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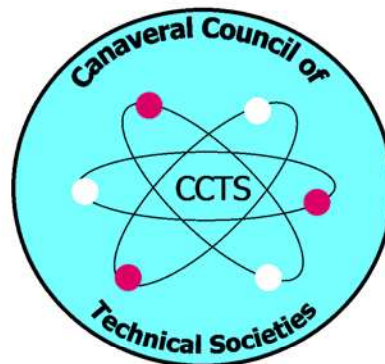
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TECHNICAL PAPER

SESSION IA

“NEW SPACE: A REVIEW”

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SPACE VISIONS CONGRESS 2007

NEWSPACE – A Review

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NewSpace.

America's manned exploration of this our solar system ended with the grounding and storage of that resolute running back Saturn V. But the sense that it had really ended didn't occur until Skylab plunged to its fiery end in Earth's atmosphere. The much promised Space Shuttle was unable to launch in time to save it. The greatest losses were the opportunities that would have allowed mankind to press into deep space and eventually begin colonizing our solar system. Only after Shuttle began operations did American astronauts frequent space again. But the U.S. Space Policy of July 14, 1984 let not latitude and they were confined to Earth orbit.

Since then support for the U.S. space program has dwindled to smaller and smaller percentages. But within the past decade, a growing fraction of mankind has stopped waiting for someone else to provide them with their opportunity to be a part of a spacefaring human race. They have formed over 40 privately financed space programs and space activist organizations in the U.S. alone for the purpose of commercially developing space. This commercial and private space development has been called by several names, but lately the term NewSpace seems to have stuck and those involved are forging on with great determination to turn a profit in the utilization of the resources of this our solar system. During the next five years the effects of NewSpace will begin to be fully felt.

The attraction of NewSpace is that almost anyone has a chance of becoming involved in it. They can obtain roles through membership, sponsorship, donations, financing, in more and more instances employment and, soon, as tourists. Many of these organizations have an automatic e-mail service that keeps members or anyone interested abreast of their latest developments.

NewSpace participants come from all walks of life. Many are former astronauts, retired aerospace executives, and retired aerospace military officers. Some are from other nations. Many are found at Star Trek and Science Fiction conventions. One owns a hotel chain, another a series of machine shops. There are, engineers, technicians, a retired Hollywood stunt man, and thousands who, as members/investors/sponsors just want to be associated with the idea of going to space.

These privately financed man-in-space alternatives can be divided into seven broad categories:

1. Private and Commercial Launch Service Providers
2. Space Activists
3. Space Tour Guides
4. Astronaut Training
5. Spacesuits
6. Space Lawgivers
7. Amateur Rocketeers

Activists

The activists believe that:

- Humanity must become permanently established in space with regular access to space [1].
- “All of humanity has the ‘right stuff’ and everyone will benefit from opening the space frontier.” [2]
- Space is a PLACE, not a government contract and it is, in fact, the new frontier and it can no longer be the exclusive domain of the government.[3]

The Activists work constantly to these ends, for they also hold yearly treks to congress to lobby for and against the government’s policies and decisions that may or may not advance their goals. Some hold yearly conferences where NewSpace companies, other interested parties and the government are invited to attend and keep each other abreast of what they’re doing. [4,5]

Space activist organizations have chapters around the world.

Private and Commercial Launch Service Providers

This group includes providers of launch vehicles, services and a multitude of other entrepreneurial companies working on complete infrastructures to put mankind in big working space stations that are tended by orbital maneuvering vehicles and supplied by upgraded shuttles [6, 7]. Some are working on pieces of the spacefaring pie, such as solving the technical difficulties for colonizing mars [8], colonizing the moon [9,10], and preparing to mine those bodies as well as asteroids [11, 12]. There are single-stage to orbit launch vehicles, sounding rockets, rocketplanes, jets carrying and towing rockets to optimum launch altitudes [13, 14] and extensive construction in providing four-minute flights to space for thousands of us as tourists.

Many plan to launch in the U.S., but some have and are launching onboard Russian, Chinese, or French launch vehicles because the cost and the difficulties are fewer.

Space Tour Guides

Space Adventures, Inc., [15] advertises itself as the “world’s premier space tourism company.” A reasonable claim as they assisted with Dennis Tito’s flight to the International Space Station in April of 2001, followed by Mark Shuttleworth and more. A few of their other offerings are:

- Circumlunar Spaceflights (\$100 m)
- Orbital Spaceflights (\$20-25 m)
- EVA (\$15 m)
- Suborbital Spaceflights (\$102,000)
- Cosmonaut training
- Space shuttle and *Soyuz* launch tours

Currently, Space Adventures is taking reservations for suborbital flights onboard its own spacecraft, the C-21, undergoing development. They predict that flights will occur within the next two years or so.

Astronaut Training

Some companies such as Virgin Galactic have already begun a program to train their own astronaut pilots. Others haven’t included it into their budgets, because they have not yet decided how to handle it. Currently, there is only one startup company dedicating its business to train astronauts for NewSpace, and that is Orbital Commerce Project [16]. OCP plans to construct a training facility that will be based upon a military style regimen, where distractions will be minimized to facilitate efficient learning. Training will be a balance between physical and mental components. Initial course offerings will be for Suborbital Pilot and Payload Specialist. Course curricula will consist of classroom, simulator, and flight time.

Spacesuits

Orbital Outfitters is a California-based corporation manufacturing industrial quality spacesuits and related services for commercial and government space travelers and explorers. The first suit under development by OO is a basic pressure suit. Its primary function is to provide a line of protection in the event of a loss of atmospheric pressure within a vehicle. It will be manufactured to operate at an altitude of 500,000 feet (92 miles) for 30 minutes. [17]

Amateurs

There are hundreds of Rocketeers across the U.S. Most notable is the Civilian Space eXploration Team. On May 17, 2004, Ky Michaelson launched their 21-foot *GoFast* from Nevada's Black Rock desert. Without much ado, it quickly reached an altitude of 60 miles. That officially placed the *GoFast* at the edge of space. A first for amateur rocketeers and a success that places them in among the best traditions of Robert H. Goddard. [18] With each success, these amateurs are pursuing goals to eventually orbit tiny payloads [19]. And in Brevard County there is the Spaceport Rocket Association. [20]

Space Law Givers

Currently the United Societies in Space (USIS) is the only one of these. [21] They believe that the lack of property laws and an outer space government infrastructure hinder the development of Man in Space. USIS has been working toward supplying means and methods to fill this void. Current space treaties don't address the everyday laws in space that correspond to what we live under on this planet. Consequently, USIS has written a space constitution that takes a major step in that direction.

Where is the Money coming From?

On February 1601, the first fleet of four East India ships left England for the East Indies to make fortunes or lose everything for their investors. They returned in September 1603, two-and-a-half years later with full cargo holds. [22] While the fleet was on that dangerous voyage, subscribers had plenty of reasons to worry about their investment. Clearly, they had to be financially independent or needed some other source of income to survive during the chancy expedition. Not just the passage itself but after, for profit from the voyage was first paid out as dividends over a period of years.

To ensure that the first voyage provided a profit, the commander of the fleet, James Lancaster, cheated—or was typically English. He forcefully overpowered and took a fully laden Portuguese cargo ship to ensure a profit for the subscribers. Even so, it wasn't until the third voyage that profit was sufficiently high to generate excitement among potential investors.

The history of the beginnings of the East India Company certainly has good and bad lessons that can be applicable to the commercialization and utilization of this our solar system.

Startup Space companies have as much difficulty in raising their initial capital as any other business venture, because the questions investors ask are usually the same. The key question is “Who are the members of your management team?” It can be summed up in the words “People, people, people”[23]. The investor must have confidence in managers with who will push the company through the required milestones to its ultimate goal. Specifically, people with good track records as innovators and having the required technical skills or business expertise. Both qualities must be involved in determining ways to make money. Good teams will determine how to make money even if their first plan falls through.

NewSpace startups have a problem with engineers being managers. It would help “if everyone thinking of building a start-up space company would put down the engineering books and pick up a few management books.” [24] More MBAs than engineers are needed. The most talented and gifted engineer may not be able to make a business work. Effective management can be deceiving in the simplicity of its goals.

Those who raise the money for the venture cannot run the business and those who are running the business shouldn't be raising the capital. Gary Hudson once lamented that he spent so much time trying to raise money, that he had no time for involvement in developing his Roton Rocket. [25] Raising money requires a salesman and it is a full time job. The salesman must have some of the qualities of an Elmer Gantry in presenting the company's goals to potential investors—and a good Business Plan.

“Capital should not be spent to raise capital. This is part of Business Entrepreneurship 101.” [26] A lavish and expensive gathering that includes feeding attendees to convince them to part with venture capital is something that more suits political fundraising. A wise potential investor will question how much of his investment would be spent on a lavish “show and tell” instead of going right into the project.

A NewSpace startup company “must play it [the commercial space game] and keep losses down. You must have adequate resources to stay in the “game”. The longer you stay in the game the more likely you are to reach the point where luck comes into play. Your message will have reached the right investors and your project will have a better than even chance of succeeding. [26]

Investors will want to know who your customers are or will be and what they're willing to pay for your services or product. If

you have one customer, you're likely to have problems.

The last question investors ask is “What kind of rocket is it?” In this regard, if you have some cash and can begin to build your rocket with demonstrable results, then you are ahead of the game. You have demonstrated to potential investors that you have “skin” in the game, and people are more willing to invest in your venture.

Investors

Before there are investors, there must be development capital. And investors may be required before there is development capital. Catch 22? Not really. A matter of hard work and hawking the start-up's goals, visions, assets, and a solid Business Plan.

The Business Plan or big picture should come from the team. Some start-up companies have been unable to develop a good Business Plan because they may basically know what they want to do, but are unable to chart a direct course to achieve their final goals. Goals that may be too encompassing.

Investors like being part of any well-publicized financial effort. Some put up money for reasons similar to those who invest in expeditions to find lost Spanish Galleons. They invest a lot or as little money as possible just so they can say they are an investor.

Until NASA's Commercial Orbital Transportation System(COTS) award, most significant NewSpace financing had been from Space Angels. These are wealthy entrepreneurs. Elon Musk, John Bigelow, and John Carmack and so on, willing to take a big risk. It has been incumbent on them that they show by their investments and results how they made a small fortune into a big one instead of vice versa. Elon Musk has begun at SpaceX and is ready to fly his first payload on Falcon 1 at a cost of around \$5.9 million. His Falcon 5 was to orbit payloads for about

\$15.9 million, but he has cancelled it and jumped to his Falcon 9. It is a certainty that his charges that will cut into Delta II's \$50 million dollar cost. [27]

Since the success of Burt Rutan's SpaceShip One, SpaceX and the COTS award, investors have become more interested in listening to pitches from NewSpace start-up ventures. Though they have not yet materialized in the numbers one would expect. Interestingly, more money appears available outside than inside the U.S., for commercial space projects. [28]

Sponsors and investors currently range from beef jerky vendors to numerous individuals investing major dollars. Wealthy investors appear to be on the increase.

Venture Capitalists invest tens of millions of dollars, and they expect returns much more quickly than most investors do. The returns they expect are in the one-billion-dollar-a-year category in a relatively short term, because VCs are spending other people's money and relative few of their ventures really takeoff.

Are investors more willing to take a big chance today than in the past? Many believe that the first trillionaires will be made in NewSpace's private/commercial space industry. That's a tempting claim for any entrepreneur. While the costs of development are great, so are the returns. The risk taken by the East India Company's subscribers was enormous. Wooden sailing ships were sailing thousands of miles without so much as a flashlight to help find their way in the dark. And the number of them lost at sea is staggering. Yet, they met in London in 1599 to raise their money for the "voiage to the East Indies." They subscribed 30,133 pounds, 6 shillings, 8 pence. At the time, this was a very considerable sum of money. Of the 218 investors, some gave as much as 3,000 pounds and some as little as 100 pounds. The majority of the subscribers contributed 200 pounds. Only one gave change: John Hewitt,

333 pounds and 6 shillings, 8 pence. A subscriber's money went into the "voiage" not the company. So subscribers to one voyage could loose his money while subscribers to another could realize huge profits. It would take awhile for this to change. [29]

Insufficient funding in a start-up has fallout effects. Gary Hudson of t/Space points out that without sufficient funding "it becomes vastly more difficult to hire the people to get the job done. One must then hire the 'enthusiasts' in place of proven performers, and that leads to no end of problems." It is possible to occasionally get an enthusiast that is also competent, but it is rare." When a start-up has the money to hire the right people, they have already waited six months and longer before offering the first engineering job. [30]

Risk and investment go hand in hand and anyone adverse to either should keep both hands in their pockets.

Advent Launch Services financing was very revealing. Their goal was 200 subscribers. Their customer base was to be space tourism. They collected \$341,000 from 62 people who paid up to \$5,500 for a ride on their Mayflower rocket. They also collected \$12,000 in membership dues. When they realized there wouldn't be enough money to start their program they refunded everything.

On the second try, Advent became an employee-owned corporation of approximately 100 people. Most of who worked without pay. Team members and contributors owned Advent in proportion to their contributions in labor and time.

Jim Akkerman has never stopped and NASA is currently testing Advent's oxygen/methane rocket engine to qualify its rocket engine test stand with the goal of developing its own such engine

Once the money hurdle has been resolved—for the time being—start-ups can't afford to miss another key step in their goals.

And it is, who will their customers be? Any startup NewSpace company must temper its vision of success early with the clear understanding of the type of customers they will want to attract.

Examples are Pat Bahn's TGV. It is looking at the sale of suborbital photographs of Earth on a near real-time basis. SpaceDev will send micro-and nano-satellites into deep space. [31] Lone Star Space is working toward same-day worldwide package delivery with suborbital rockets. [32] By far, the biggest customer base appears to be that of space tourists. It isn't unrealistic at this time to believe that there are thousands of people worldwide waiting for the opportunity to travel to suborbital space if only for a few minutes. Many of these potential customers are willing to pay \$100-\$200 thousand for the experience and are putting up the full amount or deposits to reserve their seats. The number of customers is quickly approaching the 1,000 mark.

Obtaining enough funds to maintain a cash flow until the business can show the necessary profit to continue its business, is how to succeed. It is clear that not only not having enough money is a problem but "more importantly, not knowing if there is money for the next month or the next six months or the next year."

Off-the-Shelf Technology

Off-the-shelf should be a plus to investors.

NewSpace keeps its programs as cheap as is reasonably and safely possible. Scaled Composites essentially set the pace in this regard. Excessive reliance on exotic and cutting edge technology implies or should imply unnecessary costs. It also implies an iffy situation as to whether or not it will work as advertised and if it will be available when needed.

Simple and cheap is not what the American space program has been all about.

In NewSpace companies, simple and cheap means using off-the-shelf, a term that is misleading, for it too often implies materials and ideas that are old and obsolete. This is not what it appears. Technology from the 1970's or 1980's imply that it may be too old but it is not obsolete if you need something you know will work every time. Materials and ideas become off-the-shelf when they are cheap and can be used reliably at any time on a day-to-day basis. And much that is off-the-shelf is being constantly replaced or updated with the next technology as it proves its reliability and its cost lowers.

TGV is using off-the-shelf technology and off-the-shelf components from major suppliers as much as is possible. In regards to needed parts that a supplier doesn't have, they will determine if the part is within the suppliers design envelope. If they are confident that the supplier can actually reengineer the item then the request will go in.

Technology that will some day replace off-the-shelf or state-of-the art is being R&D'ed at this moment.

Liability

NewSpace companies flying passengers require two kinds of liability. The first is liability insurance against claims made by those participants, and the other is third-party insurance mandated by federal law. The latter type of insurance covers the maximum probable loss (MPL) to uninjured parties or worst case scenario. This requirement comes from the space treaties [33] signed by the various world governments. The cost of liability insurance is mitigated through the use of horizontal takeoffs and landings and sea launches. The sea launches being the least expensive. Activists and space companies are pushing American legislators to revisit the cost of existing U.S. liability laws on the matter.

A variety of insurance is available from brokers.

- Pre-launch insurance that protects the spacecraft against loss or damage while it is in transit or in storage.
- Insurance that will cover the spacecraft in-orbit and during its operational life.
- Political risk insurance that could cover a loss if a government bars execution of some requirement needed for launch operation or launch.

The Associate Administrator for Commercial Space Transportation (FAA/AST) has a complex set of formulae worked out to determine the Maximum Probable Loss (MPL) insurance liability. It determines the requirement when it issues a license or permit. Two examples of space company MPLs are Scaled Composites' MPL liability: \$3.1 million and Interorbital's Tachyon MPL: \$250,000. All assigned MPLs are routinely reassessed by the AST. Insurance tends to be available and not unduly expensive: John Carmack of Armadillo Aerospace said he obtained a policy that covers unlimited launches for one year with \$3 million in coverage for \$50,000. [34]

An interesting answer to mitigating liability suits is in a law recently passed by the Virginia legislature that doesn't allow lawsuits if space tourists are killed in a spaceship accident. The requirements are that the participant understands and attests to the fact that going to space is a totally dangerous venture and he/she undergoes considerable personal risk. [35]

The Next Stop

The desire for profit in NewSpace is no longer limited just because a startup company is too small to tackle larger projects. Many start-ups have begun to determine who holds what expertise and have formed larger

ventures that will improve their capabilities, financial position, and business clout for bigger things. Transformational Space (t/Space) is just one of these. It consists of six partners and obtained its first contract from NASA's from which it advised the agency on the best architecture for Moon-Mars exploration and the best initial design for the Crew Exploration Vehicle (CEV). [36]

Rocketplane and Kistler Aerospace formed the company Rocketplane Kistler (RPK) to bid on NASA's Commercial Orbital Transportation System (COTS). RPK was awarded \$446 million.

A Last Word

Government is acknowledged to be one of the world's most unreliable customers. As pointed out by Christ Carberry in "2009: A Space Vision", [37] President Bush's Vision for Space Exploration (VSE) for NASA has, unfortunately, taken on its own role in the politics. Support for the vision depends on whether or not some people know it's his idea. In which case, it becomes a fair question to ask if the VSE will survive Bush's presidency. If it doesn't, then, unabashedly, the American man-in-space program will pass increasingly into the hands of NewSpace. Some will fail because of the lack of funding, but many will continue. And new start-ups continue to appear in the U.S. and around the world with increasing tenacity.

How is success measured in NewSpace? Like any business, success can mean that you are receiving a profit on your investment and your company has business that extends into a future that portends expansion. For any visionary, however, success doesn't stop at profit—or loss. Commercial space development is a business, but if you scratch the visionaries involved, you will find, besides the profit motive, a wide deep vein of an overwhelming desire for spacefaring.

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