Written Testimony
To
The House Subcommittee on Space and Aeronautics
Hearing:

The Emerging Commercial Suborbital Reusable Launch Vehicle Market.

S. Alan Stern
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Chairman Palazzo, Ranking Member Costello, and Members of the Subcommittee, thank you for the opportunity to testify today on *The Emerging Commercial Suborbital Reusable Launch Vehicle Market.*

As you may know, I am a planetary scientist who has used suborbital sounding rockets since the 1980s, a principal investigator on numerous NASA suborbital, orbital, Space Shuttle, and planetary missions, formerly NASA's Associate Administrator for the Science Mission Directorate, and the current chairman of the Commercial Spaceflight Federation's SARG (Suborbital Applications Researchers Group) committee for the scientific and educational applications of commercial reusable suborbital vehicles. These and other relevant experiences have provided particularly relevant experience in executing and managing research in space, including the application and benefits of suborbital flight systems.

In 1946, when the U.S. Army formed its Rocket Research Panel to determine how researchers could best exploit the capabilities of captured German V-2 rockets, only a tiny fraction of the Nation's astronomers, atmospheric scientists, biologists, and solar physicists were aware of the powerful impact that suborbital rockets like the V-2 could have on their research. After all, the V-2s were developed for another purpose—war fighting—and few U.S. scientists had ever had access to any space launch capability to do their research. Yet just a decade later, rocketborne research had become so powerful a tool that it formed the centerpiece of 1957's productive and impactful, and now legendary, International Geophysical Year (IGY).

In 2012, the space research and education communities, and large parts of NASA and other federal research agencies like NSF, NOAA, USGS, DOD, NIH, and the Department of Education, are unaware of the powerful opportunities that reusable suborbital vehicles like Virgin Galactic, XCOR, Armadillo Aerospace, and Masten Space Systems, and Blue Origin offer for research and education/public outreach (EPO) activities in space. After all, these new commercial, reusable suborbital vehicles were developed for another purpose—in this case space tourism—and few U.S. scientists have ever had the scope of access to space launch capabilities to do their research that these vehicles are specifically designed to provide. The analogies in this new commercial, reusable suborbital vehicle era to 1946 and the offering of V-2s to the research community are strong. Similarly, I believe the analogies to the demand growth for sounding rockets by 1957 and the great dividends from—and high demand for—suborbital research using commercial, reusable vehicles, will be similarly strong later in this decade and early in the next.

This hearing asks, "What are the unique benefits that suborbital RLVs offer the scientific community for research? (And) How can these new vehicles be applied to STEM education?"

So let me point out some of the major, unique benefits that these vehicles offer; these include:

✓ Frequent access to space at low cost, a game changing combination. Specifically, within a few years we'll have the capability to fly hundreds to thousands of experiment opportunities annually at typical launch costs of $100,000-$200,000 per seat equivalent payload (depending on the suborbital provider)—that's 10 to 100 times the launch rate of current suborbital payloads, at launch costs 10 times or more lower than today's typical $1M to $2M suborbital payload launch costs on sounding rockets. And most payloads will fly many times—e.g., to study changing phenomenology in atmospheric science or to explore large parameter space problems in microgravity science—something never before feasible or affordable, another game changer.

✓ Much gentler rides for payloads than current suborbital rockets. The new generation of reusable suborbital vehicles have been built for average tourists to fly. As a result, rather than the special, custom designs required today for telescopes, spectrometers, and other sensors to ensure they survive and operate after strenuous launches on sounding rockets, many kinds of standard, off-the-shelf laboratory equipment can be flown on the new generation of reusable suborbital vehicles, creating important savings in terms of payload development.

✓ Far simpler and more rapid payload safety/integration processes, akin to airborne research aircraft than the high Shuttle/Space Station paperwork hurdles that space researchers are familiar with today. I believe this will entice many new entrants into space research.

✓ The opportunity to fly larger payloads than could normally be flown inside a Space Shuttle cabin, e.g., allowing sophisticated medical imagers to study test subjects as they acclimate to microgravity for the first time.

✓ Flexible operations that will include worldwide launch basing, the ability to launch at specific times coincident with natural terrestrial and astrophysical phenomenology, with classroom schedules, and with circadian rhythms, and the accompanying, essentially immediate (minutes scale) access to samples, test subjects post-flight—all things no human flight systems offer today or have in the past.

✓ And, very importantly, the opportunity to fly researchers with their payloads. This capability—another game changer—will further reduce experiment development costs, and increase experiment reliability, by eliminating the need for expensive experiment automation that has for too long been common in space as a substitute for the researcher or educator being able to be there themselves. It will also offer high appeal to many space researchers, just as geological and oceanographic field expeditions do for researchers in those fields.

As a result of these and other benefits offered by commercial, reusable suborbital vehicles, I expect high demand in the following application areas:

- Upper atmospheric research
- The space life sciences
- Technology testing for spaceflight
- Microgravity physics and chemistry
- Auroral and ionospheric research, and
- Education and public outreach.

Finally, I would be remiss if I did not point out two other key benefits I expect the new generation of commercial, reusable suborbital vehicles will provide.

The first is the newfound ability these vehicles offer as stepping stone to try out and develop research players and experimental techniques at low cost before they are brought up to the International Space Station, just as the minor leagues in baseball try out players and techniques before advancing them to the majors.

The second key benefit I foresee is the power of these vehicles to inspire STEM education, by flying large numbers of student experiments at low cost—something otherwise impossible today—and to take teachers and educators to space from and back to the classroom to inspire students to pursue STEM careers. The immediacy of spaceflight access provided by commercial, reusable vehicles is, I believe, going to be another game changer.

The impact of commercial, reusable suborbital vehicles won't be limited to the US. At their low experiment launch cost, virtually every one of the 190+ nations on Earth can afford a human spaceflight program for the first time showcasing the flight of their nationals and their experiments on suborbital spaceflight. The returns—for national pride, for education, for motivating students into STEM careers by seeing their citizens conducting operations in space, and for basic R&D purposes—will be high, and the consequent returns to the US will be as well.

Simply put, next generation suborbital spaceflight offers to make space access frequent, inexpensive, and routine for researchers and their payloads alike—something never before achievable in spaceflight.

The hearing invitation also asked, "what is the current demand for research and development, scientific, and educational payloads on suborbital RLVs? What is the timeframe for flying these payloads?"

The current demand is small, perhaps a few dozen payloads per year. But I expect this demand to grow dramatically when routine flights by commercial, reusable suborbital vehiclers begin in 2013 or 2014, particularly when researchers and educators see early-adopter colleagues beginning to reap the many benefits of these new vehicles that I enumerated above. I fully expect demand by researchers and educators to grow by factors of 10 to 100 by late in this decade. And as evidence for the first sign of that demand growth, I point out that in just the past two years, the number of individuals attending annual Next-Generation Suborbital Researchers Conferences has grown from about 200 in 2010 to over 400 this year.

Finally, the hearing invitation asked, "What are the regulatory uncertainties that have the most impact on the suborbital researchers that intend to fly experiments on future RLVs?"

To this query I would answer that the primary regulatory uncertainties are those associated with the commercial, reusable suborbital industry so that they can achieve high flight rates at low cost, and to be able to fly researchers and educators efficiently, as they will tourists. So I urge you to minimize the regulatory burden on this new and highly promising industry, to the benefit of the research and education communities here in these United States, and to the development of this uniquely American industry which will service many more of the 190+ nations on Earth, so that their education and research communities can also enjoy the many strong benefits these vehicles offer.

Thank you for your time and for inviting me to share my views at this hearing. I very much appreciate the opportunity to provide this testimony and I look forward to working closely with all of you and your staff to nurture and promote the development of this promising new domestic industry for research, for education, and for advancing the importance of spaceflight to this nation's economy.

One Page Written Statement and Testimony Summary for The House Subcommittee on Space and Aeronautics

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- The era of commercially reusable suborbital vehicles is almost upon us.
- These vehicles offer numerous game-changing capabilities for both research and education.
- These include far more frequent and far less expensive access to spaceflight than we have ever known. They also include the further game-changing capability for researchers and educators to routinely operate their own experiments in space.
- Application areas as diverse as atmospheric science, microgravity science, space life sciences, and technology testing are expected to be big beneficiaries of these new vehicles.
- Researchers and educators from countries around the globe are expected to use these vehicles in the coming years.
- NASA and other domestic agencies can also exploit these vehicles to inspire students in STEM education and to serve as proving grounds for experiments and experimental techniques needing to be tested and developed before they are sent to the International Space Station.
- For this industry to be successful, the regulatory environment surrounding them must not stifle their ability to fly frequently and at low cost, and to carry researchers and educators on flights.