Economical Transport of Probes into Interstellar Space

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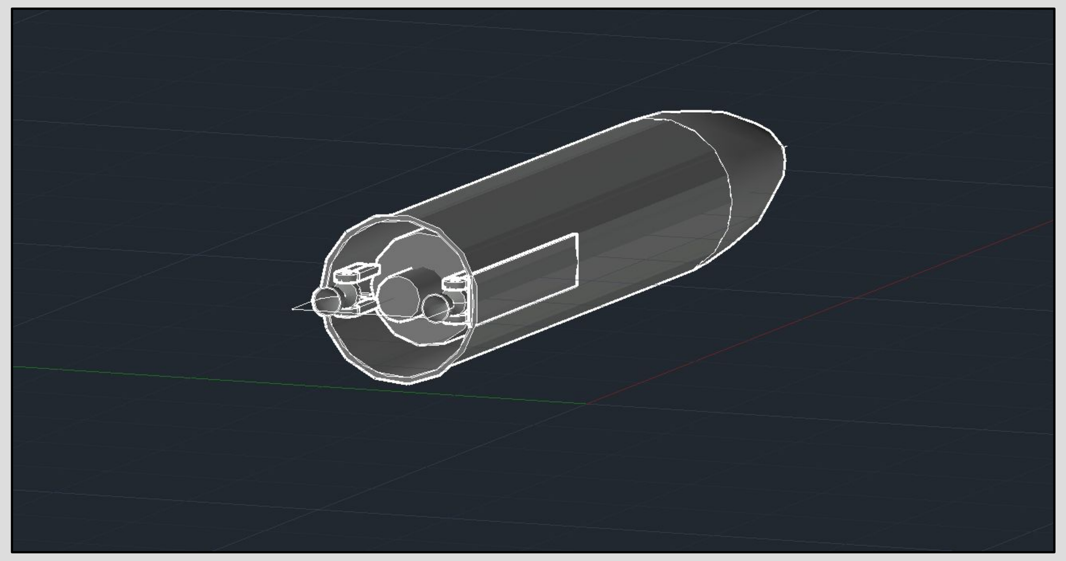
INTRODUCTION

The economics of space travel has made its way into the minds of even the most decisive of scientists, yet it persists to conflict with the confines of modern propulsive technology. Even decades after the launch of the first payload into space in 1957, the economics of space travel have rarely been considered. Forthwith, a solution to such a complication in projectile design would decree a revision in system engineering for suborbital rockets. The intent for such a research question is to innovate, and recreate the elements of a projectile that constitute a successful transfer of a probe into space.

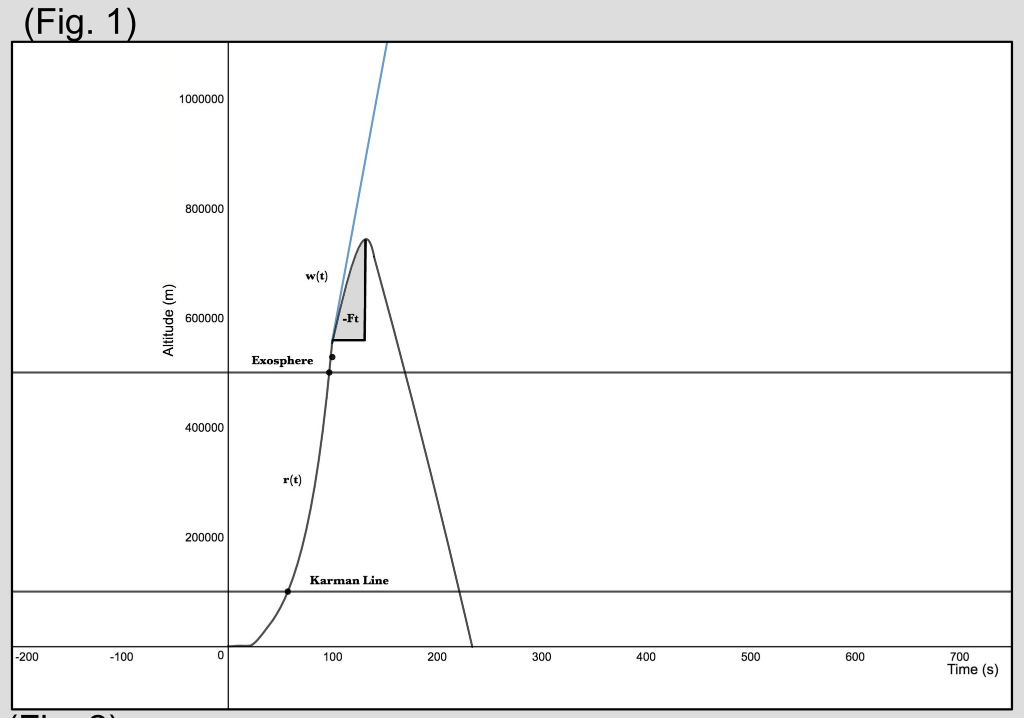
DISCUSSION, ANALYSIS, AND EVALUATION

Using research gathered on previous launches, a trajectory for a prototype rocket was set up. Moreover, more components and parameters were implemented into the trajectory functions (i.e, density and drag coefficients) over time. The stages of trajectory involve no separation of the projectile components to maintain a low cost and environmental impact. For this reason, the same boosters that powered the Delta IV Heavy in 2004 are to be vectored in multiple directions to alter the direction of the projectile. Furthermore, the projectile will reenter the atmosphere after a burn in the polar direction to drop itself below escape velocity.

DATA AND FINDINGS



(Fig. 1)



(Fig. 2)

Trajectory/Statistics

Cost: N/A
Structure Elements: Carbon Composite w/ Insulative Layer, Titanium
Net Weight: ~140,000-200,000kg
Propulsion: RS-68A (2) - 6274 kN
Fuel/Oxidizer: Hydrogen, Oxygen
Stability/Control: Gimbaled Thrust
Maximum Payload Size/Weight: $2744m^3$; 1000kg

As a result of the simplicity of the projectile, the trajectory has been separated into three stages. Below are two functions (Fig. 3 & 4) that make up these launch stages, although the parameters may differ. In this case, r(t) represents the trajectory of the rocket, while w(t) refers to the trajectory taken by a probe. A variation of these functions has been plotted. (Fig. 2)

$$r_\alpha(t) = \left[\frac{F_t}{2(m_1 - C_1 t)} t^2 - \left(\frac{\frac{G\cdot(m_1 - C_1 t) m_2}{((r_\beta(t)) + Q)^2} + \frac{1}{2} P_b \cdot e^{\frac{-g_o M(r_\beta(T) - h_b(r_\beta(t)))}{R \cdot T_b(r_\beta(t))}} \cdot (v_\beta(t))^2 C_{DR} A}{2(m_1 - C_1 t)} t^2 \right) \right]$$ (Fig.3)

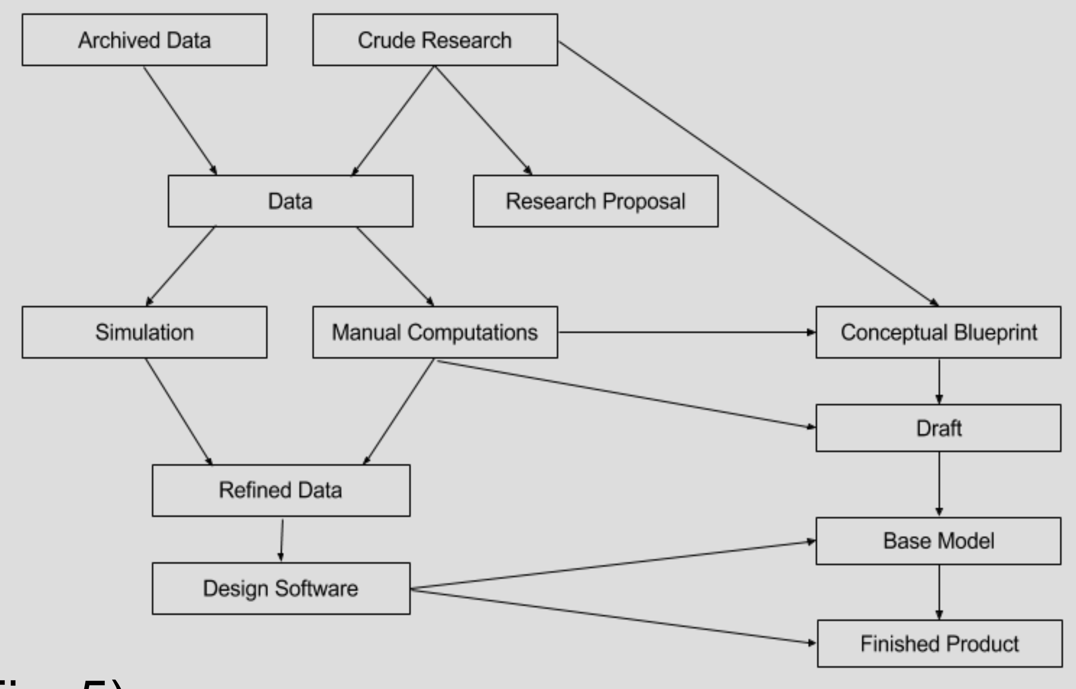
$$w_z(t) = \left[r_\alpha(T) + w_v(T)(t - T) - \left(\frac{\frac{G m_2 m_3}{((w_{z'}(t)) + Q)^2} + \frac{1}{2} P_b \cdot e^{\frac{-g_o M(w_{z'}(T) - h_b(w_{z'}(t)))}{R \cdot T_b(w_{z'}(t))}} \cdot (w_v(t))^2 C_{DW} A_w}{2 m_3} t^2 \right) \right]$$

(Fig. 4)

CONCLUSIONS, IMPLICATIONS, AND NEXT STEPS

A “mathematical” prototype projectile was developed to see where the transport of probes and other payloads into space was headed. It can be seen that **no cost label** has been placed on this theoretical rocket. Nevertheless, as far as the insight this endeavor has provided it can be concluded that rockets have the potential to be simplified mechanically and could use more abundant fuels.

RESEARCH METHODOLOGIES



(Fig. 5)

The procedure I followed to design this rocket prototype is shown in Fig. 5. In contrast, a much less compendious way to express these steps is as follows:

1. Obtaining data and information on the structural engineering of rockets and analysis.
   - 1.1. Data on atmospheric properties
     - 1.1.1. Barometric Pressures/Density
     - 1.1.2. Drag Coefficients
     - 1.1.3. Temperature Variation
     - 1.1.4. Radiation
   - 1.2. Data on gravitational field
     - 1.2.1. Escape Velocity
     - 1.2.2. Force Variation
   - 1.3. Fuel Component
     - 1.3.1. Hydrogen and Oxygen
     - 1.3.2. Chemical Reaction
     - 1.3.3. Combustion Rate
   - 1.4. Structural geometry
     - 1.4.1. Surface Integrals
     - 1.4.2. Material Composition
     - 1.4.3. Material Properties
   - 1.5. Control System
     - 1.5.1. Fuel Monitoring
     - 1.5.2. Vectored Thrust
     - 1.5.3. Gimbal Integrity
     - 1.5.4. Pressure Monitoring
     - 1.5.5. Signal Transmission
2. Computations and Drafting a Blueprint
   - 2.1. Drafting a Trajectory
     - 2.1.1. Differential Equations
     - 2.1.2. Composite Functions
     - 2.1.3. Staged Functions
   - 2.2. Economical Design
     - 2.2.1. Simplifying Parameters
     - 2.2.2. Launch Stages
     - 2.2.3. Atmospheric Conditions
3. Data constitutes a Framework for Projectiles
   - 3.1. AutoCAD Blueprint
   - 3.2. Where is projectile design headed?
   - 3.3. How would cost be reduced for future probe launches?

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Works Cited: (n.d.). Retrieved from https://history.nasa.gov/sputnik

Delta IV Heavy. (n.d.). Retrieved from http://www.spaceflight101.net/delta-iv-heavy.html