Risk and Reward
Remarks by Alan Ladwig
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As a replacement speaker for George Nield due to the government shut down, I really appreciated Pat's invitation to participate in this year's symposium. In her solicitation she told me to bring my "wry sense of humor and irony for the audience." I'll see if I can achieve that objective, but frankly over the last couple of years neophytes at the White House, congressional staffer twerps, and spineless senior managers at NASA did their best to dissuade me of doing such things in public, so I'm a little out of practice.

If you are really interested in my brand of commentary and daily opinions and snarky remarks, pleae follow me on Twitter at @SpaceArtAl.

I retired from NASA last May and other than a couple of speeches I've been enjoying a bit of a sabbatical – something I highly recommend that everyone take advantage of at some point in your career. Over the past several months I've been focusing much more on my space art than space policy.

Given the Congressional shenanigans involved with the government shutdown it appears I haven't been missing all that much. Heck, I threw in the towel much earlier in the year when the Sequester kicked in and public outreach and education programs were, for the most part, suspended. I didn't care to participate in a going out of business sale for public outreach. But, I admire my former NASA and contractor colleagues who have hung in there and have stayed focused on the main event as they return to work today. They've not let the insane politics of the moment get in the way of their dedication and commitment to advancing the space agenda.

I'd like to begin my remarks with a brief historical point of information concerning this symposium series.

That first International Symposium on Personal Spaceflight took place in 2005 and was co-chaired by Pat Hynes and Bill Gobatz, of DC-X fame. There was just one Primary sponsor, Ariane USA, for which we have Clay Mowry to thank, and continue to thank for his superior on-going support.

The speakers were primarily drawn from the then fledgling NewSpace community with just two government speakers: Paula Trimble, from the Office of Commercial Space Transportation at FAA (who is now a senior program manger at the Tauri Group), and Anhtan Ngo from the Air Force Research Lab.

As noted in the official 2005 program guide the Symposium was designed to "lead participants through the multi-faceted dimensions of Personal Spaceflight

ranging from the technical developments necessary to achieve safe routine flight to and from and through space, to the new personal business opportunities and economic benefits that will open in space and here on Earth."

Among the various tracks available to attendees at the first symposium, my favorite was "Creating the Personal Spaceflight Revolution."

The panel description noted that "Winning of the Ansari X PRIZE by the Spaceship One Team provided proof, through multiple flights, that the technology is available in the private sector to support evolutionary development of safe, affordable spaceships, enabling routine flights to space by the general public.

"These are incremental steps, starting with suborbital flights from single spaceports, progressing to suborbital flights between nearby spaceports and finally to orbital flights and flights between spaceports pairs located halfway around the world. The continued competitiveness of the industry will be dependent on the continued improvements and development of new technologies that will lead to increased safety and lower costs."

Even though the symposium took place one year after the award of the X prize, a snicker factor was attached to the discussions and aspirations of those promoting sustainable personal and commercial spaceflight.

But think about it! Here we are just eight years later and the snickers have, for the most part, been silenced. This has occurred for several reasons.

Beginning with the second symposium, NASA personnel have regularly appeared as speakers and panel members, each year representing higher levels of management. Joining the top-level leaders from NewSpace companies, who have been standard bearers for this venue, senor officials from legacy aerospace companies have become routine as well.

Over the years the word "Commercial" was added to the Symposium's marquee featuring speakers and discussions on business opportunities in Low Earth Orbit and beyond.

Since the first symposium, the ISPCS community can be proud of successful commercial cargo flights to the International Space Station by SpaceX and Orbital Sciences. We are on the verge of commercial suborbital flights for the public by Virgin Galactic and XCOR, with several other companies working to enter the field. The publication of scientific and technical papers on a wide range of sub-orbital flight and space tourism issues has become much more common. And, a number of companies dedicated to astronaut training have begun to put Space Flight Participants through their paces.

Spoiler alert: I've been working with a new group that also plans to offer astronaut training for Space Flight Participants and the public so stand by for the official roll out.

Further validation of the original vision of this symposium series can be seen in the recent market study completed by the Tauri Group for George's office FAA. In their "*10-Year Forecast for Demand of the Suborbital Reusable Vehicles*," the Tauri analysts reported that it is reasonable to project a baseline of sales of up to 4,000 seats/cargo equivalents across eight potential markets over a ten-year period once suborbital commercial service becomes available.

These sales could generate any where from $300 million to $600 million, perhaps as high as $1 billion. If you've not already done so, I encourage all of you to take time to read the full report that is available on line.

Finally, with the development of two space-based reality shows we've even - secured a niche in popular culture. As Pat mentioned in her opening remarks yesterday, earlier this month Richard Branson and Mark Burnett announced that they are collaborating on a new program called the *Space Race*. According to NBC Entertainment president of alternative and late night programming Paul Teledy, "The scope of this endeavor is so staggering, that it took these two titans to even imagine it."

While it's wonderful that NBC is participating in this new program, Mr. Telegdy may have exaggerated the uniqueness of the program by claiming it took "these two titans to even imagine it." This was a bit of typical Hollywood over-hype since a month earlier Sony TV announced their own show and collaboration with the Dutch TV station, Netherland 1, for the production of the *Milky Way Mission*, a reality show that will select a winner among Dutch celebrities (whoever they might be) to fly on a suborbital space mission.

I have a very personal interest in seeing the expansion of personal and commercial space initiatives as a means to directly engage the public in space opportunities. My first job at NASA was to manage the national competition that placed high school student experiments on Space Shuttle missions. My next assignment was to lead the Space Flight Participant Program that featured the Teacher in Space and Journalist in Space opportunities.

Along the way I was also involved with the Get Away Special Program, integrating Mid-Deck Experiments on shuttle flights, coordinating Corporate Payload Specialist flights, and helping to place the first art object flown on a shuttle mission through the Non-Scientific Payload Program. During my non-NASA career I worked with the ZERO Gravity Corporation during its start-up phase and while at Northrop Grumman I was involved in creating the Weightless Flights of Discovery Program that sponsored parabolic flights for educators.

Hearing from the other speakers and seeing videos of the progress that is being made with commercial activities to engage the public does the heart good.

Clearly, given all this progress in the commercial sector, Pat, Joylynn, and the rest of the organizing team have come a long way since that first gathering in 2005. Their tenacity and vision are to be applauded.

I don't hear anyone snickering here today – and if you are one of those who are still amused by the aspirations of the individuals and companies in this sector, a flight attendant will gladly guide you to the exit and to the corral full of longhorns.

In addition to being provocative, Pat asked me to address issues related to the Risks and Rewards of personal spaceflight, especially for the sub orbital market. When talking about risk, sooner or later the subtext gets around the issue we speak about in whispers: what happens if someone either on a flight or on the ground gets killed!

I received my first tutorial on risk during my time with NASA's Space Flight Participant Program. It afforded me an excellent opportunity to get up close and personal with "ordinary citizens" who had the dream to fly in space.

In 1982 a NASA Advisory Council Task Force was formed to determine if it was appropriate to fly a non-astronaut on a shuttle flight. After a year-long study, the Task Force concluded that their "fact finding indicates that it is feasible for NASA to fly individuals on the Shuttle beginning in the mid to late 1980s."

By the summer of 1984 the Space Flight Participant Program was born. NASA determined that the first opportunity would be solicited from the ranks of the nations educators. A second competition was designed for a journalist.

Over the course of the program we received thousands and thousands of letters from astronaut-wannabes, each presenting a strong case for why they should be THE ONE to be on the next shuttle mission. It was truly a universal dream regardless of age, gender, occupation, nationality, or even physical challenges.

Despite the Task Force rationales and recommendations, not everyone was convinced this business of flying a private citizen was such a great idea. After all, the task force began its deliberations just as STS-4, the final Orbital Flight Test completed its mission. Their report came out around the launch of STS-7 with the first flight of an American woman in space, my friend and colleague the late Sally Ride.

One of the common complaints among the naysayers was that spaceflight was too RISKY for anyone other than professionally trained astronauts. Surely it was too early to even think about placing a "passenger" on board.

As manager of the program I was on high alert to refute any criticism of the program so the concern about risk was always front and center. While the initial string of successful launches created a perception that space shuttle missions had become routine, experienced veterans knew there was no such thing as worry-free flights.

To bring a reality check to the Teacher in Space Program, the element of risk was mentioned early and often during the selection process. When the state finalists came to Washington DC for the down-select to 10 finalists, the teachers heard from program managers and astronaut commanders who brought home the message that the selected individual would be engaged in a risky business. Commander Dick Scobee told the educators that this “ain’t no fire cracker you’ll be getting on.”

At this stage of the selection process, talking openly to all teacher candidates about risks may have been as close as we got to “informed consent.” But in their excitement did the teachers really understand the full extent of the risks involved?

Years later one of the state finalists was quoted in a book saying, “well, yes, risk was discussed, but it was a little like reading the warning label on the back of a can of oven cleaner.” I’m so glad HE didn’t make it as one of the 10 finalists.

Certainly during their six-months of flight training, Teacher in Space designee Christa McAullife and her backup Barbara Morgan (shoe eventually flew on STS-118) were given additional insight to the dangers and risks of space flight. However, after the tragic accident of the 25th Shuttle launch, the “I told you so” chorus was highly vocal in complaining that Christa didn’t fully appreciate the true threats and challenges that are inherent in human spaceflight. Therefore, future flights should be reserved for professional astronauts.

The nation was again reminded of the risks involved in spaceflight in 2005 when the Columbia Space Shuttle broke apart during reentry just before landing. This second accident created a culture at NASA that supported the belief that in the future human spaceflight should only be undertaken if it is truly worth the risk. How such risk is defined has always been somewhat elusive.

Fast-forward to today and it’s encouraging to see the issue of risk and public spaceflight is once again front and center.

Earlier this year a conference on the topic of Space Tourism: Risks and Solutions was held at Lloyd’s of London, the mother ship of risk and insurance. The International Institute of Space Commerce co-sponsored the conference. Panels discussed the space tourism market with the associated issues of insurance, health care for Space Flight Participants, regulations, and business assumptions.

During the discussions in London it was noted that the public needs a clear understanding of the risks involved with commercial space transportation and it will need to be convinced that the risks are being managed effectively. However, the legal liability framework for space tourism flights is still evolving, with little international agreement on regulation.

Elements of risk cover a wide range of concerns. What are the specific risks that this new sector needs to address?

One would hope that safety is on the top of the list. Yet, at a special 2004 NASA-sponsored conference on risk, space historian Steven Dicks noted we should have a “balance between caution and boldness. Safety will always be the secondary priority in any bold adventure, because the first priority is simply to go. Otherwise, there would be no exploration.” I doubt that we would find any senior manager at NASA who would be willing to endorse Steve’s view. Throughout my career at the Agency, safety always needed to be on chart number one.

I think a more realistic approach to the point Steven Dicks spoke of is to have a balance between well-mitigated risk and acceptable risk because an element of the risk will always be there.

When Aerospace Industries Association President Marion Blakey was the head of FAA, she was interested in safety as a priority for the non-flying public. In 2004 she stated “Our first concern will be the safety of the uninvolved public, making sure that as this grows and develops that we’re doing everything to protect the folks on the ground and to make sure that the people who go into space understand the risks.”

During the same time, then-Associate Administrator for the Commercial Space at FAA, Patti-Grace Smith observed that passenger awareness of risk was a key hurdle in the way making space travel as routine as aviation. “How do we know that a Space Flight Participant understands the risk they are undertaking? How do we know they understand what they are doing?”

A lesson learned from my NASA experience is: are we sure the individuals have taken the risk message to heart as something more than a warning on a can of oven cleaner?

Some commentators note that “eccentric millionaires might be willing to accept any risk and wave every claim against an operator in exchange of being pioneers of the beyond Earth adventure.” However, as a result of marketing promotions, lotteries, and sponsorship activities, there could very well be a number of not so eccentric people on early flights who deserve protection.

It will be up to the experience providers to help insure that their customers come to a personal Eureka moment regarding risk. Surely, after Challenger and

Columbia the majority of American customers ought to be respectful of the inherent risk of space flight and realize that despite taking all the necessary precautions, you can still have a bad day in space. Addressing areas of risk will be essential and integral to any pre-flight training protocols developed by the vehicle operators.

Thus far the FAA and George's Office of Commercial Space Flight (AST) have promulgated regulations based on "informed consent." According to the regulations, operators must prepare a written informed consent waiver form for the review and signature of each space flight participant. The written informed consent must:

(1) State when the operator informed the space flight participant in writing about the hazards and risks of the mission, including the safety record of the launch vehicle type.

(2) Identify the specific launch vehicle to which it applies.

(3) State that space flight participant presence on board the launch vehicle is voluntary.

(4) Be written in plain language.

(5) Be signed and dated by the space flight participant at the time of consent.

(6) Specify conditions under which informed consent remains valid.

However, signing the form does not relieve the operator of responsibility in the case of gross negligence.

As part of the process, participants must also provide their medical history to a physician experienced or trained in the concepts of space medicine.

Based on comments I've heard from sub orbital operators, the FAA's Office of commercial Space and George Nield are to be recognized and applauded for developing regulations that are not onerous or detrimental to start-up operations for the emerging industry. Rules may change as more experience is gained, but for now Space Flight Participants are expected to accept the risks involved.

The FAA rules are intended to inform participants of the dangers and risks of space flight, thus relieving the government and space flight operators from any liability in the event of a mishap.

As was noted in one scientific paper, "Many space entrepreneurs assume that a person will be willing to pay up to several hundred thousand dollars in return for what essentially amounts to a joyride. People capable of paying such a price are

frequently business owners whose insurance (not to mention boards of directors) place direct limitations on their non-business-related activities. More importantly, such people also have relatives and sizeable earning capacities.

“In the case of a suborbital flight gone awry, these friends and relatives could well be willing to challenge waivers signed by a passenger on the grounds that grandma or grandpa could not truly make an informed consent to waive risks because the late relative was not in a position to realistically assess (or even fully comprehend) all of the associated risks of space flight.”

Although informed consent waivers signed by participants will indicate that they are responsible for assuming risks, it remains to be seen how enforceable such waivers really are in a culture that can’t drink a cup of hot coffee without looking for someone to sue. Technically, if passengers sign the waiver there will be no requirement for additional regulations. It remains to be seen if this regulation protocol can be maintained.

The conferees at the gathering at Lloyds of London spent considerable time on the insurance risks of sub orbital flights. It was agreed that space tourism requires a brand new class of an insurance framework for the emerging industry. A key point is that we are dealing with new vehicles operating in a new environment with a sparse and unproven track record. The conference delegates reviewed the risks involved in the various stages of the experience including the launch, the zero-g portion, and the landing. As we’ve seen with NASA and Russian missions, accidents can occur during all three of these phases.

David Wade of Astrium, a European company still very much interested in the sub orbital market, pointed out that another key question on insurance coverage is whether the crafts are rockets with wings or rocket propelled aircraft. At what point do insurers transfer from an aviation to space risk and vice versa?

Yet another aspect of risk involves physical and medical issues. As described in a recent paper for the Aerospace Medical Association Commercial Spaceflight Working Group, most of the medical issues for suborbital spaceflight are relatively straight forward as compared with those for orbital spaceflight.

As noted in the paper, “the short duration of suborbital flights eliminates any concern for most of the medical problems associated with orbital flight such as deconditioning, fluid shifts, and acclimation to weightlessness or re-acclimation upon return to Earth.

“There is also a large amount of experience and a large medical database concerning orbital spaceflight. It would be easy to conclude that the medical risks of sub-orbital spaceflight are well known and would be similar to orbital spaceflight, but less significant or less intense. However, the orbital spaceflight database is based upon medical standards for astronaut selection and

certification that are very restrictive.

“Commercial suborbital flight crewmembers, under current regulations, will only be required to have an FAA second-class medical certification. Also, a critical aspect of suborbital spaceflight is the rapid change from the high-G acceleration launch forces to 0-G weightlessness followed quickly by the high-G deceleration of entry. These transitions could lead to both cardiovascular and neurovestibular effects that are currently unexplored. Even using a centrifuge and parabolic flight, there is no way to completely simulate these forces and this total environment preflight.”

This is yet another area where a better understanding of associated risks will take place over time and with the benefit of experience and the collection of statistics.

Over this past weekend I was able to see the movie *Gravity* on an IMAX screen in 3-D – a highly recommended way to see the film. (And by the way, I hope none of you are among the knuckleheads that are overly concerned about how accurately the film portrayed certain aspects of science or engineering. I don’t recall people becoming unglued because Star Trek or Star Wars took poetic license with the principles of physics. It’s like getting upset that Roy Rogers shot 12 bullets from a six-shooter. For goodness sakes, *Gravity* was a movie created to entertain. Get over it!)

In any case, the heavy emphasis on space debris in *Gravity* made me wonder if this would be a risk factor at some level for sub orbital consideration.

A review of scientific papers on the topic, presented me with a bit of a surprise. The risk factors that were addressed did not involve the potential impact of orbital debris to the sub orbital vehicle, but rather how debris from a sub orbital vehicle accident might impact the commercial air space. Given the low number of flights anticipated during the start-up years sub orbital vehicle debris is not likely to be a major concern. However, if marketing projections for numerous flights per day become real, this risk will have to be addressed.

If you haven’t cracked the code by this point of my remarks – human space flight is loaded with risks, be it sub orbital, orbital, or beyond LEO.

I didn’t even broach the business risks the operators must face in terms of whether or not they can sustain this market and actually make a profit. Nor did I get into the risks that could occur if one operator does something stupid that risks the credibility of the entire space tourism industry.

Perhaps we should listen to June Scobee- Rogers, the widow of Challenger Commander Dick Scobee. In her remarks on a risk panel we were on earlier this

year at the National Air and Space Museum June concluded, “the greatest risk in space exploration is to take no risk.”

As John Grunsfeld observed at the NASA risk conference in 2004, the concerns are about risk-taking, not sure thing-taking. It is not realistic to believe that sub orbital spaceflights will be accident or catastrophe free. However, from my personal observations and discussions with company personnel, I am optimistic that the vehicle providers are doing all they can to eliminate, mitigate, and minimize risks associated with sub orbital flights.

Contrary to critics who often carp that private space flight providers – especially the NewSpace providers – will cut corners and costs to improve profit margins, I believe the opposite is true. This industry will only succeed if they can deliver a premium experience with an acceptable level of risks and a exemplary safety record.

It is clear to me that the providers intend to follow the basic FAA regulations, focus on safety, allow customers to opt out at any time, communicate frequently with their customers, and insure the training experience maximizes informed consent.

If they have not done so already, I would recommend that the space tourism industry, perhaps led by the Commercial Spaceflight Federation, develop a comprehensive contingency plan in case of an unthinkable accident. A united front by all carriers may help reassure participants in the pipeline, government officials, and the public that an isolated incident should not shut down an emerging industry during its start-up phase..

I’ve always wondered why accidents involving the space seem to have a bigger impact on the public psyche than the loss of life in other human endeavors. After Challenger and Columbia we went through prolonged periods of reassessments and self-flagellation. As a nation we seem to be incredibly risk adverse when it comes to the loss of astronaut life.

Is it because the public feels such a special connection to the astronauts? Does the public believe space is an idealic reserve where bad things aren’t supposed to happen and success is supposed to be guaranteed?

How will the space community and the pubic at large react to the first sub orbital space disaster? Are we willing to accept more risk for high-income daredevils and people of means than we are for government-sponsored astronauts? Might there be a sea change where we care less if an accident happens to the financial elite – or in any case, Ashton Kucher? I have no specific, but ask you to ponder these questions as we look forward to the first sub orbital flights, hopefully in the near future.

While Pat also asked me to address the rewards side of the risk-reward equation for sub orbital flights I really don't have much to offer.

I can tell you that I saw the rewards of placing student experiments on Shuttle flights and teachers on parabolic flights. It will really be up to the customers of the eight markets identified by the Tauri Group study to determine if their participation in the flights was worth the risks and price of admission.

As we have seen from 50 years of human space flight, a trip into space impacts individuals in different ways. Some astronauts have come back with stories of glory and feelings of world unity enabled from the Overview Effect. Others struggle to put the experience into words and would rather be left the hell alone and not have to trot out how they were personally impacted.

The key thing is that from now on, commercial flight opportunities will make it possible for a much wider range of humanity and a larger number of people to take a risk and experience their dream to fly. What new things might occur as a result of more and more people being able to break the bonds of Earth.

A 1984 article in Newsweek about the original Space Flight Participant Program did a fun job of summing up what drives our dream to fly.

"It is an unabashedly utopian dream, a return to the old pioneer ideals of limitless expansion and the perfectibility of mankind, and a chance to start over. Be tadpoles, not frogs."

I look forward to the stories and revelations the early Space Flight Participants will have to share once they assume the risks and are rewarded with the opportunity to make their dreams come true – and to start over.

Happy trails to you fellow tadpoles and See you in Orbit.