ON THE HEELS OF NASA'S EARLY MANNED RECONNAISANCE:

MOUNTING AND SUSTAINING SECOND-WAVE MARS PRESENCE DECADES BEYOND APOLLO'S PRECEDENT

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ABSTRACT:

During the Apollo program's exploration of Earth's moon, NASA committed itself to only seven manned landing attempts. Even if a variant of Mars Direct prevails with NASA, the program is pursued vigorously, and successful landings dominate world headlines, a powerful precedent has already been set by the U.S. government and NASA: "Don't count on an endless stream of funds to dot the landscape of Mars with NASA landing sites." In order to sustain exploration and habitation of Mars beyond the first quarter century of human presence, it is imperative that a program be mounted to implement a cost-effective longer-term infrastructure, one that can be achieve operations at the quarter century mark. This paper argues that the Space Elevator project is not a "parallel universe" with galactic-scale coffers designed to digest galactic-scale funds, but a remarkable and cost-effective opportunity to mount such a long-term second-wave project for Mars.

THE PROBLEM

On July 20, 1969, Apollo 11 landed Neil Armstrong and Buzz Aldrin on the moon. Five more manned landings were to follow. And then, no more. In all, Apollo committed itself to seven landing attempts, even though flight-ready hardware had been built for operation and stood at the ready in warehouses. The manned lunar phase of Apollo lasted no more than four years. Four years is also the interval between Presidential elections. Even if, in some hypothetical alternate universe, Apollo had continued beyond Apollo 17, this author questions whether NASA's most successful effort in all its history could have been sustained for more than three or four Presidential election cycles. Sooner or later, a President lacking in vision would come along who would curtail the program. Not even Buzz Lightyear has been able to rekindle a groundswell of enthusiasm for the program that Buzz Aldrin, along with Neil Armstrong, brought to its first climax.

As most members of the Mars Society would agree, in order for human exploration of the planet Mars to become reality, we need to rally behind Dr. Zubrin's Mars Direct, and if not exactly Mars Direct, then the closest NASA appears likely to come to Mars Direct and its key feature of in-situ resource utilization. Perhaps NASA's current program of "Moon, Mars, and Beyond" will suffice. But having supported Mars Direct -like missions, we cannot afford to let happen to the manned Mars program what happened to the manned Moon program. In the case of Mars, the stakes are larger. On the one hand, we must do everything in our power to push for a NASA-led exploration of Mars lasting on the order of at least 4 or perhaps even 5 Presidential election cycles. Most supporters of manned Mars exploration acknowledge that NASA is the only realistic means of getting to Mars in the next two decades. On the other hand, based on the Apollo precedent, NASA's efforts to explore and work on Mars become radically unreliable once the time horizon of one to two decades is crossed. With bad news to tarnish the accomplishement throughout the entire period, even 15 consecutive years of Mars exploration under NASA management may prove to be optimistic.

Consider a scenario in which NASA has landed astronauts on Mars -- successfully. As soon as 8 years have passed, with something on the order of 8 successful landings, clearly the media will be taking a hard look at the fact that Mars has been explored twice as many times, in terms of manned launches, as was ever the moon explored. On each of those Mars missions, the surface stay time was already many multiples of the surface stay time that the longest-staying Apollo mission ever undertook. "Eight times Apollo" is then easily re-cast as "8,000 times Apollo." It isn't hard to hear the cry, "Isn't it time we drastically scaled back these Mars missions and instead aimed our nation's precious resources on more pressing needs?"

Although a strong rebuttal to this clarion call can be constructed, nevertheless a chorus of naysaying voices are likely to attract enough attention to jeapordize funding. I would argue that naysayers of this sort will be inevitable. Some reports already question our government's funding of manned Mars exploration years in advance of the first landing commitment. We're grown accustomed to that type of report. Other reports will question our government's funding of it as soon as the first manned landing is completed, especially if there arise setbacks. But even if we are able to overwhelm the public with the good news of successes on Mars, over time pressure will build to divert our taxpayers' dollars into other baskets.

The first major increase in this sort of report will likely come as soon as *four years* have elapsed between the first successful landing and the most recent attempt – that is, the time between Apollo 11 and Apollo 17. Another increase should be expected when the number of successful landings is about six (because six was the number of successful landings for Apollo) – probably in the *sixth or seventh year* of manned exploration. I hope that we, and others who see the promise of more successes and longer-term exploration of Mars, will overwhelm these skeptics with contrary evidence. Among the evidence should be included the trail of evidence, long thought too cold to follow but recently grown warm, behind life on Mars – even if that life should prove to be or prove to have been at most only viral or bacteriological in scale.

Compared to Earth's moon, Mars deserves a much more thorough exploration. How long did our ancestors take to explore the dry surface of the earth? Rain forests still exist with huge volumes of space that are largely unexplored. In the thousands of years mankind has spent scoping out the dry surface of the earth, we are just now barely reaching the end of that journey. Yet the surface area of Mars (dry but far less dry than once thought) is equal in magnitude to the dry surface area of Earth! It would be naiive and arrogant to think that an exploration program lasting anything less than a hundred years could conclusively say whether Mars harbors or has harbored life on it, much less decisively research its nooks and crannies.

In addition to the opportunity to explore, Mars offers a beautiful incentive for those interested to settle its surface. As Zubrin points out, the frontier spirit, tested to its limits by harsh living conditions, are what made the United States the success story it became. Only in the decades of time since its frontiers vanished has the United States seemed to lose its momentum for discovery, innovation, and progress. It would be wonderful to convince the government that permanent settlement on Mars should be set in motion. Yet, how realistic are these hopes on a political level?

Perhaps I am wrong, but I believe that getting the government to actively fund permanent settlement on Mars is a pipe dream, in the absence of the emergence of a radically charismatic political personality who reinvents the entire political landscape such as it has stood over the past half century.

In that case, assuming that many of us listening to this presentation or reading this report would like to facilitate Mars exploration on a sustained basis, whether or not we dignify it by the name of a "settlement," what are our options? Where can we turn to ensure that Mars exploration doesn't become the 10 or 20-year version of the Apollo program, a blaze of inspiration and rockets' red glare that expires for untold decades or centuries in the wink of an engine burning out?

In order to ensure that momentum for manned Mars exploration -- and here I do not refer to political momentum but the combination of technical, practical, and financial momentum -- in order to ensure that this momentum continues beyond however long we might count on NASA to do, we must stay at least 8 or 9 years ahead of the curve with a "second wave" of explorers, a "second wave" of exploration infrastructure, and a "second wave" of financiers gathering forces to pick up whenever NASA may eventually drop the ball. We know with certainty that, sooner or later, NASA will drop the ball. If it doesn't drop the ball on its own, politicians will ensure that the ball is forcibly taken away from NASA. (The obvious conclusion is that we need a NASA with balls!!!)

In fact, we have to make preparations for a NASA *without* balls. The question is, how?

I propose an answer called the Space Elevator project.

Dr Zubrin and many others have proven that the Conestoga Wagon/Live-off-the-land approach, a pragmatic, “modest tech” approach will best assure human access to Mars within our lifetimes. Or, in space program language, the way to get to Mars in the smallest, cheapest, and fastest package is using Mars Direct and in-situ resource utilization (ISRU). The worst way to get to Mars requires a techno-marvel on the order of Battlestar Galactica, a battalion of construction vessels, and the establishment of an entire “parallel universe” to keep the infrastructure in business.

The Space Elevator costs on the order of the Hoover Dam. It is not cheap. It involves expensive engineering. Setting cost aside, is the Space Elevator a rejection of the Mars Direct/ISRU ground rule, regressing back to Parallel Universes, Battlestar Galacticas, and Death Stars?

No, we must imagine how long and far NASA resources can be leveraged in pursuit of Mars Direct/ISRU. Suppose we measured payoff or scientific return, instead of investment. In a matter of years, perhaps as few as two missions, we reach 10, 100, or 1000 times the payoff of Apollo. If it hasn’t happened by then already, naysayers who tend to scorn spending money on manned spaceflight will become most insistent that we back off. We've gotten our paydirt, we've gone much further than Apollo ever did, back in the early 70's we had the "sense" to leave the moon behind ... who do we think we are? These sentiments are not mine, but they must be anticipated.

The political danger index will rise even if we establish a successful track record much more impressive than Apollo. For this reason, the Mars exploration community needs to have a Plan B ready to a quarter century into Plan A.

THE SOLUTION

Given that we can't afford another Apollo-style pullout, no matter how delayed compared to Apollo this pullout may come, The best insurance against the Apollo-style demise of manned Mars missions, is something called the Space Elevator.

A “Space Elevator” is a tether that physically links together the surface of a planet and a synchronous orbit. At the altitude of synchronous orbit, a body in orbit keeps pace with the rotation of the ground directly below. This is the principal that enables a user of satellite dish TV to point her antenna at a spot in the sky and tune into the many channels beamed from the satellite. In the case of the “Space Elevator” the unique feature is that the ground, tens of thousands of miles below, and the synchronous orbit are physically in contact with each other via an incredibly long tether. The existence of a sufficiently tension-resistant tether enables cargo to be able to be transported up and down the tether as though it were a vertical railroad at considerable cost-savings compared to conventional rocketry.

A dozen years ago, Brad Edwards was an upstart aerospace engineer who ran across an article claiming that the building of a "Space Elevator" is hundreds of years beyond the reach of the current state of the art. Brad Edwards wondered whether the claim was true. He launched a literature search and engineering analysis that eventually resulted in a seed funding research contract from NASA. Prior to the development of carbon nanotubes (CNT's), indeed the building of an earth-based Space Elevator would have been impossible. As of this date (October 2006), he is convinced not only in theory but by laboratory findings that a Space Elevator can be constructed, given sufficient funding, during the next 15-20 years.

The method for constructing a Space Elevator on Earth orbit would be as follows. A conventional staged rocket would lift a payload into geosynchronous orbit for approximately a billion dollars. (See Technical Budget.) The main constituent of the payload would be a spool of CNT in the form of a ribbon. At the end of the ribbon would be a smaller spacecraft designed to guide the ribbon (slowly at first) as it unspools. The unspooling spacecraft would be drawing the ribbon toward the Earth below. Meanwhile, due to conservation of momentum, as the ribbon and spacecraft unspool Earth-ward, the original upper stage housing the spool will gradually "back away" in the opposite direction.

After a long descent (entering the atmosphere at speeds far slower than would create the normal reentry conditions necessitating heat shields), the spacecraft is met by hoverable (VTOL) aircraft somewhere over the Pacific Ocean (tentatively off the coast of Ecuador). These aircraft ensure that the ribbon is carefully connected (either in the air or at sea level) to the equivalent of an oil rig specifically modified for the project. Once the initial ribbon is secured, a second ribbon of CNT, deployed by a "crawler" powered, in one design, by electromagnetic energy laser-beamed upward from the platform, is hauled up the same line until it reaches the spool-housing. This process can be repeated as many times as necessary to ensure that the tether between the Earth and orbit is very secure.

"[Space Elevator] could do for the new century what railroads did for the 1800's."
Wired Magazine

The point of all this is to reduce payload to orbit costs by no less than a factor of 10 to 1. The beauty of the entire project, like ISRU, is that, other than the CNT innovation, the principles and technology have more of the spirit of the Conestoga wagons than Battlestar Gallactica. Like a bridge connects opposite banks of a river, the Space Elevator conveniently connects Earth and space. Brad Edward's organization predicts operating costs in the neighborhood of $250/kg to any Earth or Earth-neighboring orbit.

Let us assume first that even Brad Edward's 15 year planning horizon is optimistic. Let us assume 20 years instead. Assuming, further, that NASA first lands a team of astronauts on Mars in the year 2018 (not overly ambitious given the technology, the policy Moon-Mars-&-Beyond,

and the political climate), then at a mission-per-year rate, the Moon-Mars-&-Beyond program will reach its "quicksand funding" era probably around 2030, give or take a few years.

If we want manned Mars exploration and habitation to continue with little or no interruption, then flights to Mars using an Earth-based Space Elevator (a Mars-based Space Elevator would be even easier!) would need to start no later than 2032 or 2033. Backing up 20 years from the latter year, we conclude that the Space Elevator's green-light should occur no later than 2013.

Our goal is not a flag planted on Mars. Our goal is Mars itself. The road to Mars will be tough enough without having to re-engineer, re-build, and re-deploy the entire infrastructure from scratch, decades later, like Apollo. The nightware would be the equation "Mars now = Apollo then." The success of the early missions to Mars must be backed up with long-term commitment, perhaps a collaboration between public and private sectors, to the Space Elevator project or some variant of Space Elevator project. In this way, manned presence on Mars will endure beyond the 25 year mark and become out of reach from government cutbacks.

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Figure 1. Mark Moran on Mars Desert Research Station Crew #18

Figure 2. The road to Mars is tough enough, without having to re-build it, decades later, like Apollo.

Figure 3. The Technical Budget for Space Elevator (courtesy Dr. Brad Edwards).

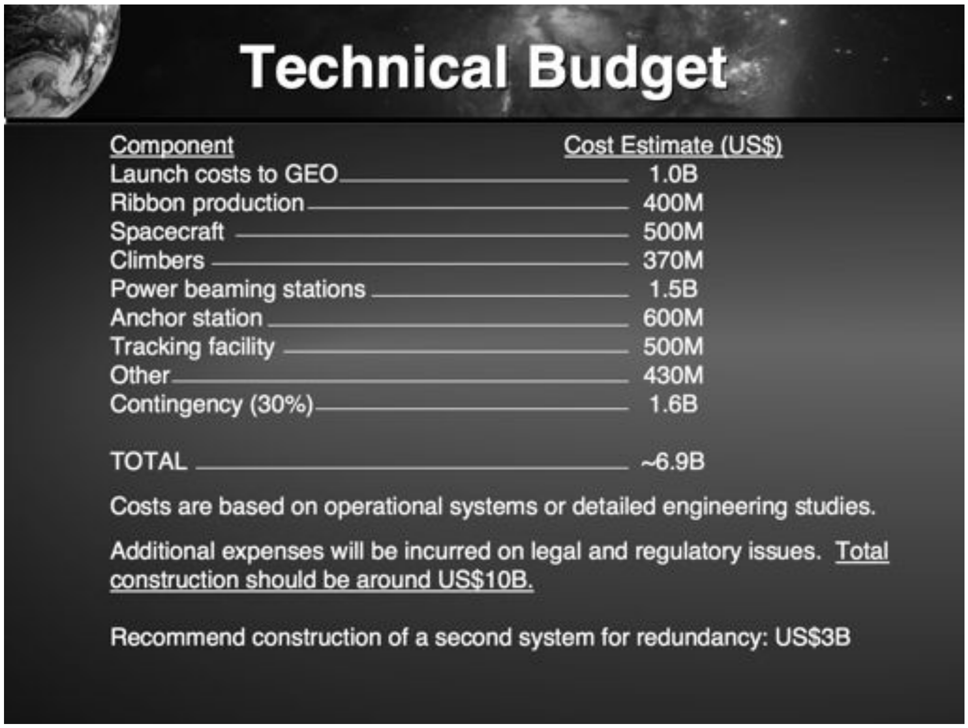

Figure 4. Over a game of chess, Mark Moran and MDRS Crew 18 discuss the sustained exploration of Mars in the wake of NASA's initial reconnaisance of the early 2020's. (Photo courtesy Joan Roch.)