched on top of an expendable vehicle, possible the core of the HLV or an up-rated Ariane V and make unpowered gliding landings.

Conclusion

At first glance the SFO Space Exploration Plan may look large, complex and challenging but after closer examination many parts of the plan have been proposed or done before. The wheel shaped rotating space station was proposed in 1928 and again in 1952, in both cases the idea was put forth by credible and knowledgeable people resulting in the generation of a large volume of valuable information, the Saturn V and Skylab programs were the path finders to an easy and attainable way to lift the parts needed to build a large space structure. NASA has done the basic design for a passenger craft in the form of the HL-20. In all cases, what SFO is proposing is not new, it builds on the knowledge and experience of the past. What SFO is doing that is new, is integrating all these components into a tight and cohesive plan of action with the emphasis on execution and commercial usage.

References

Exploring and Using the Space Environment. A Different Approach - Andrew W. V. Clark, Space Frontier Operations, Inc. – May 2000

SFO Space Exploration Plan – Space Frontier Operations – May 2001

The Problem of Space Travel, The Rocket Motor - Hermann Noordung (Herman Potocnik)

Collier's Space Program – Wernher von Braun

ISS: Continuing the Journey – Microgravity News, Spring 1998

Saturn V Genealogy – astronautix.com

Titan III Feasibility for HL-20 Prototype Missions – Journal of Spacecraft and Rockets, Vol 30, No. 5

The HL-20 as the Personnel Launch System – Sherilee F. Beam

21st Century Space Transportation System Design Approach: HL-20 Personnel Launch System - Journal of Spacecraft and Rockets, Vol 30, No. 5

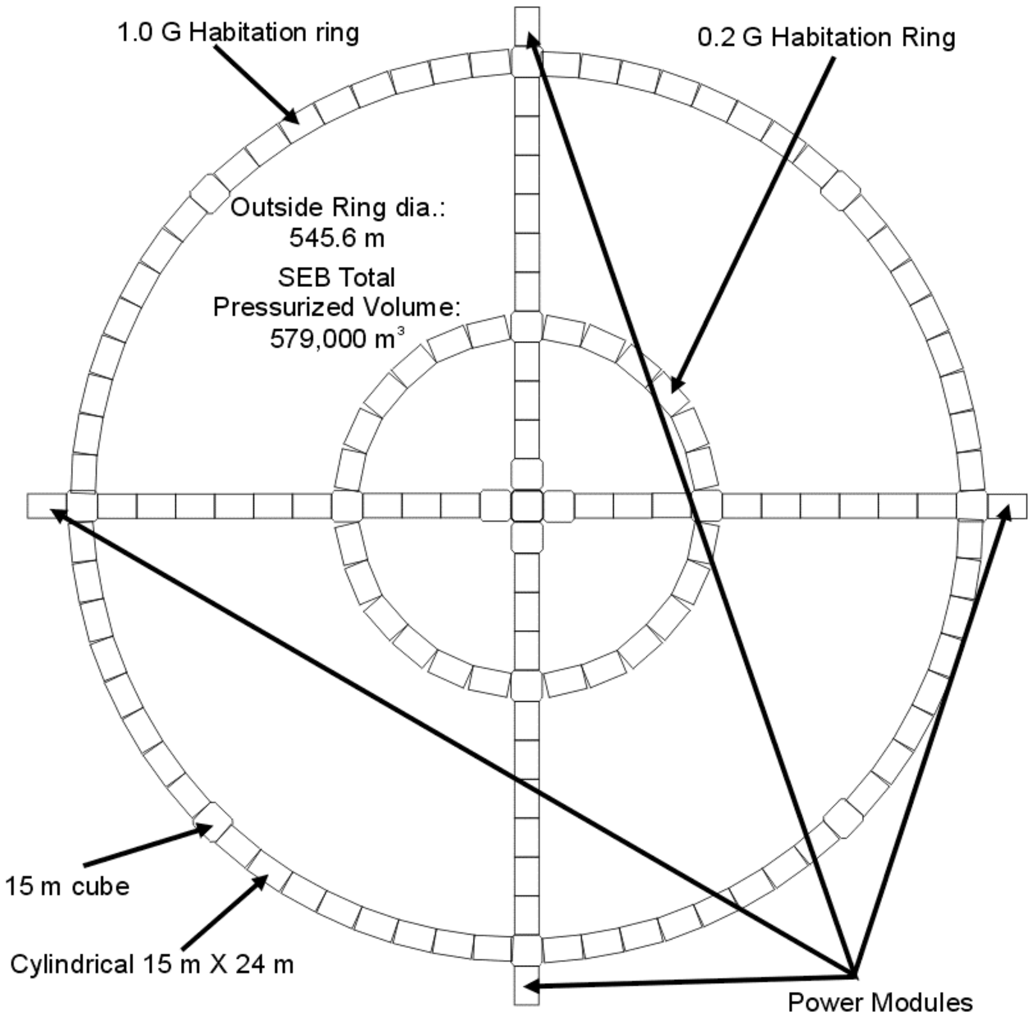

Figure 1. SEB at completion

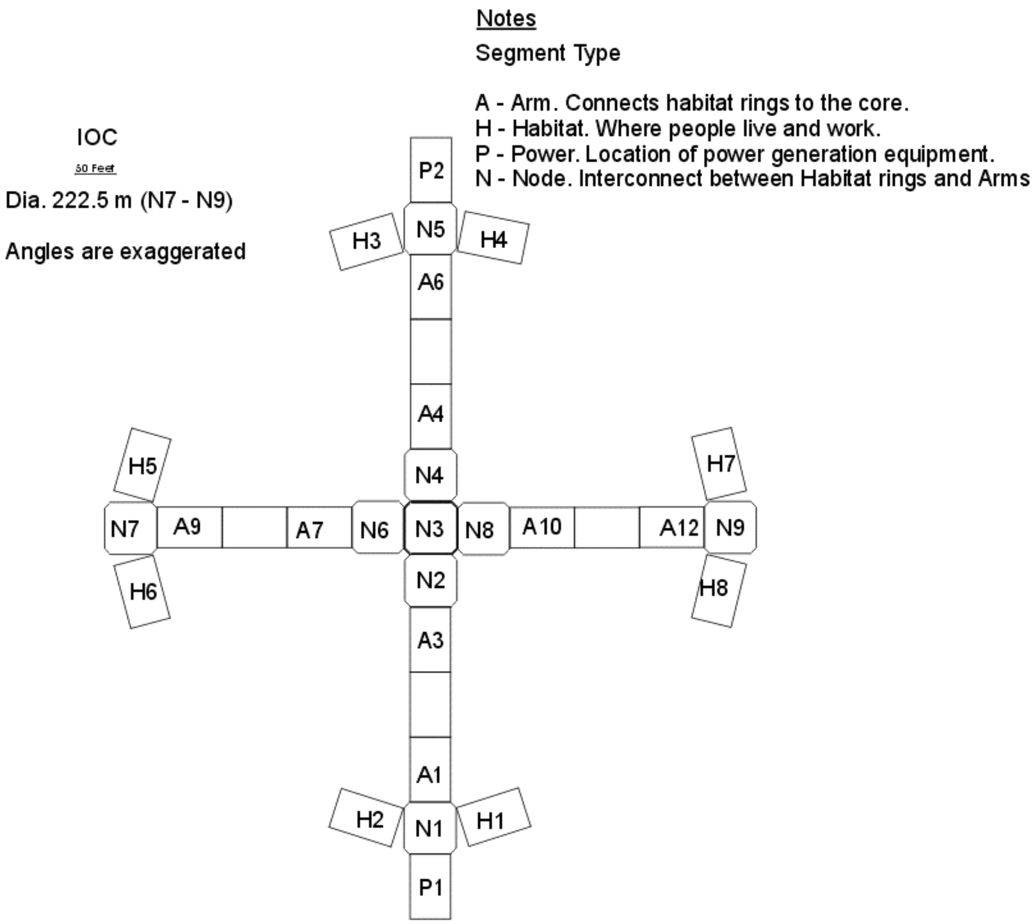

Figure 2. SEB at IOC

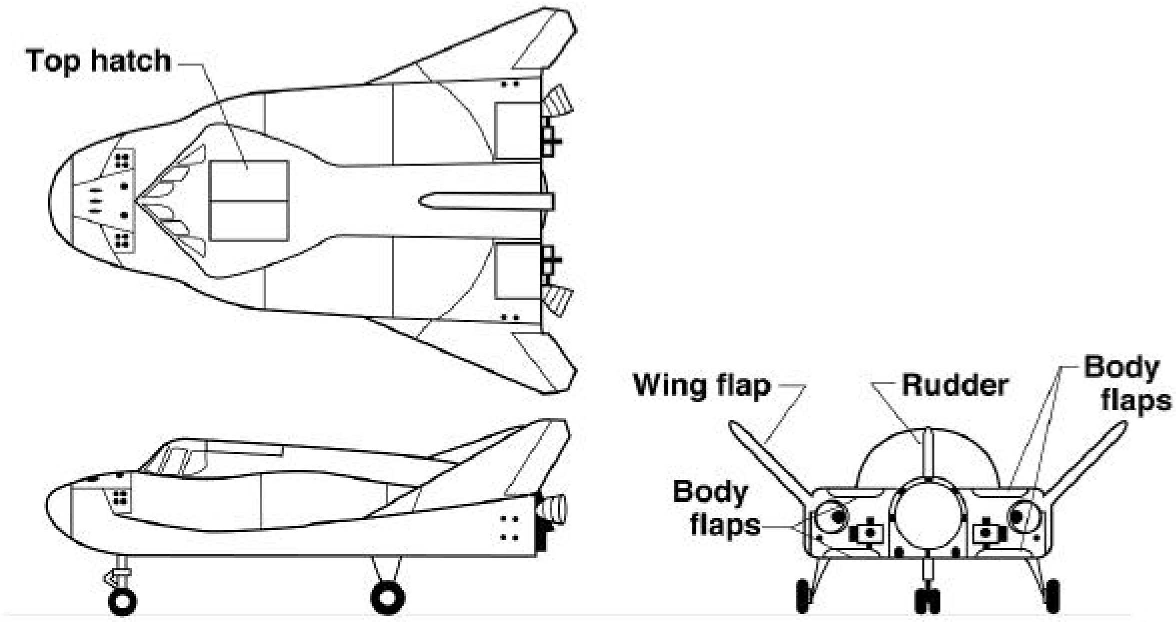

Figure 3
Dryden Flight Research Center February 1998
HL-20 3-view

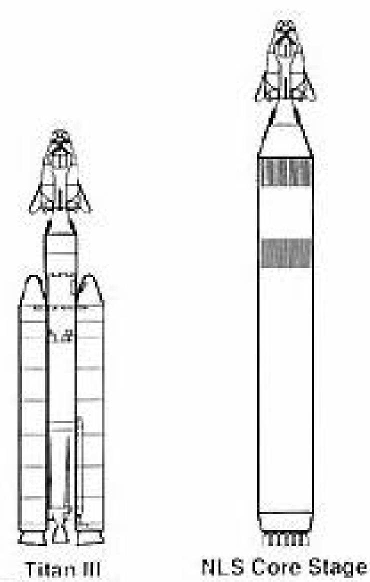

Figure 4. PLS Booster options

Parameter	SEB		Skylab	MIR	ISS
	IOC	Completion			
Orbital Altitude, (km)	1700	1700	435	387	407
Orbital Inclination, (Deg)	5	5	28	51.6	51.6
Pressurized Volume, (Cu. M)	121,000	597,000	91	90	409
Crew Complement	137	175	3	3	6
Iterant Users	150	300	0	3	0
Year	2012	2015	1973	1986	2000

Chart 1. Comparison of the SEB with other stations

Parameter	HLV	Saturn V	Shuttle	HEDS	UR 700M
GLOW, (kg)	4,700,000	3,038,500	2,029,633	2,187,000	16,000,000
Orbital Inclination, (Deg)	5	28	51.6	51.6	51.6
Payload to LEO, (kg)	170,000	118,000	12,500	100,000	750,000
Core Diameter, (m)	15	10.1	N/A	TBD	31
Orbital Altitude, (km)	1700	185	407	410	250

Chart 2. Comparison of the HLV to other rockets

Parameter	MV	HL-20	Orbiter	Hermes
Mass, (kg)	30,000	10,000	99,000	21,000
Launch Vehicle	HLV / Ariane V	Titan III / NLS	N/A	Ariane V
Crew	3	2	8-10	3
Payload				
Mass (kg)	4,500	545	12,500	3,000
Passengers	20	6	-	-

Chart 3. Comparison of the MV to other manned vehicles