ON SPACEPLANES AND X VEHICLES

Testimony of Henry F. Cooper[1]
to the
House Subcommittee on Space and Aeronautics
Committee on Science
October 11, 2001

OPENING STATEMENT

Mr. Chairman, thank you for the opportunity to share my views on the need for a viable Science and Technology program to build spaceplanes – particularly for military applications, which is my main interest.

I strongly support developing reusable launch capabilities that are a prerequisite for sound spaceplane development – and am greatly troubled by the slow development pace of the past eight years. I hope the Pentagon's new organization for military space will take seriously the role of spacelanes in the full gamut of military space activities – from supporting our terrestrial forces to applying force in and from space. If a logical spaceplane development progression is followed, suborbital reusable launch technology will be proven first and can substantially enhance our rapid reconnaissance and force application capabilities.

Rapid development is possible, but requires innovative development methods unlike the government's usual formal acquisition processes. My written testimony gives examples of the Pentagon's wasteful process from my SDI experience, and I believe NASA is no better.

I much prefer a "build, test, grow" approach to rapid development – like that used by General Schriever and Admiral Raborn in developing our first land-based and sea-based intercontinental ballistic missiles in the 1950s; or by Kelly Johnson – of Lockheed Skunkworks fame – who built the U-2 and SR-71 in record time, and more recently the F-117; or by the SDI program I led in planning to develop a single-stage-to-orbit (SSTO) through that three step process that I'll describe in a moment.

First, I'd like to recall that High Frontier's founder, General Danny Graham, was persuaded in 1989 that the technology was sufficiently mature to embark on developing an SSTO capability – and he took the idea to Vice President Dan Quayle, who, in turn, requested that the SDI Organization undertake a serious development program.

They chose the SDIO because, as General Graham wrote in his memoirs, they expected that either the Air Force or NASA "would stifle our baby in the crib" – NASA because it threatened Shuttle prolongation and the Air Force because it threatened its next expendable rocket program. They were right then – and I suspect their view of both NASA and the institutional Air Force is still correct.

And regrettably, the Pentagon's current missile defense leadership has lost the vision of space defense programs in general, and, in particular, why developing a reusable launch capability would pay them big dividends.

But my predecessor, General George Monahan thought it was a good idea from an SDI perspective – as did I. After a screening competition among five contractors – all of whom

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[1] Dr. Cooper is Chairman of High Frontier, Chairman of Applied Research Associates, Visiting Fellow at the Heritage Foundation, former SDI Director during the first Bush Administration and President Ronald Reagan's Ambassador and Chief Negotiator at the Geneva Defense and Space Talks with the Soviet Union.

agreed that the SSTO was feasible, McDonald Douglas was awarded a $60 million contract in August 1991 to fly the reusable launch vehicle from the first of a three-phase development program. They delivered brilliantly – slightly late, but within budget.

The three stages of this "build, test, grow" approach were:

1) Prove with a sub-sonic vehicle that usual spaced launch logistics support requirements can be dramatically reduced for reusable launch operations;
2) Using these reduced logistics support procedures and near-term technology, prove with a supersonic, sub-orbital reusable launch vehicle that SDI targets can be inexpensively launched to support planned ballistic missile defense testing requirements;
3) Using the savings generated by the more cost effective target launching, improve the technology base for lightweight structures, high performance engines, reentry thermal protection, systems integration, etc. to support a truly versatile SSTO vehicle and demonstrate its advantages for missile defense and other military space missions.

As noted above, the small government, industry team successfully completed Phase 1 by repeatedly flying the DC-X, renamed the Clipper Graham by NASA Administrator Dan Goldin to honor General Graham's vision in initiating the SSTO effort. Dr. Goldin also gave Danny Graham NASA's highest award for the DC-X/Clipper Graham, as CNN carried worldwide video of its vertical take-off, rise, hover, high angle of attack flight, and vertical landing – all commanded by Astronaut Pete Conrad, aided by two others. Pete said he could manage all the ground and flight operations by himself from a single console. Pause, and think about that.

Regrettably, the Clipper Graham had a procedural landing gear failure after its 12th successful flight and burned – but not before successfully completing Phase 1 of the build, test, grow strategy. Even more regrettable was that the Clinton Administration completely lost the vision, in its deliberate efforts to destroy all remnants of the SDI program – "taking the stars out of Star Wars," as Defense Secretary Les Aspin said. Even Congress' efforts to sustain Pentagon innovative follow-on spaceplane S&T efforts were frustrated by Pentagon resistance, including in the Air Force which aided and abetted what was then politically correct – e.g., by transferring reusable launch responsibility to NASA. And NASA's more standard, and much more expensive, acquisition approach has produced regrettably little.

I still believe that the three phase approach we adopted was correct and can and should be restarted – in the Pentagon. The right organization – with priority, streamlined management and $100-200 million a year – can complete Phase 2 in three years – with a supersonic, sub-orbital reusable single stage vehicle that could pay for the development costs with the savings from launching targets for missile defense tests. Other applications include rapid reconnaissance or long-range weapon delivery.

As noted in my testimony, individuals in private industry are seeking venture capital to build this capability for even less to provide an inexpensive wide area sensing platform – they claim they need only a customer to succeed. Someone in government should consider this.

Mr. Chairman, ten years ago, the technology was sufficiently mature to undertake serious development of a reusable launch capability, setting the stage for a spaceplane. We made the initial investment and had a brilliant success with the Clipper Graham. Then we lost our way – more accurately, the Clinton Administration diverted the intended path of that "build, test, grow" program. It should be reinstated and supported with a national priority – the only question is where in the bureaucracy can be trusted to stay the course. Wherever it is placed, Mr. Chairman, I urge you to exercise close oversight of this important program to assure the vision is preserved.

Thank you.

WRITTEN TESTIMONY FOR THE RECORD

Mr. Chairman, thank you for the opportunity to provide my views on need and current plans to develop commercial, civil, and military spaceplanes and the role of the Department of Defense (DoD) and NASA X vehicles for flight experiments to demonstrate those capabilities.

As you requested, I will seek to shed light on three questions: 1) How have past Administrations supported DoD and NASA spaceplane programs? 2) Should DoD and NASA work together on developing spaceplanes, and if so, how? 3) How much R&D has been invested and how much should the U.S. invest annually in spaceplane development?

Perspective

Before addressing those assigned questions, I want the Committee to understand several points, which strongly influence my answers.

First, I have not been following closely recent events in the on-going saga of efforts to develop spaceplanes by either the DoD or NASA. So my perspective is biased by my experiences that are eight years old – experiences that date to my watch as Director of the Strategic Defense Initiative (SDI) during the first Bush Administration.

Second, my prejudices lean toward assuring that the nation exploits space for military applications, and, in that context, toward assuring that the DoD institutes the right kinds of science and technology programs to support the nation's future national security needs, all under the right management structure for military space programs. In that regard, I support the recommendations of last year's Space Commission chaired by now Defense Secretary Rumsfeld.

I would add that I favor a separate service to "acquire, train and equip" the nation's space forces – as soon as there is a critical mass of senior military leadership sufficiently trained and dedicated to support fully exploiting space – not only as a force multiplier, but as a medium in which and from which force can be applied to serve the security interests of the United States.

Spaceplanes should play an obvious, central role in such a Space Force. Consequently, I am most concerned that the appropriate innovative DoD science and technology programs be fostered – especially in the context of the pending reorganization to manage the Department's space activities.

My third point, in that regard, is that I am very critical of the standard system development/acquisition process in DoD and, I suspect, in NASA as well. Far too much bureaucracy is involved in "managing" and/or "overseeing" system development to permit significant innovation.

For example, during my watch as SDI Director, I had my staff keep track of the cost and time spent in running the oversight gauntlet for THAAD during the last six months of 1991, during which we underwent a Defense Acquisition Board (DAB) management review, the THAAD Milestone I DAB, and a baseline DAB review (which was canceled). We and our contractor agents spent about 75,000 government labor hours, over 250,000 contractor hours, and over $22 million on creating over a ton of supporting documents, providing briefings and attending meetings seeking to reach consensus with three staff levels to address, and invariably readdress, over 900 proposed issues often with conflicting programmatic changes (sometimes within the same office). Even to gain agreement on how we were going to manage the program, we held over 50 meetings with 35 overseeing offices and their staffs prior to the DAB to approve

the consensus, at a cost of over $7 million—not to mention the wasted time of our technical staff which could have better spent its time managing an admittedly volatile program.

In my judgment, this is a very undesirable way to manage the development of new capabilities, such as would be required to build spaceplanes.

My fourth point is that it is far more preferable to give authority and resources to a small technically qualified team, with minimum oversight, to pursue an approach that takes existing or near-term technology, tests and proves a useful capability, fills-in technology as needed and available, and then improves that capability – while, of course, maintaining a vision of the desired final objective. Some have called this approach, "Build a little, test a little." I call it, "Build, Test, Grow."

This "build, test, grow approach" is not a novel idea. It was the approach to developing our original land-based and submarine launched intercontinental ballistic missiles in the 1950s. It was used in building the U-2 and SR-71 in record time. It was the approach followed by a small technically qualified SDI team in conducting the highly successful Delta 180, 181, and 183 programs of the 1980s. It was followed in the Brilliant Pebbles Space-Based Interceptor program on the late-1980s through my watch, until the Clinton Administration cancelled it in 1993 for political reasons. (NASA Administrator Dan Goldin, while at TRW and responsible for TRW's Brilliant Pebbles development and testing, told me that the small government team provided the best managed program of his experience up to that time.) The same management approach was followed in the award-winning 1994 Clementine mission, which space-qualified Brilliant Pebbles sensors and software in surveying the entire Moon's surface in 15 spectral bands and discovering water at South Pole. Clementine was the pathfinder for the "faster, better, cheaper" approach to space exploration championed by NASA Administrator Goldin.

DC-X/Delta Clipper/Clipper Graham Experience

With these thoughts in mind, I'd like to review the history of the DC-X or Clipper Graham. High Frontier's Founder, retired Army Lieutenant General Daniel O. Graham, describes in his memoirs (*Confessions of a Cold Warrior*, Preview Press, Fairfax, VA, 1995, pp. 201-211) his role in initiating a "Single Stage To Orbit," or SSTO, Program in early 1989.

A viable, reusable, SSTO capability promised to reduce launch costs by over an order of magnitude by permitting launch, recovery, re-launch operations similar to the way aircraft are rapidly cycled through ground operations. Aside from reducing the launch support infrastructure by two orders of magnitude, other key technical challenges included having sufficiently lightweight structural materials, high performance engines, effective reusable reentry thermal protection, and overall system integration.

After being persuaded by several eminent scientists and engineers that technology was sufficiently mature to initiate a demonstration program, General Graham took the idea to Vice President Dan Quayle, then Chairman of the Space Council, and the Vice President requested that the SDI Organization (SDIO) initiate such a demonstration program.

The SDIO was chosen, wrote General Graham, because it was expected that both NASA and the Air Force "would stifle our baby in its crib. In NASA it would be viewed as a threat to the hoped-for prolongation of the Shuttle program; in the Air Force it would be viewed as a threat to the hoped for Advanced Launch System (ALS), a follow on expendable rocket system."

My predecessor as SDI Director, Lt. General George Monahan, saw the potential merits of the SSTO in supporting SDI requirements and happily supported it – as did I. Indeed, a

reusable sub-orbital vehicle could be very cost effective in launching targets for SDI tests, as later studies showed – justifying reusable sub-orbital vehicles as the first stage of the "build, test, grow" approach mentioned above.

By the time I became SDI Director in mid-1990, a streamlined management office, consisting of a technically competent Air Force Major and SETA support (less than 12 total), had initiated a screening competition among five contractors, all of whom agreed that the SSTO was feasible. In August 1991, McDonald Douglas was awarded a $60 million contract to build and fly in 18 months a sub-sonic third-scale reusable vehicle called DC-X or Delta Clipper.

To aid in advocating the DC-X in the Pentagon budget battles, I directed that the program focus on launching targets for SDI tests – an economic study demonstrated that a substantial DC-X and follow-on reusable sub-orbital launch development program could be paid for many times over by a few successful target launches in planned SDI tests. (Test failures because of target launch failures were then costing SDI substantial money, time and political support.)

Thus was a "build, test, grow" approach adopted: 1) Prove with a sub-sonic vehicle that logistics support requirements can be dramatically reduced for reusable launch operations; 2) Using the reduced logistics support procedures and near-term technology, prove with a supersonic, sub-orbital vehicle that SDI targets can be inexpensively launched (about a tenth of conventional launch costs per test) to support planned ballistic missile defense testing requirements; 3) Using the savings generated by the more cost effective target launching, improve the technology base for lightweight structures, high performance engines, reentry thermal protection, systems integration, etc. to support a truly versatile SSTO vehicle and demonstrate its advantages for missile defense and other military space missions.

The first phase, the DC-X program, came in slightly late (first successful flight in August 1993) but within budget and was widely acclaimed among space enthusiasts. Former Astronaut Pete Conrad, assisted by a Deputy and a Ground System Controller, was the operations manager for the 12 successful DC-X flights (vertical take-off, hover, lateral maneuver(s), high angle of attack flight, vertical landing). Pete claimed he could manage all ground and flight operations by himself from a single flight console. Compare this with the dozens of ground personnel in the usual mission control center that would be used by NASA's X-33 – or to launch the usual expendables. Compare the DC-X program management with that for the X-33: DC-X critical reviews involved about a dozen experts; the X-33 Critical Design Review involved hundreds of government experts from dozens of organizations. McDonald Douglas' DC-X contract team involved 20-30 key people vs. hundreds, perhaps thousands, on the X-33 team.

In 1996, NASA Administrator Dan Goldin gave General Graham NASA's highest award for his early role in championing the SSTO idea and renamed the DC-X the Clipper Graham. After an additional flight or two, the Clipper Graham regrettably had a procedural landing gear failure (due to a technician's error after completing it's 12th successful flight) and burned.

After the first successful DC-X flight in 1993, Pentagon advocates proposed Phase 2 of the "build, test, grow" strategy, a follow-on three year program using essentially off-the-shelf technology to build and test a sub-orbital Mach 12 vehicle, called the SX-2, to provide a missile defense target launch capability and to be a stepping-stone to a SSTO vehicle (Phase 3). This follow-on initiative was enthusiastically supported by Congress, but the Clinton Administration, including the new management for ballistic missile defense, was hostile to the idea, canceled the follow-on program in 1994, transferred the reusable launch mission to NASA in 1995 and, in 1997, used its transitory line item veto to kill the remnant DoD spaceplane program that Congress continued to support via directives to the DoD and additional appropriations.

In spite of the lack of Pentagon support for reusable launch, including for sub-orbital capabilities, it should be understood that the foundation of the Clipper Graham was soundly laid and still can be built upon. Launching targets for missile defense testing could still be done much more cheaply by a reusable sub-orbital launch capability based on existing technology than by continuing the standard practice of expendable launches – e.g., at less than 10-percent the cost according to industrial advocates who are currently seeking venture capital to build and demonstrate reusable launch capability and to sell services.

For example, Dr. Patrick Bahn, the President of TGV Rockets, Inc., says that he has an investor who will provide the necessary venture capital to make his development program viable if there are customers who will simply commit to buy $10 million worth of services if the venture capital funded development pans out. It seems to me that the government should take a close look at this possibility. By the way, Dr. Bahn is not seeking a government contract to develop his MICHELLE reusable launch vehicle because he distrusts government program management – in both the DoD and at NASA. I am sympathetic with Dr. Bahn's apprehension.

Dr. Bill Gaubatz, who led the Clipper Graham program at McDonald Douglas and now heads Space Available, LLC, also is seeking venture capital for developing such capabilities, so Dr. Bahn is not alone in seeking the means to continue such development in the private sector.

Maybe the private sector is the path to success. Neither the legacy of the DoD's successful Clipper Graham effort nor NASA's X-33 stall-out is encouraging.

Lessons From the Clipper Graham Experience

As is often the case with efforts at innovation, the tale recounted above suggests that, because of political and bureaucratic forces, "No good deed goes unpunished."

The lack of consistent advocacy for military space activities during the past decade was influenced by the political agenda of the Clinton Administration – best illustrated by President Clinton's September 1997 line item veto of Congressional funding initiatives for an ASAT, the Clementine follow-on and the military spaceplane.

But the Air Force has not been a serious advocate for military space programs either – otherwise it would not have supported transferring the reusable launch mission to NASA, an organization that has shown little responsiveness to supporting innovative military space programs. It remains to be seen whether Secretary Rumsfeld's military space management initiative, which makes the Air Force the Pentagon's executive agent for military space, will make a serious difference.

Now, let me answer more directly your questions, Mr. Chairman.

1) <u>How have past Administrations supported DoD and NASA spaceplane programs</u>? – *"I believe the Reagan-Bush Clipper Graham experience is the right approach to develop the needed technology for a military spaceplane: "build, test, grow" via a streamlined qualified government management team with ~$100-200 million investments annually rather than continuing NASA's billion dollar X-33 approach using the standard government acquisition process."*

A lot of blame for this failure can be laid at the feet of President Clinton and his Administration for his line-item veto of Military Spaceplane, which contributed significantly to the Air Force's cowardice on the issue—as did the earlier Air

Force/Clinton Administration decision to give NASA the "lead" for developing Reusable Launch Vehicle technologies. The Air Force Space & Missile Center apparently interpreted this "guidance/policy" to mean that the Air Force was not going to participate in RLV technology work at all.

NASA's selection of the technologically over-optimistic Lockheed X-33 concept can also be squarely laid at the feet of the Clinton Administration. The subcommittee should also note that tens of millions authorized and appropriated for military spaceplanes in the 90s was often diverted for other purposes. I understand the NASA historian has written a very interesting paper on this subject, and suggest you may want to review it.

2) <u>Should DoD and NASA get together to develop spaceplanes? If so, how</u>? – *"I think not, because NASA has a different agenda than the DoD's – and developing a military spaceplane is important to future U.S. national security. They might coordinate on common technology, I suppose."*

NASA's priorities are substantially different from the DoD's. Examples abound in the experience of the last 20 years with NASP, early versions of EELV, X-33, X-37 and other programs. In each case, NASA has subordinated DoD requirements to its own. I believe Congress and the Administration should give DoD the clear lead on reusable rockets. NASA should participate in a supporting role with respect to technology. The DoD should "build, test and grow" a military spaceplane capability, beginning with sub-orbital missions.

I believe reusable launch of targets for missile defense testing would be highly cost effective. Other "air" reusable rocket launch missions include replacements/supplements for sub-orbital aircraft missions (i.e. the long-range short-notice highly survivable reconnaissance mission abandoned when we retired the SR-71, a space control capability, and the long-range strike mission conducted by the B-2 in Allied Force and Enduring Freedom). A reusable rocket launch capability arguably would be less expensive and less technically challenging than reusable rockets for spacelift, space control and all of the other "orbit required" missions.

We should, therefore, concentrate on revolutionizing our ability to do the easier (air) missions first. This incremental "build, test, grow" approach is less demanding technically, is responsive to immediate national security requirements, and provides a foundation for revolutionizing our ability to do the things that DOD and NASA need to do in orbit.

3) <u>How much R&D has been invested in space planes and how much should the U.S. invest annually</u>? – *"I understand that the U.S. has invested about $4 billion in the 70s, 80s and 90s (on such programs as Have Region, Copper Canyon, NASP, DC-X, MSP, X-33, X-37/40), not counting Shuttle development and operations – and the residue of our total investment is four aging Shuttles, one crashed vehicle, a hangar queen, some drop-test articles and static displays. I believe the DoD should support a viable, robust "build, test, grow" reusable launch program for about $100-200 million a year – managed by a small competent technical team with incentives to produce. We do not have such an organization today."*

Any single organization able to focus on what reusable spaceplanes would mean for U.S. national security would certainly have spent that $4B in a much more useful way. Under the SDI program defined on my watch, we should have been flying reusable sub-orbital missions by the

late 1990s – and we should now be pressing toward demonstrating an SSTO capability, funded largely by the savings in providing targets of the Pentagon's missile defense test programs.

Unfortunately, DoD is currently an organization of fiefdoms with competing bureaucratic interests that are an impediment to progress. BMDO seems uninterested as far as I can tell, in spite of the clear benefits to its centerpiece test programs. DARPA has a piece of reusable rocket research – as does the Air Force. Within the Air Force, the air labs fight with the space labs for money and programmatic leadership – whether the Pentagon's military space reorganization will improve this situation remains to be seen.

A program without a clear goal will absorb any amount of money that can be authorized and appropriated. The goal for an effective program should be a flying vehicle with specific technical capabilities clearly leading to operational capabilities – and as I have emphasized, I strongly favor the "build, test, grow approach" to development.

DARPA and the Department were able to do this with Predator and Global Hawk – a similar model could be pursued for sub-orbital and space operations vehicles. Alternatively, the Secretary of Defense could establish a high-level program office with national priority – something like SDIO – or the old Polaris and Atlas programs. Perhaps, such an office could be part of the initiatives undertaken as part of the Pentagon's new military space reorganization now being undertaken. This office should be given 2-3 years to produce a flying sub-orbital vehicle.

Wherever it is placed, this program office should be structured as the SDIO program office was for the DC-X/Clipper Graham – a small, dedicated experienced team of DoD and contractor personnel, embarked on a build, test, grow mission to ultimately build spaceplanes for a future U.S. Space Force.

In this way, the U.S will get revolutionary new capabilities to enhance our national security--and industry will get revolutionary new products that will give the United States enormous advantages that are as unforeseen now as intercontinental air travel was in 1901.

Closure

Mr. Chairman, ten years ago, the technology was sufficiently mature to undertake serious development of a reusable launch capability, setting the stage for a military spaceplane. We made the initial investment and had a brilliant success with the Clipper Graham. Then we lost our way – more accurately, the Clinton Administration diverted the intended path of that "build, test, grow" program. It should be reinstated and supported with a national priority – the only question is where in the bureaucracy can be trusted to stay the course. Wherever it is placed, Mr. Chairman, I urge you to exercise close oversight of this important program to assure the vision is preserved.

Thank you.