The Ultimate Journey

Inflating Tourism to the Horizon of Space

by Peter Kung, Nicole Rodia, and Miguel Salas

The world of the future, as portrayed by science fiction novels and movies, often involves people inhabiting outer space or other planets. Popular movies, like *Star Wars, 2001: A Space Odyssey*, and award-winning books, like *Ender's Game*, give possible scenarios for the way civilization would expand beyond the earth's atmosphere. Maybe these scenarios are too far off in the future, but some of the ideas about space cultures and entertainment are possible within our lifetime.

Space Tourism Society writer, Rocky Persaud, presents the possible workings of zero-gravity sports. ParaBall, which stands for parabolic football, is a game with similar rules to American football, except that it is played in the gravity-free environment of space. Even more mind-blowing is the potential establishment of the Space Olympics after an entire space colony is in place.

There is no limit to what you can do in space. "You can lift a 500 lb block with one hand and move it around with one finger… You can fly and float around instead of walking… you can do somersaults at any age… and you can play with your food," according to space tourist Anousheh Ansari.

To add on to the space hype, don't forget about going into space with style. Janet Planet, fashion designer and member of the Space Tourism Society, proposes various styles of clothing for space travelers. Imagine humans lifting off into space with jumpsuits like those worn by the Storm Troopers in *Star Wars* or sporting extra protection sunglasses to shield themselves from stray floating objects.

All this can happen when actual trips to space are underway, and a habitation center is proven safe and secure. The dream begins with the development of the inflatable space module, an effort spearheaded by multimillionaire Robert T. Bigelow.

Owner of Las Vegas hotel chain Budget Suites of America and now of start-up company Bigelow Aerospace, Bigelow has already spent $75 million out of an estimated $500 million of his own funds to launch the most risky project in the industry: a family of inflatable spaceships that will jumpstart the space tourism market.

Bigelow's ambitious project has gained much attention after the successful launch of Genesis I, the first inflatable space module, in July 2006, from the ISC Kosmotras Space and Missile Complex in Russia. According to Jay Ingham, Bigelow Aerospace deputy program manager, not only did Genesis I inflate successfully, proving the feasibility of inflatable spacecraft, but it has been transmitting extensive data and images to Las Vegas' Mission Control Center.

At the end of this month, Bigelow's newest spacecraft, Genesis II, is scheduled to be launched. If suc-

Bigelow's great success: In July 2006, Genesis I is launched from Russia, setting the hopes high for inflatable modules.

cessful, it will be one step closer to making space tourism a reality.

Despite the recent commotion surrounding Bigelow's inflatable habitats, the idea of an inflatable spacecraft is by no means new. It has been considered by NASA since the early 1960s, and for good reason; inflatables have distinct advantages over traditional metal structures for use as orbiting habitats.

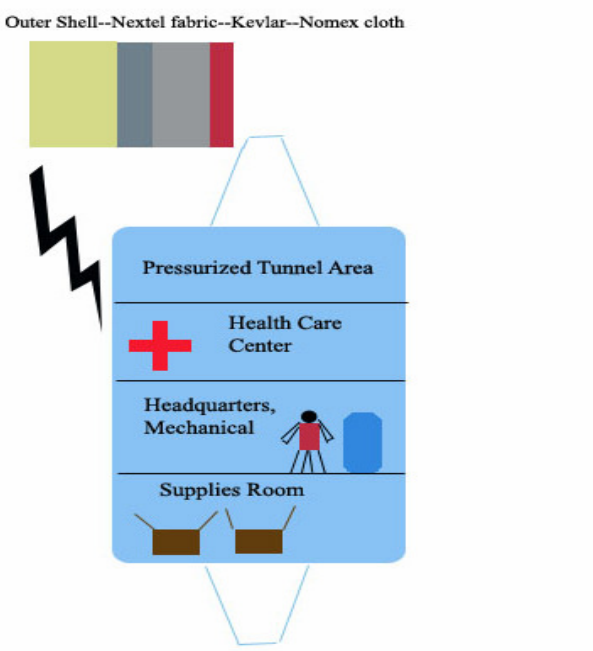
Particularly, a similarly sized inflatable module can be launched for considerably lower fuel costs than a rigid metal craft due to its high volume-to-mass ratio. Further, the need for on-site construction materials, such as those flown into orbit to assemble the International Space Station, would be virtually eliminated.

The technological advances necessary to make an inflatable payload successful, however, are a much more recent development. Essentially, the most recent inflatable space station design includes a metal or composite core and an inflatable shell. The core serves as the basis of the spacecraft during launch, and critical subsystems, including power and life support, are located there.

The shell functions as an impermeable bladder to contain the gas with which the spacecraft is inflated; the outer protective layer, or shell skin, protects the spacecraft from small meteorites and prevents any gas from escaping.

The shell skin is multi-layered and contains specialized materials, such as Kevlar synthetic fiber and Nextel ceramic fabric, to protect against impacts, shield from radiation, and control the inside temperature. When the module reaches orbit, it inflates with nitrogen gas, and the shell expands radially outward by six to ten feet to allow additional space for the crew and onboard equipment.

Though a high-tech inflatable space module has many advantages over a traditional structure, safety is still an important consideration. Any inflatable spacecraft is vulnerable to puncture or leakage, necessitating a monitoring system to ensure that any holes or leaks are immediately detected and repaired.



A conceptual diagram of an inhabitable space station, including everything you need to stay up there

Illustration by Peter Kung

Even after 40 years of space flight, fatal accidents, like that of the space shuttle Columbia in 2003, are still a grim part of the reality of manned space missions. In the US, there have been a total of 17 fatalities in only 732 people sent into space, an astronomical 2.3% fatality rate.

In order for space tourism to become a popular tourist endeavor, the safety of space flight must be substantially improved. Additionally, the effect of gravity-free environments and space-launching acceleration on humans must be evaluated.

In addition to safety, business trade-offs must be taken into account. "Increasing spacecraft reliability from 96% to 99% would be as expensive as the reliability increase from 80% to 96%" says David B. Sawaya, a graduate of the International Space University and an OECD magazine writer. This points to the fact that, though it may be possible to make space flights as reliable as airplane flights, the cost could be highly preventive.

If the price of a trip could be kept low enough, space tourism could prove to be highly profitable. A 1995 market study, supported by the National Space Laboratory, showed that about 60% of the population in the United States, Germany and Japan would be interested in paying up to $10,000 for a short space trip. The results of this survey indicate that the high demand for space travel could generate over $10 billion in revenue.

A more recent survey, conducted by the consulting firm Futron in 2002, shows that the demand for orbital space tourism has the potential to generate $700 million in net profits per year. Due to the current high cost of an orbital trip, this survey was targeted at American households with a net worth of over 1 million dollars.

Additionally, it showed that a price drop from $10 million to $1 million would result in a 14% increase in the respondents' willingness to pay for an orbital flight. Consequently, the space tourism

industry must balance affordability and safety to ensure continued consumer interest while optimizing profits.

But how will a space trip become economical and still safe? Although questions of this sort cannot yet be answered in the current state of the market, the private industry seems to be more successful without the aid of government funding and technology. Bigelow seeks to "[create] viable businesses in space that do not involve living off of phase I, II or III government grants or making hardware that only the government is going to own." Thus, private industry intervention may after all be the missing link critical to market growth.

Bigelow, using NASA's abandoned inflatable technology efforts that culminated with a design known as TransHab, has gathered the best engineers from companies such as Lockheed Martin to finish what NASA could not: successfully build and launch manned inflatable spacecraft.

Bigelow has made as strong start with the Genesis I module. According to the latest reports, the inflatable structure still remains "perfectly intact". The passively controlled internal air temperature ranges between 40 and 90 degrees Fahrenheit, and the battery capacity is maintaining well.

After seven months in orbit, the pressure inside the inflatable bladder has "maintained exceptionally well, achieving lower leak rates than […] tested on the ground." It is clear that inflatable technology has the potential for huge success.

Although Genesis I has suffered a few computer glitches, Bigelow's engineers managed to solve them successfully. Genesis I is only one-third the size of future modules, but nevertheless it is a pioneer in the new generation of private space vehicles.

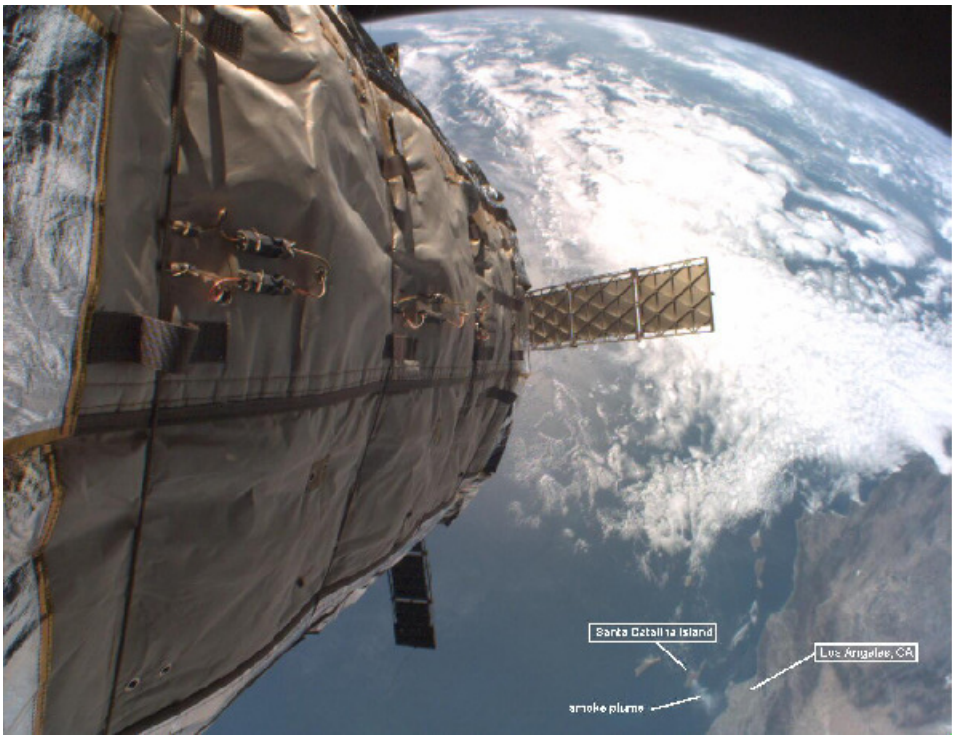
The next-in-line inflatable space module, Genesis II is not just a duplicate of Genesis I. Rather, it is an improved module with innovations such as enhanced vision capabilities and a multi-tank inflation system. Genesis II will have 22 cameras on-board for improved image gathering along with additional outer layers for shielding of micrometeoroid collisions, according to Eric Haakonstad, program manager of Bigelow Aerospace.

Furthermore, Genesis II has been equipped with additional pressure, temperature, and radiation detection sensors. Such an improvement is expected to help gather data on the impact of an artificial life system on small-scale biological organisms.

Nevertheless, Bigelow Aerospace inflatable spacecraft projects are far from finished after Genesis II. Bigelow expects to send from six to ten more inflatable modules culminating with a human-habitable module, named Nautilus, based on NASA's TransHab.

Galaxy, the next inflatable space module to be launched after Genesis II, is expected to "bridge the evolutionary development between the Genesis-Class vehicles [… the] first human-inhabitable module, Sundancer," according to Dan Cohen, program manager of Bigelow Aerospace. Galaxy will have a 45% larger usable volume than its Genesis predecessors, structural upgrades, and increased communication bandwidth.

The module will take into account human-factor considerations and is expected to serve as an element of the



While in orbit, Genesis I captures a smoke plume from the fire on Santa Catalina Island, off the Southern California coast. The built-in cameras of the module possess great resolution capabilities. The shot also shows the protective shell skin on Genesis I's exterior.

This size comparison between Bigelow Aerospace's future space modules shows that Genesis II is about one-third the size of the first planned human habitable one, Sundancer.

Environmental Control Life Support System, making it the great step towards manned inflatable spacecraft implementation. Galaxy design work will continue through the end of this year, with a scheduled launch of late 2008.

In addition to technological advancements, Bigelow's aspirations include business stimuli. An example of this is the "Fly Your Stuff" program along with the Genesis II launch. It allows the public to send small items into space inside Genesis II for $295 each. Customers will be allowed to see pictures of them in orbit online. Bigelow announced that it guarantees 100% money-back should Genesis II fail to successfully accomplish the task. Such a program targets potential future customers, a strategic move to further stimulate the young market.

The American Space Prize is another example of Bigelow's business incentives. The $50 million prize will go to the first privately funded spacecraft that can hold at least five passengers, be able to dock with one of Bigelow's inflatable space modules, and remain there for a total duration of six months by 2010. If such a spacecraft launches successfully, it is expected to stand as the vivid proof that orbital commercial manned flights are indeed possible.

The progress that Bigelow, along with his competitors, has achieved in making space tourism a commercial reality is very promising. Several improvements have been made from Genesis I to the still in-development Galaxy, with many more on the way. The steadfast progress of technology, along with the added ambition of Robert Bigelow and the zeal of many competing space programs is building a bridge between space science fiction and reality.

Bigelow Aerospace continually expands, hiring more engineers to find ways to lower production costs and maximum efficiency. With Bigelow's new and improved business plan to bolster the role of space travel in the economy, Bigelow Aerospace may be able to make a tremendous market impact and bring us ever closer to the reality of space tourism.

Should Bigelow's plan be successful, we should not be surprised to see manned commercial space flight as soon as 2015. The mission of Bigelow Aerospace, "[to] develop an affordable and flexible space complex architecture that can be adapted for any manned or unmanned mission" may some day fulfill the dream of many generations, and perhaps yours, too: a ticket to outer space.