

**Testimony of N. Wayne Hale, Jr. before the United States Senate Subcommittee on Science and Space of the Committee on Commerce, Science, and Transportation, May 16, 2013**

I thank the committee for inviting me to testify concerning the growth of the space industry including the private sector space transportation.

In the interest of full disclosure, I am hardly a disinterested party in this topic. I am and have always been a passionate believer that space exploration and the industries that may derive from it will benefit humanity in ways beyond our imagining. I have spent most of my professional life working in the large government space programs of the Space Shuttle and the International Space Station. During those years I have seen NASA at its very best and at its worst. The hard working dedication of my colleagues at NASA personnel is nothing short of phenomenal, and their talent and creativity is second to none. However, their endeavors have frequently been stymied due to the inherent bureaucratic inefficiencies of government work and the frequent shifts in priorities and funding that whipsaw most space initiatives. This has led me to believe there must be a better way to develop and operate space systems.

In my last assignment before retirement from government service, I worked with Frank Bauer, the Chief Engineer of the Exploration Systems Directorate, to define the management philosophy, protocols, and processes for the then new Commercial Crew Program within NASA. After my retirement, my work has continued as a consultant. My company, Special Aerospace Services, and I are paid advisors to a number of entities involved in the commercial crew and commercial space cargo enterprises. And I have volunteered my time to work with the Commercial Spaceflight Federation to establish safety, management, and engineering standards for all the members of this fledgling industry. So the committee can see that I am hardly a disinterested party and should weigh my testimony as such.

Establishing good, effective safety, engineering, and management standards in a voluntary industry association is the hallmark of any reputable and mature industry. I am pleased to report that the CSF is making good progress in setting up voluntary processes which will ensure public safety and promote general success in this difficult business. Industry group standards can alleviate the need for government regulations by allowing the members of a trade association to tailor best practices specifically for their industry. Evolution of these industry standards inevitably proceeds more rapidly than the development of government regulations and can therefore take rapid advantage of best practices as they emerge.

The most singularly vexing problem with space flight is the high cost of getting to low earth orbit. As the noted science fiction writer Robert Heinlein once observed, ‘when you are in earth orbit you are half way to anywhere in the universe’ which accurately reflects the physics of the situation.

The lack of low cost transportation to that point located just above the earth's atmosphere and moving at 17,500 mph forward velocity has prevented potential space entrepreneurs more than any other factor. Hundreds of potential business opportunities in the limitless resources of the solar system have floundered on the high cost of transportation to low earth orbit. Asteroid mining, energy production, zero gravity manufacturing are all within our grasp technologically but will not be profitable until reliable and reasonably affordable transportation systems are in place.

New systems for transportation to low earth orbit have enormously high development costs. Private investors, with a few exceptions, are loath to provide the capital needed to develop low earth orbit transportation without clear and immediate business ready to purchase tickets.

So we are in a 'chicken or the egg' paradox. Space business needs low cost transportation to become profitable, while potential private transportation services need established business to justify the cost of construction. This is not the first time that America has been in this situation. Both the early railroads and fledgling air transportation industries found themselves becalmed in similar straits. In both these cases, and others, the federal taxpayers stepped in to provide critical resources to help new industries develop. Those investments have been paid back myriad-fold in tax revenues when the new industries caught fire and provided transportation systems that were the envy of the world.

NASA and its predecessor agency the NACA provided needed aeronautical research to make air transportation as inexpensive and safe as we find it today. The federal investment in aeronautics development has paid off handsomely in the development of a multi-billion dollar industry. Indeed, one of the largest sectors of net exports in the American economy is aerospace with billion dollar sales a common occurrence.

The history of space flight – after the first early steps to demonstrate that space flight was even possible – has been marked with the goal of decreasing the cost of transportation to low earth orbit. In my home I have an entire shelf of books populated by volumes of studies and proposals from a multitude of thinkers spread over decades on that subject: how to provide reliable safe space transportation on the cheap.

The space system that consumed much of my professional career, the space shuttle, was established to achieve just such a low cost goal. But the technologies of the 1970s, harnessed to a risk adverse government apparatus resulted in a system that was only slightly less expensive than those which went before.

In the last decade, the United States embarked on a bold new experiment to turn over the creative reins of spacecraft development to entrepreneurial, nimble, flexible, creative private commercial teams. Bolstered with a modicum of taxpayer resources, these businesses have leveraged private investment to create the critical mass to develop new, much cheaper transportation systems. We see the first fruits of success today with cargo carrying craft: the SpaceX Falcon and Dragon, and

the Orbital Antares and Cygnus. These cargo carrying privately developed vehicles are starting to supply our government outpost, the International Space Station. In future years others, the Boeing CST-100 and the Sierra Nevada Dream Chaser will be added to the fleet to carry human beings as well as cargo.

Poised on the cusp of these new systems, we run the risk of being penny wise and pound foolish as we make the same mistake that doomed the space shuttle to much higher cost operations: starving a spacecraft development program in the name of saving a few pennies for today's budget bottom line resulting in the compromised systems that, if they fly at all, will not be cheap enough to enable business in space.

This is not to devalue the development of truly deep space exploration systems by the government. Those high risk, high cost systems payback over such are long term that they would never be funded by private investment. But, like the expenses incurred by Lewis and Clark, Captain Zebulon Pike, and a host of other government expeditions in our history, the payback from exploration will be enormous for both the country and for all of humanity. Just at a more distant point in the future than business spreadsheets normally run. The SLS and the MPCV should be developed in conjunction with the commercial low earth orbit transportation systems. Flying to cis-lunar space to inspect a captured asteroid is an engineering and operations test worthy of a first deep space mission. But that mission can only be a first step. More should follow.

The commercial systems will enable the deep space exploration initiative in substantial ways. First of all because the ISS is our space test laboratory for the technologies and systems that deep space exploration will need. Operation in space, aboard the ISS, is the most effective means to wring out life support, communications, propulsion, and other technologies. Commercial transportation of cargo and crews to the ISS directly support deep space systems development. As deep space exploration proceeds, commercial cargo and crew vehicles will likely be called upon to aid with assembly and fuel delivery to low earth orbit where we will finalize preparations to head into the vasty deep. Cost effective commercial transportation to low earth orbit can make a vital difference in equipping the deep space fleet.

So the two efforts go hand in hand. Funding equity between the two programs is necessary to ensure the timely success of both. Currently, the commercial space effort stands uncomfortably close to the brink of financial starvation. Deep space transportation development is being stretched out by similar restrictions. Business is looking to see if the government is serious about providing the critical support or whether this effort will be wasted as so many earlier government programs which withered away on the very cusp of success: National Launch System, Orbital Space Plane, and others.

I urge the Congress to fully fund these vital activities, both the commercial crew program and the exploration systems. They will allow America and American industry to lead in the exploration

and development of human activity in our solar system. When the historians of the future look back on our era, they will recognize the movement of humanity from planet earth into the solar system as the pivotal event of our times. There is no project that is so important for the long term success of humankind. I would hope that those historians record that at this crossroad of history that a creative, enterprising, farsighted nation called America led the way.

The prizes both economic and historic are too great to bypass. If America does not lead in these enterprises, somebody else will. And the leader will reap the greatest rewards both in the near term and in the longer term.

For all our limitations, America is a very rich country. There are many things which America needs to do for the present moment: provide for a strong military to protect us in a dangerous world, educate our children, care for our elderly and infirm, revitalize our transportation infrastructure of roads, bridges, airports, and more. All of these activities are of vital importance today. Space exploration is about the future. Space exploration is possibly the only line item in the federal budget that is all about the future. Currently we spend one half of one percent of our nation's treasure on the future. Isn't the future worth that investment?