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SINGLE STEP TO ORBIT:
A FIRST STEP IN A COOPERATIVE SPACE EXPLORATION INITIATIVE

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INTRODUCTION - THE SPACE EXPLORATION INITIATIVE (SEI)

At the end of the Cold War, disarmament planners included a recommendation to ease reduction of the U.S. and Russian aerospace industries by creating cooperative scientific pursuits. The idea was not new, having earlier been suggested by Eisenhower and Kruschev to reduce the pressure of the "Military Industrial Complex" by undertaking joint space exploration.

The Space Exploration Initiative (SEI) proposed at the end of the Cold War by President Bush and Premier Gorbochlev was another attempt to ease the disarmament process by giving the bloated war industries something better to do. The engineering talent and the space rockets could be used for peaceful pursuits, notably for going back to the Moon and then on to Mars with human exploration and settlement.

At the beginning of this process in 1992 staff of the Stanford Center for International Cooperation in Space attended the International Space University in Canada, met with Russian participants and invited a Russian team to work with us on a joint Stanford-Russian Mars Exploration Study. A CIA student and Airforce and Navy students just happened to join the Stanford course the next year and all students were aware that the leader of the four Russian engineers was well versed in Russian security. But, as long as they did their homework, they were welcome to participate with other students in defining the Mars mission and the three engineers they sent were excellent.

At the end of this study we were invited to give a briefing to Dr. Edward Teller at Stanford's Hoover Institution of War and Peace. We were also encouraged to hold a press conference on Capitol Hill to introduce the study to the world. At a pre-conference briefing at the Space Council, we were asked to please remind the press that President Bush had asked for a cooperative exploration proposal not a U.S. alone initiative.

The Stanford-Russian study used Russia's Energia launchers, priced at $300 Million each. The mission totaled out to $71.5 Billion, to send a six-person crew to establish a Mars base and return. It was an on going international venture with plans for new crews, base expansion, and extended exploration at every two year opportunity.

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The $71.5 Billion international approach contrasted with NASA's own 90-day U.S. - alone study that proposed a package topping $500 Billion by some admissions. NASA's approach was also challenged by an internal D.O.E. proposal at much lower cost, described to the Mars Society last year by Lowell Wood and, of course, by Bob Zubrin's "Mars Direct" proposal.

Through the 90's NASA and its contractors continued to push their own S.E.I. domination, being reluctant to share responsibility and budgets with other agencies at home or abroad. The $500 Billion S.E.I. approach failed to generate public interest for such a tax burden. It also failed to generate a worthy opponent to interest Congress in another space race. NASA today is facing a further 1 0% budget cut and has been issued a Mars gag order.

Bob Zubrin's "midnight supply" Shuttle cores are rusting away. The Energias are mothballed. The Magnum is a set of viewgraphs ignored by Congress. It might well be the time to re-think the issues.

In the following paper we will propose a new start to the S.E.I., coupled, as the original was, to Cold War disarmament and tapping the world's interest in science and adventure, especially if it can be coupled with steps towards cooperation and peace on this planet. We propose the S.E.I. be pegged to the development of the next millennium's space launch technology and that it be configured from the beginning as an international aerospace industry co-venture, with balanced participation from the worlds technological and economic superpowers.

The cornerstone technology is the SsTO. The development teams are the Boeing-Tupelev and the Airbus consortia together with their Russian partners. The goal is Mars and Peace in the next millennium

THE SINGLE STEP TO ORBIT SPACE PLANE (SsTO)

The Aerospace industry has turned to the Single-Stage-to-Orbit (SSTO) concept as a candidate for the next generation of launchers. In this concept a fueled rocket plane takes off from the Earth's surface and flies up to Low Earth Orbit. It releases its payload, fires retrorockets and re-enters to land once again on Earth. Since an SSTO can be refueled to fly another mission, there is no replacement cost as in expendable launchers. Per launch cost, as with commercial aircraft, is based on prorated purchase price of the vehicle, fuel and crew operations and profit goals of the operating company.

The Delta Clipper (originally funded by BMDO), the X33 and X34 (funded by NASA), were projects started to develop the SSTO technology. Unfortunately, as our studies have shown over the last five years, the Single Stage concept is untenable. Analyses show that

structural technology, engine efficiency and the rocket equation combine to give no net payload to Low Earth Orbit for a single-stage rocket. Though the goal is attractive, the technology is not up to it.

However, an alternative approach suggested by several corporations is viable, The Single step to Orbit (SsTO) uses a conventional heavy lift cargo plane to bring a fully fueled rocket plane to 30,000 or 40,000 feet Mere it is released. From that altitude with the help of wing lift and Liquid Hydrogen-Liquid Oxygen fuels, the rocket plane can make it to Low Earth Orbit with a useful payload.

In a sense the SsTO is cheating, since in effect the cargo plane is serving as a virtual first stage. However, since the cargo plane returns to base to be refueled for the next flight, all systems are recovered and the SSTO cost objectives are met. Ref. 1 shows the estimates of $10 Million per-launch of an operating SsTO system, employing one cargo plane and two space planes, in regular service.

A number of architectures have been suggested for the SsTO. The Kelly Corporation proposes to tow the space plane fully fueled to altitude. The Molnya and Hot'l concepts carry the plane fully fueled on the back of the cargo plane. A version based on the early "X" planes would drop the plane form the belly of the carrier plane.

The Stanford study concluded that the version proposed by Capt. Mitchell Clapp of Pioneer Rocket has advantages. In this approach the rocket plane loaded with the payload and liquid hydrogen flies up to the cargo plane using standard jet engines. It docks with the carrier and loads on liquid oxygen. This SsTO version has more comfortable abort paths in case of problems in either aircraft and, if the cargo plane is the Antonov 225; the world's largest cargo aircraft, the system can deliver about 9.5MT to Low Earth Orbit.

Since 1995 Stanford studies have refined this design. The background is contained in Ref. 1. This year's study has introduced a new concept in thermal protection. During re-entry, boil off of residual LOX in the main tanks is used to maintain temperature in the body compartment and the evaporated oxygen is vented through the wings to help in their thermal protection. Analyses were also extended on the possibility of using a tow cable in the refueling line to enhance overall performance. These analyses are being added to the detailed report for next year's study.

This year the team also studied how the SsTO can be used to deliver payloads to support Mars exploration. The Ares Payload Service (APS) is described in the 1999 Proceedings of the Mars Society (Ref. 2).

We feel the SsTO technology will evolve along the lines we have recommended once the limitations of the X33 and X34 are realized. The purpose of this paper today is to recommend a form of international partnership to produce the SsTO.

AWASH IN LAUNCHERS FOR THE NEXT MILLENNIUM

Analyses of the world's launcher market (Ref. 1) show that the SsTO can replace all the world's expendable launchers (except for those stockpiled for warhead delivery). One SsTO system, a cargo plane and two space planes would fly as often as once per week. One system can supply launches for all the world's communications, earth observation and weather satellites. About one fourth of a SsTO system would replace all space station and science flights of NASA's Shuttle. The low cost to L.E.O., well under $1,000/lb, may support growth in new industries: space tourism has high potential; zero gravity manufacturing is worth considering. And, as presented in the APS paper, one system will be able to generously support a Mars exploration mission with capacity left over for other enterprises.

Between now and inauguration of SsTO services there are hundreds of Russian SS18's and other Cold-War-Surplus launch vehicles made available by the Start I and Start II treaties, at least for Mars precursor and other space science missions.

Putting the Shuttle and Expendable launchers together worldwide, the SsTO when developed will replace a $20+/yr. Billion world industry with one $1/yr Billion service with excess capacity. This is not good news for the industry.

PEACE AND CO-VENTURES

Peace planners after the Cold War assumed the world would be happy to cancel plans for self-annihilation, destroy the hundreds of rockets and thousands of warheads and get on with more peaceful pursuits. They encouraged use of Russia's Energia production line to support Mars Exploration. They even allowed the Russian SS-18 and other launchers and U.S. Minute Man launchers to be used for science projects as an acceptable means of disposal. Co-ventures between Russian and Western corporations were encouraged to ease transition for the Russian high-tech industries into world commerce.

It is clear today that these disarmament hopes were uncomfortable for an industry that had been based on threat and distrust, one that faced dramatic downsizing as a result of the disarmament treaties. Nonetheless, despite heavy lobbying, politicking and sensational reporting, peace planners are slogging ahead with their efforts to pull off their peace agenda. Here's an update colored by the insider information we get from Stanford's Centers working on world peace.

- Armageddon is on the back burner, but not canceled. Fifteen to twenty thousand warheads are still on their missiles in Russia and the U.S., waiting for political resolve to ratify the Start 11 treaty and proceed with decommissioning.

- Though not pretty, the coordination of Russia with European and U.S. forces in the Kosovo intervention converged to the form envisioned by disarmament planner's ten years earlier. An organized European regional peace-making force joined with U.S. Forces in NATO for the high tech missions. Russia is cooperating with these forces in restoring order in Kosovo and the U.N. even caught up with the reconstruction efforts now underway in Kosovo and Serbia.

The politics and the press were ugly, but historians may view this lesson in peacekeeping in the birthplace of past world wars, as a breakthrough for the millennium. It certainly is an incentive for encouragement of co-ventures with Russia in its transition to democracy.

- The Euro and the European flag, (the blue flag with the yellow circle of stars) are visual evidence of the emergence of a united states of Europe. A Common Market of nations comparable to the U.S. in GDP with a good balance of trade. The ECU is transitioning to common trade, social and political policies. Like the U.S., its Corporations are aggregating into large powers and it is beginning to act as a bloc on world trade issues.

- Despite public indifference, many successful co-ventures are underway with the Russian aerospace and nuclear industries. The very high technical capability coupled with job scarcity in their government programs, make Russia an ideal source of high-quality low-cost subcontractors.

  a) The Lockheed Krunichev co-venture on Proton launchers is one of the most successful in the world with high success rate, lowest cost in the industry and a backlog of scheduled launches well into the next millennium.
  b) A similar co-venture with Europe between the Arienne Corporation and the Russian Soyuz launcher provides a competing capability for the European bloc.
  c) U.S. Russian co-ventures on the Topaz nuclear space reactor resulted in successful transfer of Russian nuclear engineering know how to U.S. designers.
  d) Cooperative work continues between Russian, U.S. and European governments to build a safe disposal site to store waste from nuclear weapons and nuclear power production.
  e) MIR and the International Space Station continue to build on Russian and U.S. efforts to cooperate and to include Japanese and European participation in near-earth exploration. (We've convinced the press that the unfinished U.S. station is "ahead" of MIR because MIR has been operating so long that it needs refurbishing. A more useful "spin" might be the message that the race is over and the participants are learning to coventure in common pursuits.)
  f) Many smaller co-ventures between Former-Soviet-Union (FSU) technologists and European and U.S. ' corporations are under way. They run the gamut of free-enterprise ventures common to western economies. The most successful seem to be in

high-tech areas, computer programming, chemicals, pharmaceuticals. Large U.S. and European firms find many highly qualified and cost effective partners.

Looked at with an historical eye we seem to be at the halfway point entering the post-Cold-War era, with old relations and distrusts overshadowing the progress being made by disarmament professionals and by private-sector co-ventures.

The American public is wary of co-venturing with Russia, a nation whose leader has just narrowly avoided impeachment and whose house is divided between liberal and conservative blocs (I guess any nation can have a bad day). We're not well schooled on the emergence of the European trading bloc. And we don't yet know which direction the Asian economies will move as they repair their market structures.

But, we can, as Mars enthusiasts side with the peace planners and the corporate leaders who are moving in the direction of cooperation and peace. The world's SsTO industry and Mars budgets will never come close to the size of the world's growing tourist industry, or even the aircraft industry that serves the tourist trade. However, by linking the SsTO development and Mars exploration to that industry, Mars enthusiasts can join with the peaceful industries and help their military industrial partners find more peaceful careers.

THE BOEING-TUPELEV AND AIRBUS CONSORTIA

It is the era of corporate consolidation, with mergers reducing the numbers of competing corporations, while creating a few world giants. In the commercial aircraft industry, the buyers, the world's giant airlines, are in cutthroat competition for passengers. They have an interest in maintaining at least two major aircraft suppliers to preserve world competition.

At the top end of the airline industry is the Super Sonic Transport (SST). The newly formed Boeing-Tupelev co-venture, the High-Speed Research (HSR) Consortium promises to supplement the Russian SST technology with U.S. management and marketing. A larger SST is expected to give the European "Concorde" a run for their money. It can be anticipated that the' European team will also enhance their SST offerings so that the world's jet set and business leaders can get to their destinations with less delay and more elegance.

At the "cattle car" end of the airline industry, the European Airbus Corporation has announced plans for the A3 XXX. This project consolidates the European aircraft industry with participation by firms from all over Europe, including some from Eastern European nations. The A3 XXX is the Common Market's competition to Boeing's 777. It will carry 700 passengers and will compete on the major routes of international airlines. They are targeting service start in 2005.

These two U.S. and European aircraft conglomerates supply a commercial market that grows at a rate of 8% per year. The major airlines place orders from both conglomerates, maintaining a stable world buyer's market for commercial aircraft. Since the size of the airline's corporation is much larger than their aircraft suppliers, they can be counted on to maintain supplier competition in today's global economy.

By contrast fighter aircraft and space launchers have been developed as national monopolies for security reasons. A nation will not subcontract parts to suppliers from other nations that may become politically unfriendly in the future. Such government procurements normally show little competition. For dual use vehicles, such as military cargo or passenger aircraft, cost efficiency is improved by purchase of commercial vehicles with specified military fittings. There will be government versions of new SST's and A3 XXX.

AN SSTO CONSORTIUM

For peace and cooperation it will be effective for the new SsTO to be developed by the commercial sector, i.e. the Boeing led and the Airbus led consortia, with government agencies procuring systems for their own applications as allowed by international agreements.

The SsTO consortium should be formed from an international partnership with three components. A management corporation that has balanced U.S. and European ownership and is experienced in both government and civilian contracting. The management corporation is tasked to contract the SsTO development evenly to the Boeing-Tupelev consortium and to the Airbus consortium. Division of the responsibilities within these two corporations would be up to their existing management structure. Ownership of the SsTO design would be evenly divided between the U.S. and European conglomerates. The SsTO consortium will sell systems to any buyer equally profitable for both corporations and their financial backers. The consortium's business motivation' would be to develop the SsTO efficiently and to market systems to as many customers as possible. The customers would include NASA, NASDA, the European, and Russian Space Programs. In addition, private sector buyers would purchase systems to support ventures such as commercial satellite launching, space manufacturing and tourism. And other nations or groups of nations would buy SsTO systems for prestige, as many nations purchase jets for their national airlines.

As in often done with new commercial development, the specialized government orders serve as a risk offset to commercial investors. Fixed orders from NASA, NASDA and the European Space Agency would be expected to play this role for the international SsTO consortium.

It is expected that a number of Airforces would also be interested in purchasing SsTO systems, just as they purchase commercial cargo and passenger aircraft. Such sales would be

subject to the same security restrictions as current aircraft sales and be consistent with the progress of world peacekeeping and disarmament efforts.

RUSSIAN PARTICIPATION

In the short term support of world peace efforts *will* be served by opening up Russia's hi-tech industry to the world markets, involving them in cooperative money making ventures. The proposed SsTO project will use the Antonov 225 cargo plane. Contracts to modify the existing aircraft for early tests and to manufacture them for the operational SsTO systems provides a substantial share of the SsTO development contract to Russia's aerospace industry. In addition, the Boeing-Tupelev and the Airbus consortia would subcontract parts of the SsTO space plane development to Russian subcontractors. In the current political climate each contract will be encouragement for Russia's cooperation in peacekeeping as well as cost effective for the consortium.

Security will continue to be an issue on the SsTO development in this post Cold War period. As with the U.S. and the European co-ventures with Russian launchers, we can expect security agencies from all three parties to oversee technical contracts for appropriateness of technology transfer on systems that may have dual use.

CONCLUSION

The S.E.I. proposals were originally offered by Premier Gorbochev and President Bush as a means to switch the resources of the world's military industrial contractors to peaceful cooperative ventures. We believe that one component of the initiative is ready for the commercial sector today. The SsTO can be developed by the U.S. and European commercial aircraft sectors, subcontracting significant components to the Russian industry as a means of bringing them efficiently into the global economy.

With a real launch capability on the horizon, the Mars Society can proceed with its efforts to bring government and private interest in Mars Exploration to the table with the resources to explore the planet as a unified peaceful world effort.

CITED REFERENCES

Reference 1: “Stanford Single Step to Orbit," Stanford University E235 June 1998. Available from the Stanford Center for International Cooperation in Space. (650-723-3471).

Reference 2: "Exploring Mars: the Ares Payload Service (APS)" by Justin Bowen, Bruce Lusignan, and Robert Osborne. Abstr. in 1999 Proceedings of the Mars Society.