The Lurio Report

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April 30 SpaceX Target Date, Suborbital Researchers Meet - Part I: Announcements, Opportunities, Comparisons

Vol. 7, No. 4, March 30, 2012

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- Space Frontier Foundation -

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-- Christopher Stott, Chairman & C.E.O., ManSat LLC, <www.spaceisle.com>

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Conference Note

Space Access 2012: The Space Access Society's annual meeting, an incubator of innovation in the technology, business and politics of radically lower cost space transportation, takes place Thursday April 12 through Saturday April 14 in Phoenix, Arizona, at the Grace Inn.

Please note that this year the meeting starts _*Thursday morning*_ instead of in the afternoon; as usual it will run through Saturday evening. Information on registration for the conference and room reservations as well as the present agenda is available here.

I will be away for the meeting - but should be reachable by phone or _*occasionally*_ by email - from Wednesday April 11 through Sunday April 15.

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Quick Updates:

SpaceX Launch Date, Flight With Upgraded Merlins: The crowd that lives off of NASA pork or is psychologically trapped in the "moon-race '60's" is pushing the ludicrous notion that the forthcoming _*test flight*_ of Falcon 9/Dragon to the International Space Station (ISS) should be a "do all or die" exam for the commercial space sector's ability to provide access to the station.

Meanwhile, the rest of us can wish SpaceX the greatest possible success for the flight, now set for an initial launch attempt at 12:22 p.m. EDT on April 30. As I've said previously, its objectives combine those of two originally separate test flights. The Dragon must complete the first one's set of objectives before proceeding to the second's, which includes a "berthing" at the ISS; that is, a docking when a station remote manipulator arm is used to control the final meters of approach.

Clark Lindsey of spacetransportnews.com relayed several of Jeff Foust's twitters from an early March meeting in DC. **There, SpaceX President Gwynne Shotwell stated that if the launch comes off on the 30th, the nominal berthing date will be May 3. She also mentioned that launch opportunities come only every three days and are virtually instantaneous.** As I stated in Vol. 7, No. 1 (January 9, 2012), "For any surface-based site, potential launch "windows" to the ISS are also restricted to when its orbit is (essentially) passing overhead."

This report notes that the more powerful "Merlin 1D" engines are scheduled to first fly in early 2013 on a Falcon 9 launched from the company's pad at Vandenberg AFB. They will allow greater payloads to be put into geosynchronous transfer orbit for the critical comsat market.

- Press Announcements at the Next-Generation Suborbital Researchers Conference -

Several press releases were issued on February 27, the first day of the Next-Generation Suborbital Researchers Conference (NSRC), in conjunction with a media lunch/press conference. Among the announcements -

XCOR Raises Funds, Expands Payload Network:
Raising New Equity - **Despite the continuing economic doldrums, XCOR Aerospace was able to announce the closing of a new, $5 million round of equity funding.**

In the release, company COO Andrew Nelson called the result "a vote of trust and confidence in the markets represented by NSRC participants," while founder and CEO Jeff Greason attributed it to the company's, "demonstrated compelling value," concluding that, "Our $60-plus Million backlog of orders for Lynx suborbital vehicles, flights on Lynx, and our unique reusable non-toxic rocket engines give the investor community reason to take notice."

The funding came from both previous and new investors, among them, "Esther Dyson, Pete Ricketts (co-owner of the Chicago Cubs) and several top Silicon Valley entrepreneurs and former venture capitalists." The release also outlined several "reformulat[ions]" in the membership of the firm's Board of Directors.

Expanding Payload Integrator Network - At the 2011 NSRC in Florida, XCOR had announced the formation of a world-wide network of payload integrators for the Lynx (Vol. 6, No. 4, March 21, 2011).

To the previous total they have now added three more: EMXYS of Spain, Texas A&M's Space Engineering Research Center, and the Planetary Science Institute. **Nelson told me later that more are expected to be announced in the near future.** As well as working with experimenters to ensure that their payloads meet Lynx requirements, the Integrators will sell suborbital research flights and, "assist in creating standardization in research hardware for the suborbital market."

Two SwRI Flights During Lynx Test Program - As reported here a year ago (Vol. 6, No. 4, March 21, 2011) the Southwest Research Institute (SwRI) had purchased six flights on the Mark I Lynx, with options for three more.

Dr. Alan Stern of SwRI announced that potentially two of those flights have now been "moved up" and will take place during the flight test program for the vehicle. Thus they may occur during a "Permitted" phase of work, during which no flight payments are allowed. However, XCOR declined comment on their financial arrangements with SwRI.

Virgin to Work With NanoRacks, LLC on Suborbital Research Flights: William Pomerantz, VP for Special Projects at Virgin Galactic, announced that the company had selected NanoRacks LLC to construct a rack system for experimental payloads on SpaceShipTwo (SS2). These will use the standard rack mounting system of the International Space Station (ISS).

NanoRacks has enormous experience working with such requirements (Vol. 6, No. 10, June 28, 2011). They presently have two "NanoLab Platforms" on the ISS (mounted in standard racks) that can each accommodate up to 16 individual cubesat ("1U") sized experiments, or larger ones taking up more "cubes." Last year EADS/Astrium announced that a "4U" slot will be taken up by a mini-centrifuge for biological experiments, originally built for the Shuttle; this was handed over to NanoRacks on February 15, 2012. Company Managing Director Jeffrey Manber told me that it is presently "being worked on[to] the manifest" to go up to the ISS. The company has also been building up a suite of on-board instrumentation to aid experimenters, with two microscopes there now and a "Plate Reader" (for detecting changes in small experiment containers) scheduled for installation by the fourth quarter of the year.

I asked Manber whether NanoRacks might also act as a "payload integrator" for Galactic, analogous to the participants in XCOR's network. **He responded that the firms are in discussions on, "a number of different ways to work together. It's a good match of strengths and interests."**

Mojave Air and Space Port Seeking to Keep Industry in California: Even for those of us outside of California, its increasing hostility to business over several decades has become emblematic of a great and iconic state slowly destroying itself. Businesses, the jobs and revenue they create as well as the workers they employ have been leaving in droves.

Stuart Witt, CEO of the East Kern Airport District and manager of the Mojave Air and Space Port, has been attempting to make representatives in the state capital of Sacramento aware that the emerging commercial space industry could become yet another victim of the state's rating as the "least business-friendly" one in the nation. The human resources and aerospace heritage of California have so far kept it a leading nexus for the development of the new industry - but if past trends continue that's unlikely to last.

In a statement released during the NSRC, Mr. Witt called upon State representatives and Governor Brown to take steps to help prevent that. Suggestions include limited liability legislation for the industry (as already passed by several other states), "Zero-g, Zero-tax zones" to incentivize investment in it, aerospace job creation tax credits and taxpayer financing of industry-related infrastructure.

Virgin Galactic, XCOR and Scaled Composites are among the firms that have joined Mr. Witt's efforts.

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Dear Acquaintances,

- Part I on "Next-Generation Suborbital Researchers Conference" (NSRC-2012) -

Expanding Interest in Suborbital Research

Reports from last year's NSRC in Florida had been so positive that I made a point to attend this year. It was held February 27-29 in Palo Alto, California in the "Silicon Valley" region not far from San Jose and the NASA Ames Research Center.

This issue of "The Lurio Report" covers "Part I" of a two-part report on the meeting.

If anything, the energy and excitement that imbued the event exceeded my expectations. My congratulations to Dr. Alan Stern and his colleagues at the Southwest Research Institute (SwRI) for organizing it. There were some 400 registrants, at least twice the attendance at the first such meeting two years ago.

At least two factors "supercharged" this conference: first, an expanding contingent of those in the scientific community who see that the reusable suborbitals will be a significant new research tool (acquisition of these "early adopters" is due in no small part to Dr. Stern's own energetic efforts); second, the first high altitude flights of these vehicles are due over the coming year or so. We are now not merely hearing hopes, but variously seeing the final acquisition and assembly of hardware, the refinement and trouble-shooting of systems, and the accumulation of flight tests.

Dr. Stern remarked at the NSRC's close that two years ago it was something of a "renegade" meeting, but that it is now becoming mainstream. Unlike past space vehicles, availability of the suborbital Reusable Launch Vehicles (sRLVs) will not be limited by Congressional dollars or by costs and timelines padded with pork, but by how fast providers can acquire revenue. **He concluded that the "research and education mission" market can now stand shoulder-to-shoulder with "space tourism."**

The next NSRC will be held in June of 2013 in Colorado at a site soon to be determined. The change from February was in order to ease scheduling for academics and students, but by then, also, several different vehicles may have accumulated significant numbers of flights.

Radio Appearances - Just after the meeting I had the opportunity to speak about the NSRC on the nationally syndicated "John Batchelor" radio program, during the regular "Hotel Mars" segment hosted with Dr. David Livingston of "The Space Show." People tell me that the energy of the conference came through in my voice. You can test that observation for yourself in this clip of the segment, posted on David's website.

A couple of weeks later, XCOR COO Andrew Nelson discussed that company's perspective on the same segment of the Batchelor show.

A Professor Speaks, the X-15 Precedent and Today's Difference

One of the treats of the meeting was the talk on the first day by "Prof. Neil Armstrong (Retired)" entitled "Reflections on the X15 and Early Suborbital Flights." Readers may recall that I discussed the X-15's pioneering role in suborbital flight in Vol. 6, No. 3 (February 28, 2011), largely based upon a talk by former pilot Joe Engle.

Armstrong noted that development of the X-15 had begun in 1954, and that he was recruited into the effort the following year. Ultimately he flew it it to over 39 miles (about 206,000 ft.) altitude. He put the vehicle in the context of the post-WWII series of "X-planes" that examined the transonic realm and above because wind tunnels were unreliable at those speeds. Those craft taught lessons that were directly applied to breakthrough fighter jets.

Last year I noted that, "the X-15 was fundamentally intended as a multi-purpose research vehicle for hypersonic flight itself. Using it as a suborbital platform for research instruments was a secondary benefit..." Armstrong said that it was originally intended to fly fast but not necessarily too high. But it became obvious that as well as flying (literally) "hot" for long periods at relatively low altitude, it could also fly very high indeed and be a suborbital research platform.

A key derivative of the Professor's comments is that the new sRLVs have attributes that allow them to be far less costly and more practical than the X-15. For one thing, "going for altitude" is their starting design goal. There have also been huge advances in technologies such as materials and flight control systems. Unlike the X-15, the new systems don't have to use a high density Inconel metal alloy for heat resistance. If they land horizontally, they don't have so little lift as to require ultra-high touchdown speeds.

One topic that was evidently avoided during Armstrong's appearance was the Moon - though plenty of people rushed up to get his autograph after the session. More than one person told me later that he almost never talks about the Lunar landing publicly, because he considers himself to have been a 'mere' test pilot. For four decades he's been something of the

"Cincinnatus of Space," having metaphorically retired to his plow after performing his duty, like the legendary Roman general.

Yet as Dr. Stern noted, Armstrong had cancelled overseas travel plans to appear at the NSRC.

It's unfortunate that over the last couple of years Armstrong has been recruited to testify on the Hill against NASA reforms and the other changes in how we perform spaceflight - changes required for an affordable and sustainable human return to the Moon and to go beyond. **But his appearance in Palo Alto testified to his interest in reviving the promise of suborbital flight.**

Research Topics, Flight Training and Payload Accommodations

With few exceptions (such as the opening and closing plenary gatherings) there were three parallel sessions going on during the NSRC, and more than one on each of a range of topics. My primary focus was on better understanding the possible research gains from using the new vehicles. I feel that such a survey is the most useful metric for gauging the potential research market until the vehicles and experiments start to fly regularly.

The breadth of areas of where research may gain was shown during sessions on "Atmospheric, Ionospheric, and Aeronomical [upper atmosphere] Sciences," "Life Sciences," "Microgravity Sciences," "Planetary Science" and "Astrophysics and Solar Physics."

There were also presentations with themes of, "Markets, Policy and Other," "Public Outreach" and "Media and Suborbital Flight." Others sessions included, "Preparing a Suborbital Research Project: Lessons from Parabolic Flight" or the development of "Flight Training" procedures. The "... Lessons from Parabolic Flight" category reflected a more expansive concept of mapping insights from other experience to using the suborbitals. So it also drew from working with "traditional" sounding rockets, high altitude aircraft, and so on.

Dr. Stern pointed out that to efficiently use available time, potential researchers on the sRLVs must be physically prepared, plan carefully, develop checklists and practice repeatedly. They should take into account executing motions under varied g forces, and possible distractions such as sunlight streaming in at changing angles.

Dr. Stern and Dr. Dan Durda (also of SwRI) have tested out a "contingency" pressure suit (developed by the David Clark Company) in the NASTAR training center centrifuge in Southhampton, Pennsylvania. Insights were gained on improving mobility and helmet design as well as adaptations that are unavoidable - e.g., even the best fit gloves restrict finger motions.

The serious vehicle developers are clearly putting in a great deal of effort to accommodate payloads for science and engineering research.

A session on "Payload Integration" included presentations by Masten Space Systems and XCOR Aerospace. XCOR was distributing disks with their 53 page long, "Lynx Payload Users's Guide (Version 3b)." Among the information provided are the dimensions of the available payload volumes (two in the cabin, two unpressurized in the rear cowling, plus the dorsal pod) and their power and telemetry accommodations. There are charts of expected 'g' forces as a

function of time for "x" (front to back) and "z" directions (vertical) for both the Mark I and Mark II Lynx as well as for microgravity levels on the latter ...and more.

Possible External Pod on Lynx Mark I - I don't recall hearing previously that a "Small Dorsal Pod" could be installed on the Mark I Lynx, as outlined in the "Users's Guide." It could carry up to 280 kg of equipment or a single stage rocket that would put 40 kg in a 500 km suborbital trajectory (i.e. thus effectively extending suborbital opportunities to altitudes and microgravity times otherwise only attainable with more expensive and awkward conventional sounding rockets). XCOR Program Manager Khaki McKee stated that this Pod's development was contingent on market interest. For comparison, the "Large Dorsal Pod" on the Lynx Mark III is designed to accommodate 650 kg equipment or a two stage launcher to put a payload into orbit (estimated to be about 12 kg at 28 degree inclination, per my second Report of this year).

Comparing the New Suborbitals With the Alternatives

The sRLVs provide researchers with unique or expanded access to high altitude and microgravity compared with aircraft, high altitude balloons or traditional suborbital sounding rockets. Until the multiple stumbling blocks in transportation cost, frequency of access and return, lead time and preparation requirements are radically reduced this will be also be so for the International Space Station (ISS) or other orbital systems. (Exceptions such as NanoRacks's offerings only prove that rule.)

At the NSRC it emerged that in many respects the new suborbitals can be seen as promising a greatly improved version of the freedoms and lower costs researchers have had when using sounding rockets. Dr. Stern has told me that his own experience with them influenced his attention to the potential of the sRLVs.

Many astrophysical instruments (or their fundamental concepts) were first tested on sounding rockets before being adapted to specialized satellites. Indeed, Dr. Craig DeForest of SwRI noted that the external payload bay on the Lynx Mark III was just about perfectly sized to carry some typical solar physics payloads previously flown on NASA sounding rockets.

Several areas may be cited when comparing the sRLVs to the other options:

Flight Environment, First-Hand Experimentation - Instruments on sounding rockets endure high maximum 'g' forces (perhaps 12-19) on the way up and a "rough" parachute landing on return. As a result, they will often require repairs between flights. For several reasons, sounding rockets _*can*_ provide somewhat longer zero g periods and higher altitudes than the planned sRLVs (9-12 min vs. 4 min, hundreds of km vs. something over 100 km) but that is not critical for a large number of applications.

The corresponding problem with aircraft flying parabolas is that ...they're flying parabolas. Microgravity time per parabola is perhaps 20 seconds on each curve, followed by about 2 g's during pull-up.

Compared to that, a payload riding on an sRLV will get a longer, 'cleaner' block of microgravity. The experimenter might also be on board to operate and adjust their own system (s). Many researchers would clearly be eager get up to the ISS to operate their own payloads were it not for the present prohibitive factors. The astronaut crews on ISS are adept, but sometimes there's no substitute for having the developer/specialist "on site."

The sRLVs will also go high enough to reduce or eliminate atmospheric absorptions/ emissions that impair astronomical observations and night flights will eventually be possible in aid of such work.

Cost, Lead Time and Turnaround - NASA once had a surplus of sounding rocket propulsion stages and could offer "free" rides using those throwaway systems, but present prices are $1-3 million or more per whole flight. During a "flight campaign," if one's equipment doesn't need repair, the gap between flights of an instrument might be days or weeks. Lead time for an initial flight or reflight is typically a year.

Lead times for getting something on the ISS are significant and delivery is at the mercy of relatively infrequent supply flights. Let's not even talk about cost of transport unless the experiment gets a free ride. Experimenters must conform to rules written by bureaucracies for operating on the $100 billion, multinational facility. Return of payload from orbit is presently limited to the _*very*_ small mass and volume that fits along with crew in a Soyuz Descent Module.

The base price for an entire Lynx flight is about $100,000 including the experimenter coming along. In many cases, payloads will fly much more cheaply than that as they will share a ride with other experiments and/or a passenger paying their own way. For SpaceShipTwo (SS2), present plans are that on a flight dedicated to experiments there could be up to 600 kg (1300 lb) of apparatus as well as a Virgin Galactic "Mission Specialist."

Each vehicle among the spectrum of sRLV's will offer orders of magnitude more flight opportunities per year than any other options (e.g. the Lynx may fly up to four times a day). Since one doesn't want to "damage" the pilot(s) and passengers with excess 'g' forces, experimenters' payloads wouldn't be either. (Un-crewed systems such as Masten's are also being built with that in mind.) Thus experiments could be reflown very quickly. Between flights, flaws in an instrument could be corrected or its capabilities modified to obtain a new data set.

Timeliness and Responsiveness - One might prearrange to have specialized instruments that can be quickly fitted to a suborbital to observe a transient astronomical or atmospheric phenomenon or gather atmospheric samples at particularly interesting times. Time between alerting the operator and acquisition of data could be very short.

Continual Sampling, Geographically Dispersed Monitoring - The starting point for understanding and modeling phenomena is acquiring significant amounts of accurate data under the range of conditions being studied. The new suborbitals will provide the first such 'dense' data sets on chemical, solar and magnetospheric conditions in what have been all but inaccessible regions of the atmosphere. In frustration, that region is often dubbed the "ignorosphere" (see the forthcoming "Part II" of this NSRC report).

One might pay to have a low-mass, unobtrusive instrument - one minimally, if at all, affecting the ability to carry other payloads - installed for some period on one or more vehicles of a fleet of suborbitals. The result would be large data sets that could range over different times of the day and year. Initially, craft such as the Lynx or SS2 will only be able to fly during the day, but after some period they will surely get permission to fly at sunrise, sunset and at night. Atmospheric conditions will differ at night and during the transitional periods that often reveal data critical to understanding phenomena.

At high latitudes (such as that of Spaceport Sweden) solar particles come further into the atmosphere along Earth's magnetic field lines, and new data will be welcome. More broadly, new insights will be gained as the sRLVs start to operate with increasing geographical dispersion. (Because of population and geographic factors _*antarctic*_ latitudes will probably be excluded for some time, if not indefinitely.)

Initial and Continuous Microgravity - The duration of each microgravity period during parabolic flights is not sufficient for certain physical phenomena to emerge. Also, medical data on space adaptation has not typically been gathered during the first minutes of orbital flight. The suborbitals will allow exploring both realms far more easily, repeatedly, with very large test populations and at far lower cost than by using present orbital-capable systems.

One speaker provided a worthy coda to the above contrasts in asserting that the vast majority of human discovery has come about by accident. **Under a reasoned and reasonable level of safety, the reusable suborbitals promise to open an unprecedented spectrum of opportunities for such "fortunate research accidents" to occur during spaceflight.**

Yours very truly,

Charles A. Lurio, Ph.D.

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