CANYON SPACE TEAM

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http://www.canyonspaceteam.org

The primary goal of the Canyon Space Team is to support low cost, private, human access to space (sub-orbital, semi-ballistic flight) including research and development.

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July 2001 General Meeting

There will be no meeting for July
See everyone the second Sunday of August

"It's time we face reality, my friends.... We're not exactly rocket scientists."

Canyon Space Team

CST Newsletter

Volume 1, Issue 3 July, 2001

X-Prize Vehicle

The focus of this issue of the CST newsletter is on the X-Prize Vehicle baseline vehicle design concept. Included is a description of the vehicle construction, guidance and control, and the trajectory analysis.

Inside this issue:

President's Report

Rich Harman

Here is a brief summary of my certification rocket. *(Editors note: As mentioned last month, Rich Harman will be using the CST Hypertek engine to earn his rocket certification in order to launch and test the S4V. The rocket he describes is his personal property and was not funded by CST.)*

The rocket I will be using for my level 1 & 2 Tripoli certification is a slightly modified PML (Public Missiles) Aurora. It stands 72" tall. Its diameter is 4". Launch weight will be approx. 10 lbs.

Modifications include shortening the motor tube (it was three feet long) to make room for dual deployment and not fixing the main body to the fin section (this is where the rocket will separate). Also an altimeter/electronics bay module will be fitted inside the main body tube rather than friction fitted over the N2O tank as called for in the plans.

The fins were also cut down to reduce weathercocking and to lessen the likelihood of landing damage.

It will be using the AED RDAS flight computer/data logger as its primary recovery electronics. Back-up electronics will be a G-Wiz flight computer.

Both of these devices have integrating accelerometers for detecting apogee and an altimeter for recording altitude and firing the main chute. Drogue chute is deployed at apogee and the main at 400 ft (preset, not changeable for the G-Wiz) or 500 ft (or any altitude as programmed into the RDAS).

The RDAS also has data logging capability and can be programmed using a laptop or pocket pc.

Under Tripoli rules a member may now certify level 1 with a hybrid rocket in the "H" or "I" range. The Hypertek 440 can be configured as an "I" or a "J". Ideally, on certification launch day, the rocket will be flown first as an "I", recovered safely for a successful level 1 flight then reconfigured and flown again the same day for level 2 as a "J".

Resources mentioned in the article:

RDAS	http://home.iae.nl/users/aed/rdas/rdas.htm
Public Missiles	http://publicmissiles.com/
Tripoli	http://www.tripoli.org/
Hypertek	http://www.cesaroni.net/hypertek.html
G-Wiz	http://www.pratthobbies.com/gwiz.htm

Treasurer's Report

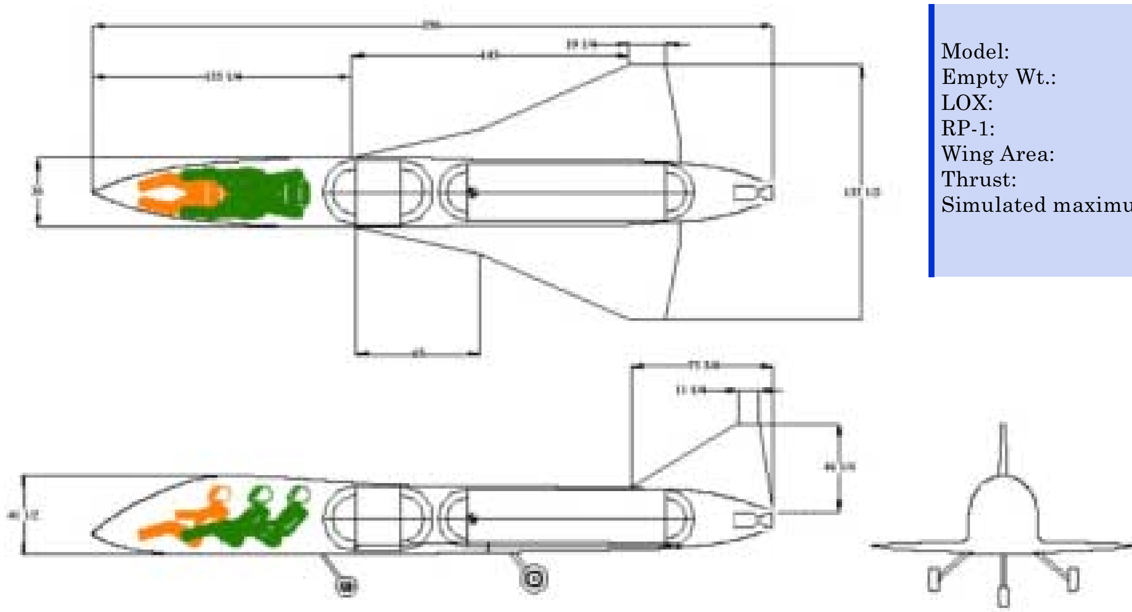
Rich Collingwood

Treasurer's report as of 6/28/01:

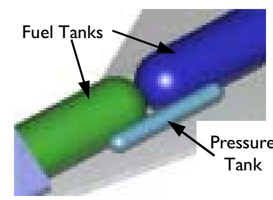
Checking Balance:	$383.50
Savings Balance:	$000.11

No activity in the treasurer's report since the last newsletter.

X-Prize Vehicle Concept



Model: Rich X-13
Empty Wt.: 2,200 lbs
LOX: 50 ft³
RP-1: 25 ft³
Wing Area: 110 ft²
Thrust: 8000 lbf
Simulated maximum altitude attained: 340,000 ft



X-Prize Baseline Vehicle Concept Design by Rich Harman and Billy Roeseler

The Super Sonic Sub-Scale Vehicle (S4V) model is based on the X-Prize baseline vehicle concept design illustrated above. Simulations using X-Plane (http://www.x-plane.com/) were used to arrive at this design layout.

The X-Prize Vehicle (XPV) will be constructed primarily of composites using high temperature resistant resins. It is expected that 90% of the structure will be below 200°, with about 300° on the leading edge and nose stagnation areas.

The XPV is fueled by pressure feed liquid oxygen (LOX) and RP-1. (The LOX tank is the longer of the two tanks in the illustration above.) The fuel tanks will also be made of composites with thin metal liners. The rocket engine will have a chamber pressure between 200 and 300 psi and an Isp of around 200 sec.

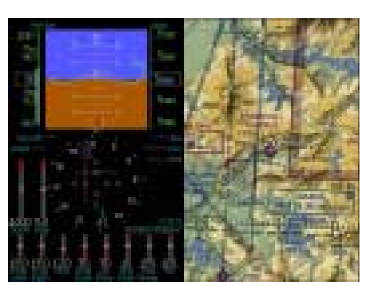
A biconvex airfoil of less than 6% has been considered for the XPV with a 6% NACA 6606 being used on the S4V. A titanium tube will be used for the wing leading edge and skins made of graphite composite with aluminum honeycomb core. Two spars, ribs, and the flaperon finish out the simple and light weight wing.

The nose gear will retract between the fuel tank and the crew cabin. The main gear will retract into the wing/body fairings aft of the pressure tanks.

Guidance and Control

A custom Electronic Flight Information System (EFIS) will be used as the main pilot reference along with other instruments to be IFR capable. An unrestricted Global Positioning System (GPS) will be required for flight above 60,000 feet altitude and 999 knots airspeed.

Power will be supplied by on board batteries for the approximately 15 minute flight.



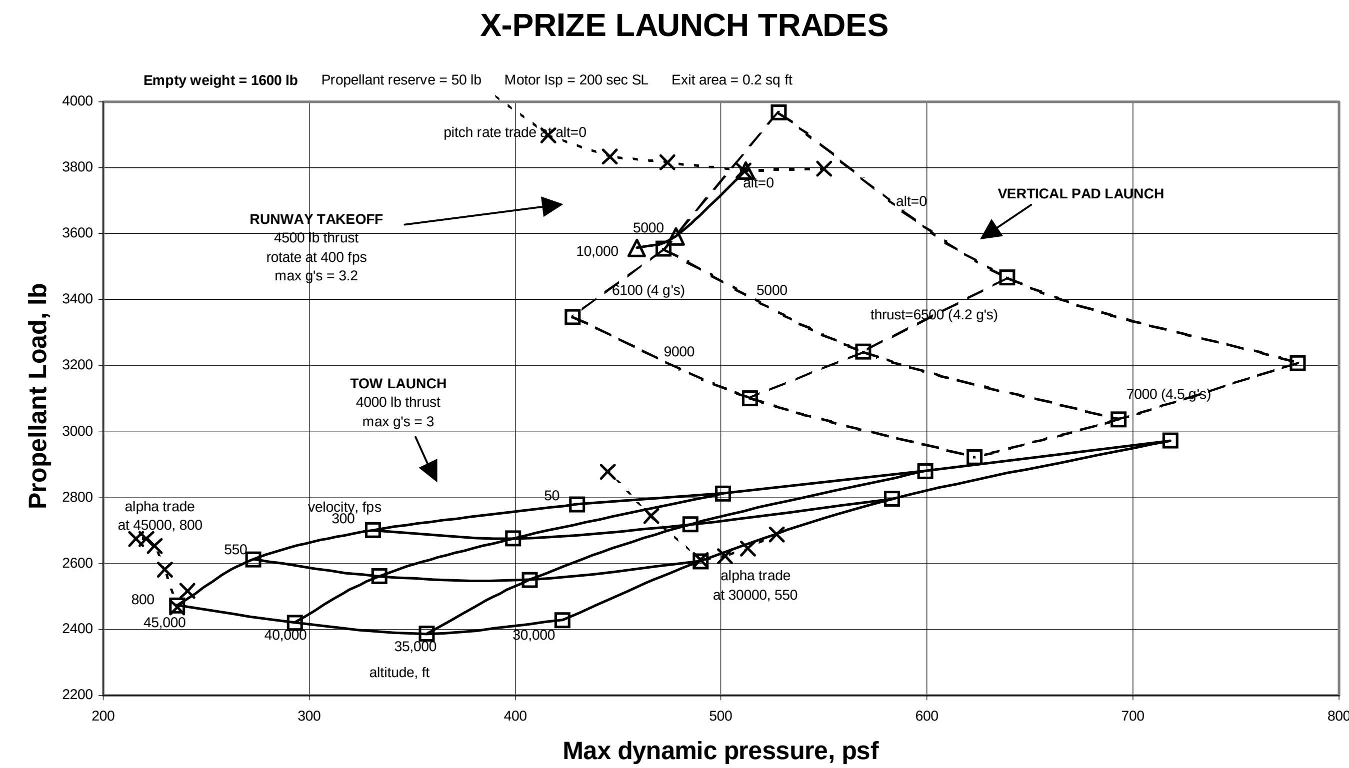
$8,800 EFIS from Blue Mountain Avionics (www.bluemountainavionics.com)

Flaperons and rudder will be driven by 200 watt 28 vdc electric actuators.

Cold gas exoatmospheric flight control will use 400 psi nitrogen from the vehicle main pressure tanks.

Also, an automatic recovery and landing system has been considered in the event of pilot incapacitation.

Trajectory Analysis



Trajectory Analysis Comparison Plot by Ted Hansen

Former member Ted Hansen performed a trajectory analysis comparisons between tow launch, runway take-off, and vertical pad launch in December of 1999 for CST.

The simulation trades Ted performed showed the required propellant as a function of release altitude and horizontal velocity for 1000 lbs empty weight, 1600 lbs with payload, 50 lbs propellant reserve, sea level thrust of 4000 lbs, sea level Isp of 200 sec, and 0.2 square foot exit area. The required fuel was pretty flat at 2400 lbs for horizontal velocity of 800 ft/sec and release altitudes between 30,000 and 45,000 ft, with 35,000 ft showing the lowest propellant required. Propellant mass fraction 2400/4000 = 0.6

He also showed 3800 lbs of propellant are required for horizontal take off at sea level and 4000 lbs of propellant are required for vertical launch at sea level, increasing the thrust levels to 4500 and 5000 lbs respectively. These options had substantially higher propellant mass fractions, as the Zero Fuel Weight was held constant at 1600 lbs. One of the most dramatic results of this study was the max dynamic pressure, between 200 and 400 psf for the popular air launch options and between 500 and 800 psf for the horizontal and vertical ground launch options.

Board Member, Billy Roeseler, performed an earlier analysis of the recovery trajectory that starts nearly straight down at M = 3.6 at the edge of the atmosphere at 180,000 ft. The high angle of attack is held for 25 sec to bleed off speed until the load factor becomes excessive at around 80,000 ft. Then the angle of attack is modulated between 0 and one degree to maintain a relatively smooth deceleration for about 2 minutes, when the vehicle goes subsonic at around 20,000 ft. Billy states, "I feel the dynamic pressure spike to 10 psi at 20,000 ft could be eliminated, but it will be difficult to control the 6 psi level without more drag."

This takes the vehicle downrange over 100 km, "which could also be eliminated with speed brakes." Ted also felt we could mitigate the 5 g acceleration peak on recovery by using deployable aero surfaces. Billy stated, "We will continue work on a system of deployable drogue and pitch angle changes to keep maximum acceleration below 3 g's if possible."