MATLAB ROCKET LAUNCH

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abstract

This project utilizes the MATLab (Matrix Laboratory) program to simulate the trajectory of a rocket given initial conditions and physical parameters. MATLab analysis is used to simulate the flight of a rocket, including effects due to drag, thrust, mass, and gravity. For purposes of this paper we empirically studied the Saturn V, though the scripts could be used to theoretically predict the flight of any rocket.

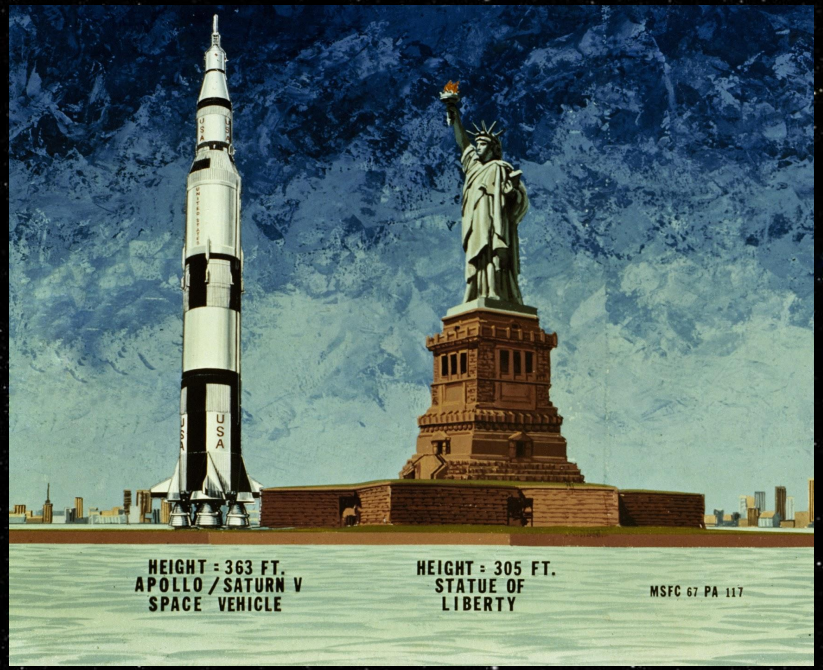
Keywords: Rocket, MATLab, Drag, Thrust, Simulation

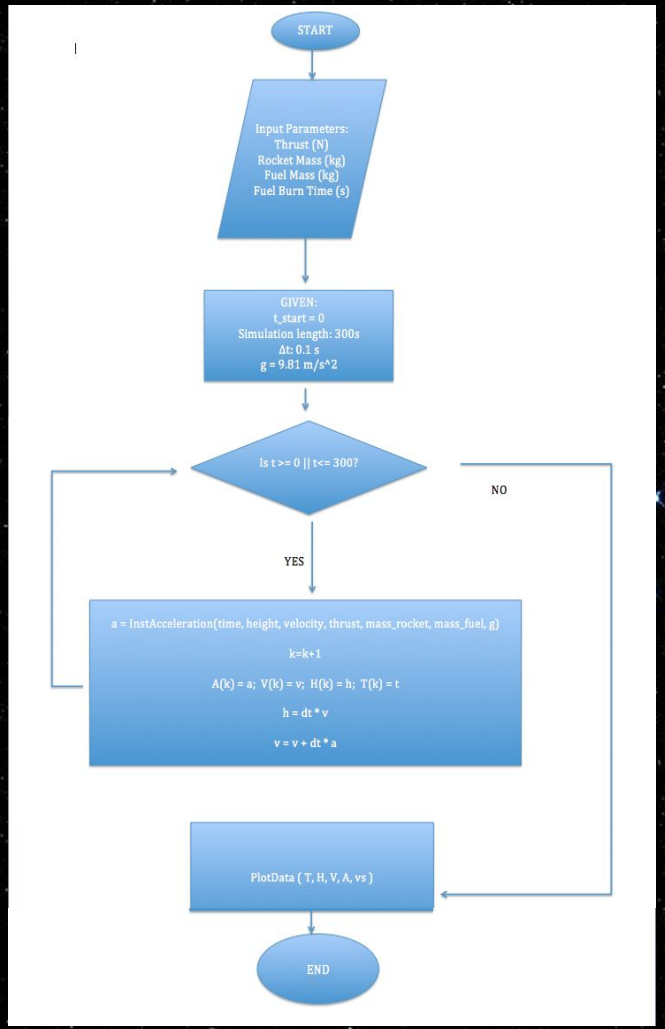
Background

The Saturn V was used in the Apollo program in the late 1960's and early 1970's and was classed as a "Heavy Lift Vehicle," meaning it was very powerful. A total of 13 Saturn V rockets were launched carrying Apollo missions as well as the Skylab space station. Every part of the rocket is used and discarded during the mission, save for the small command module at the top which returns to Earth.

The rocket generated 34.5 million Newtons (7.6 million pounds) of thrust at launch, generating more power than 85 Hoover Dams.

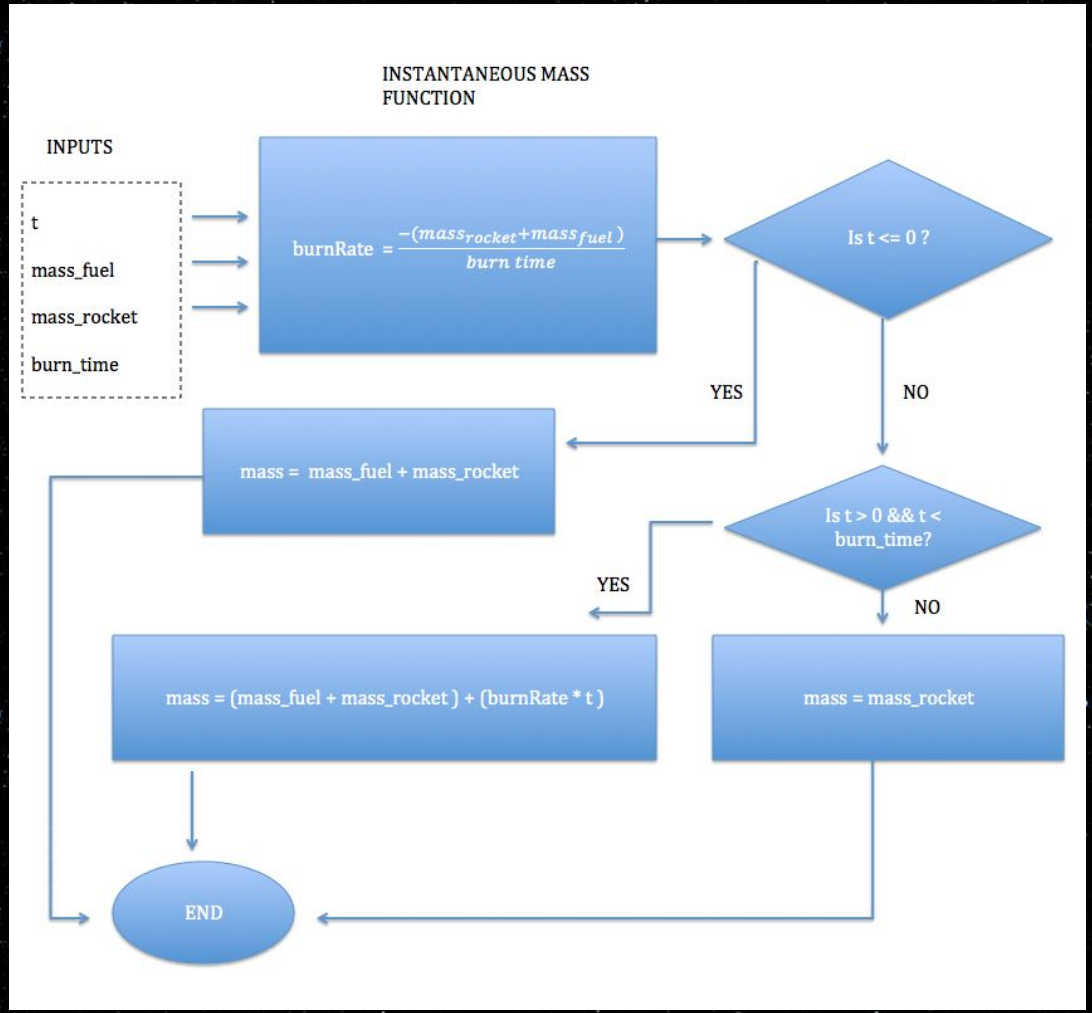
The Saturn V rocket was 111 meters (363 feet) tall, 60 feet taller than the iconic Statue of Liberty.



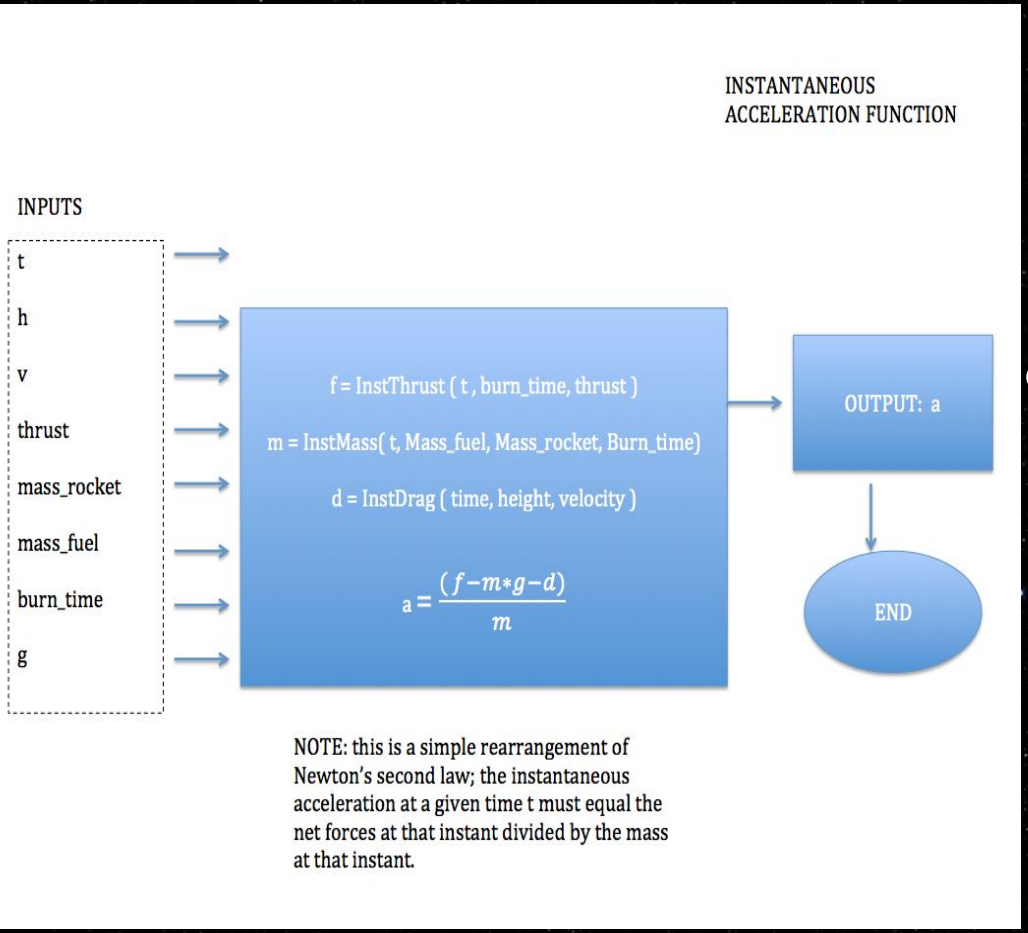


FULL SIMULATION FLOW CHART

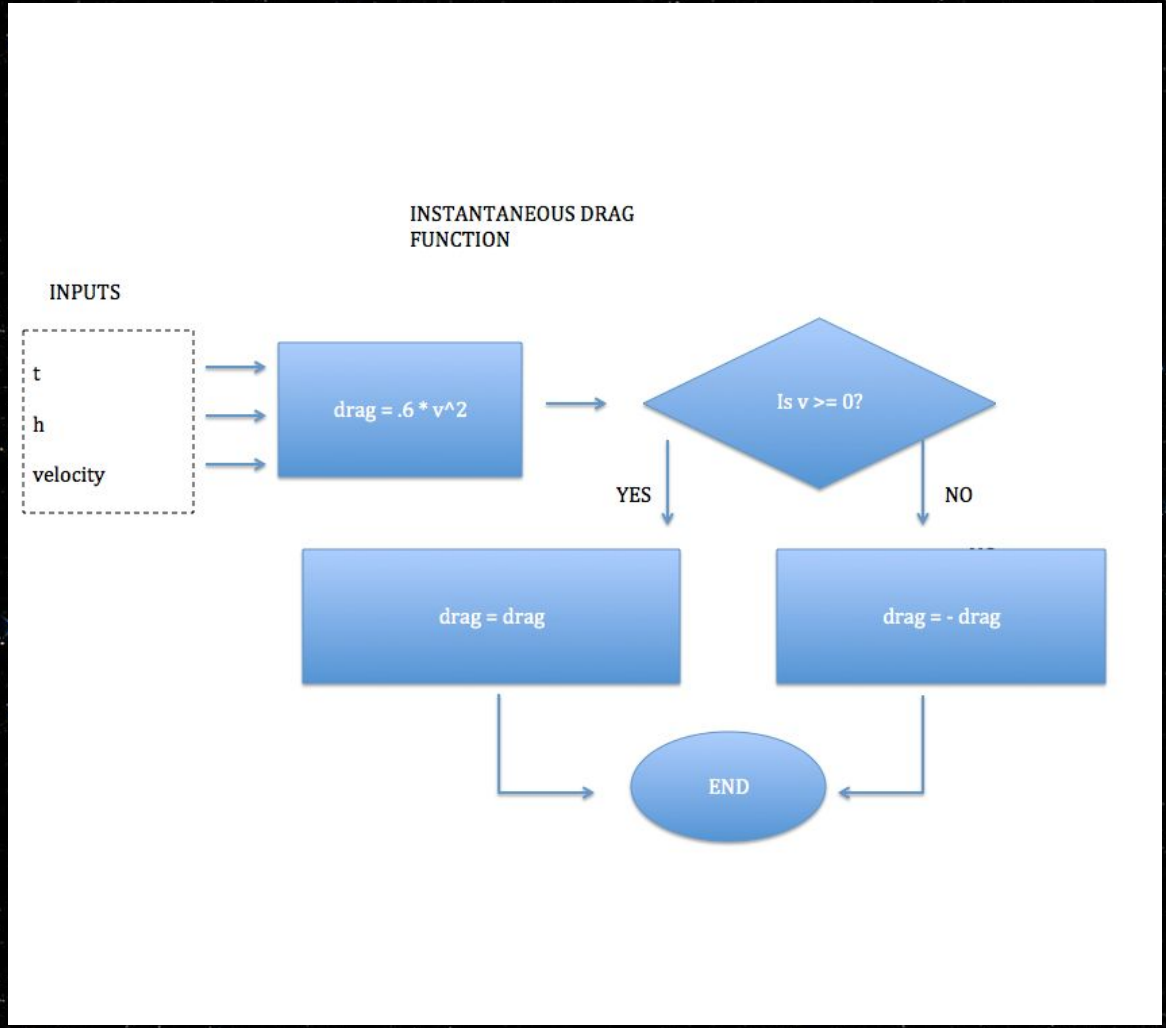
mass flow chart

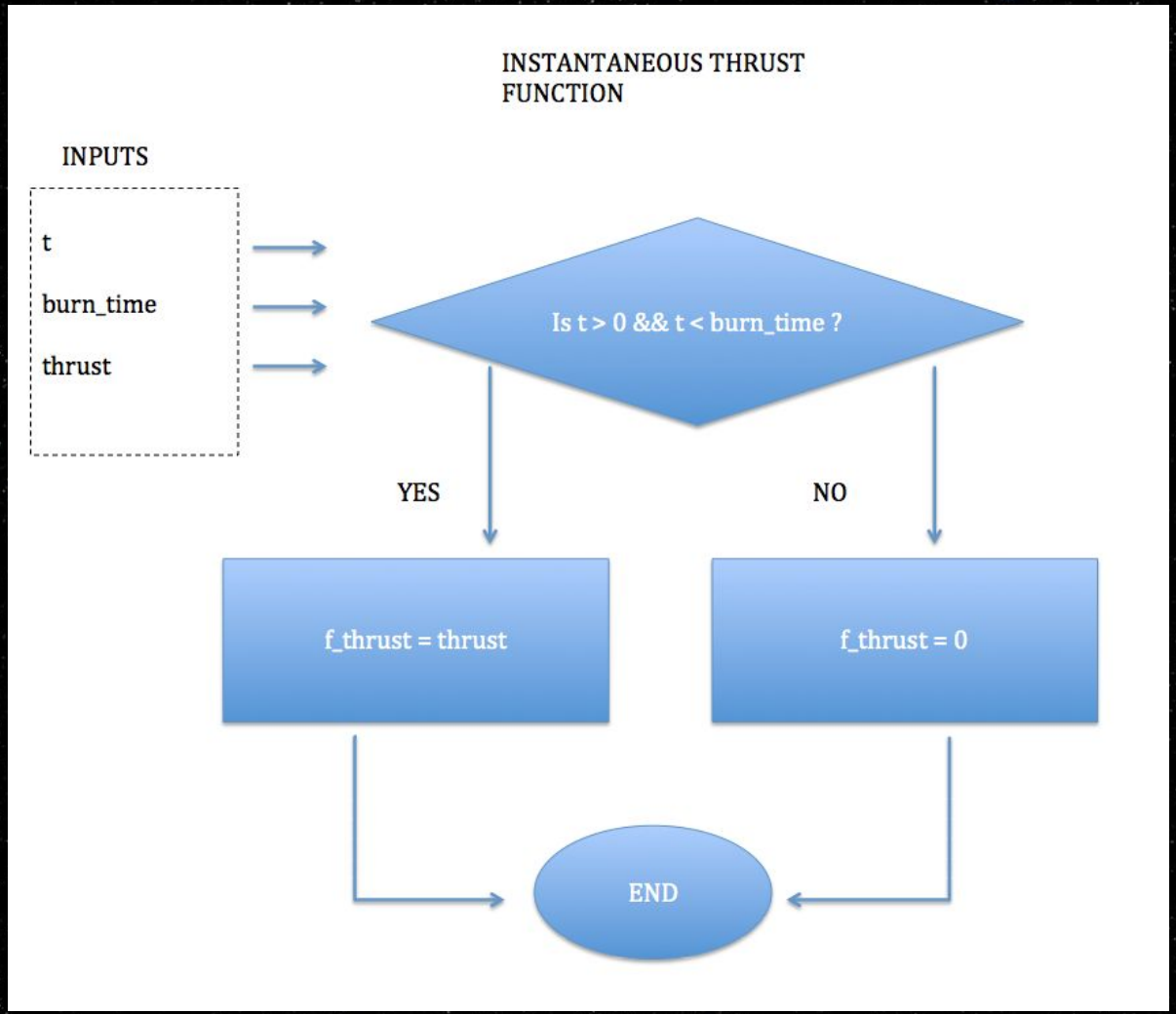


acceleration flow chart



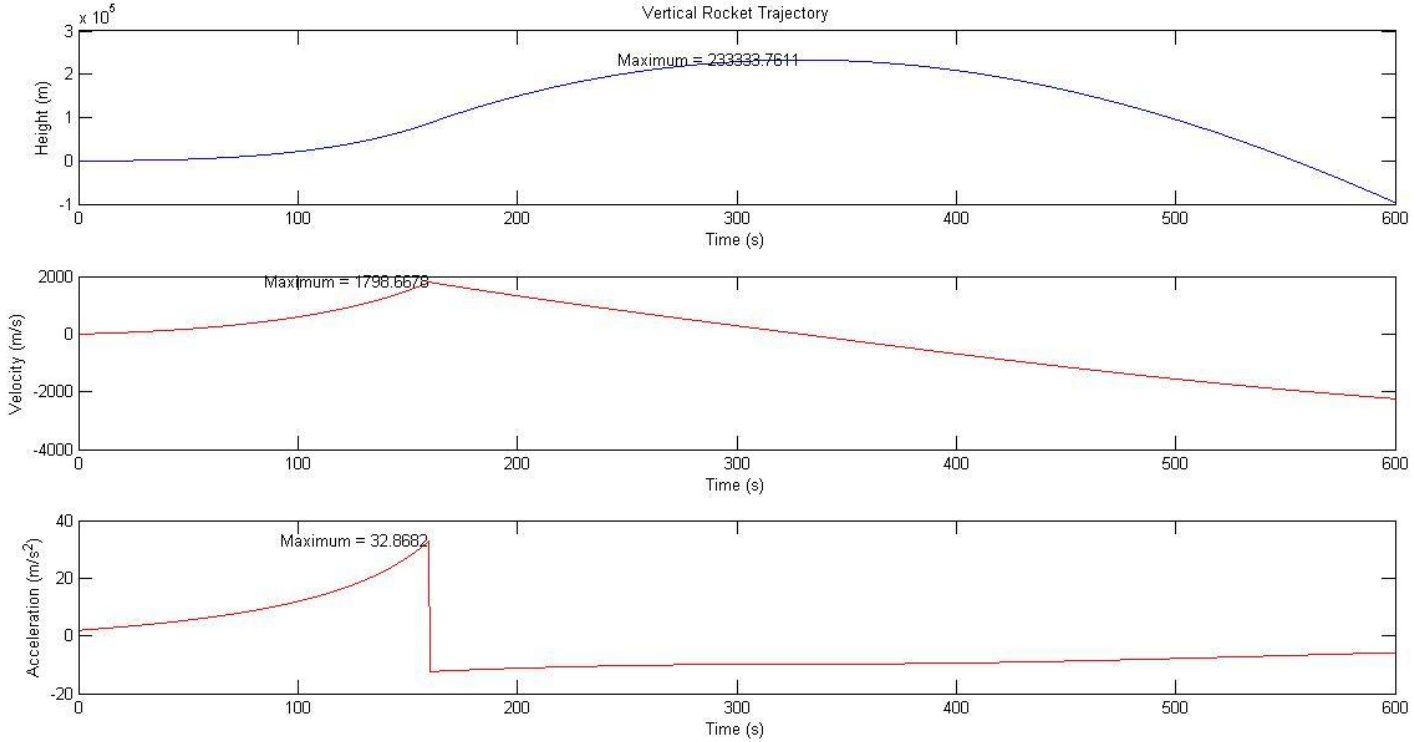
Drag Flow Chart





THRUST FLOW CHART

Results


Vertical Rocket Trajectory
x 10^5
Maximum = 233333.7611
Height (m)
Time (s)
Maximum = 1798.6678
Velocity (m/s)
Time (s)
Maximum = 32.8682
Acceleration (m/s^2)
Time (s)

altitude

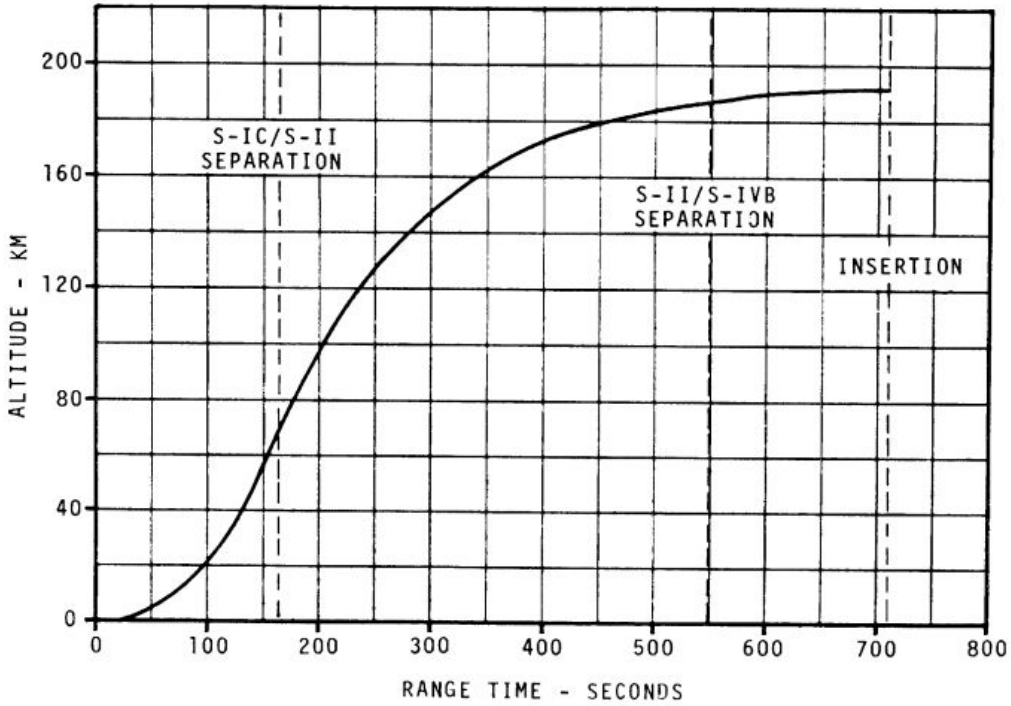


FIGURE 3-2. ALTITUDE - ASCENT PHASE

VELOCITY

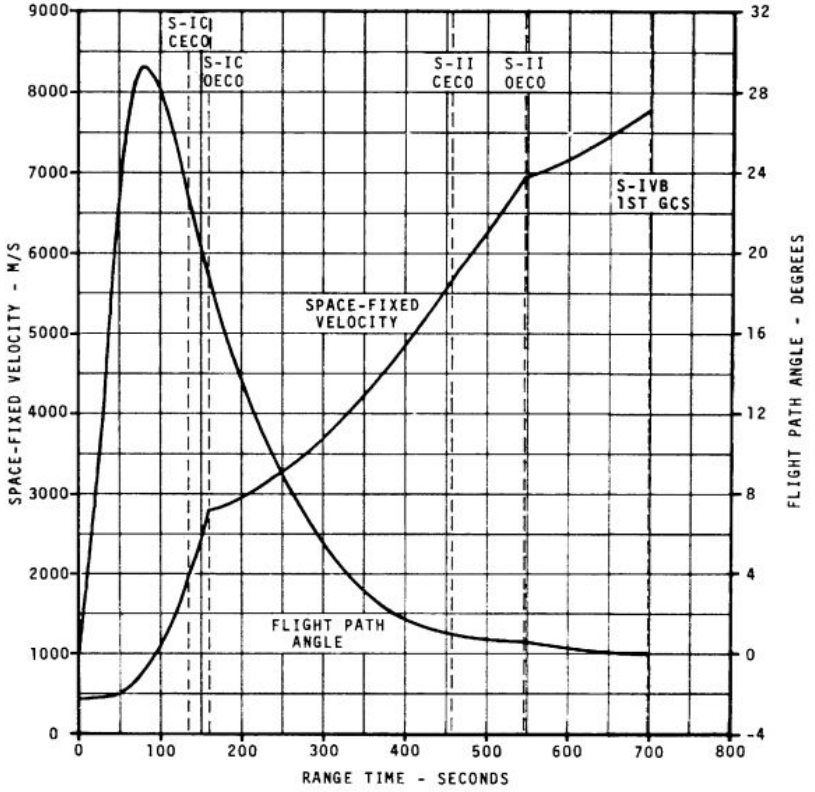


FIGURE 3-5. SPACE-FIXED VELOCITY AND FLIGHT PATH ANGLE - ASCENT PHASE

acceleration

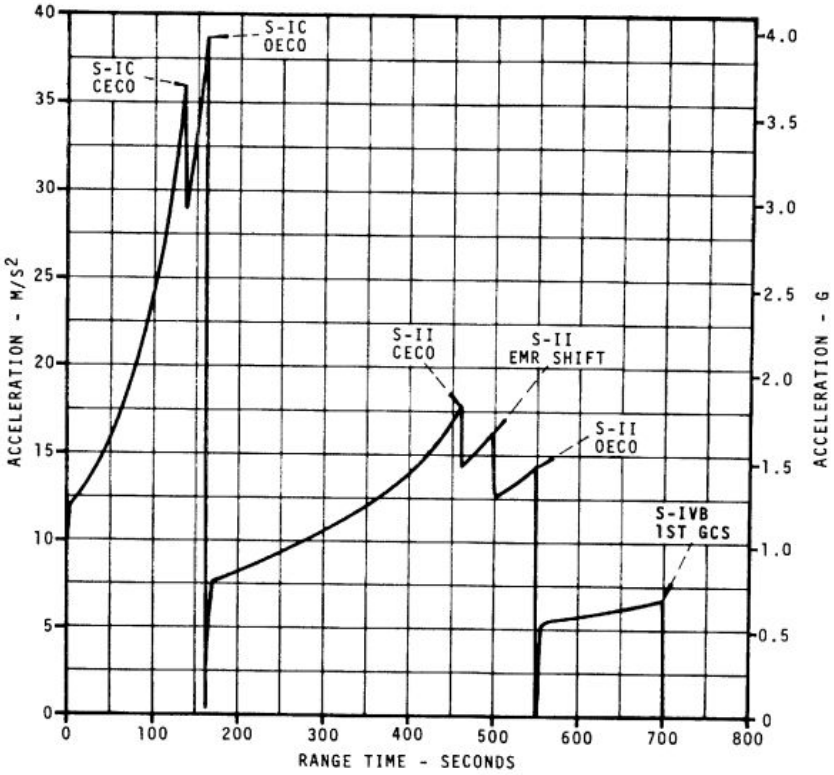


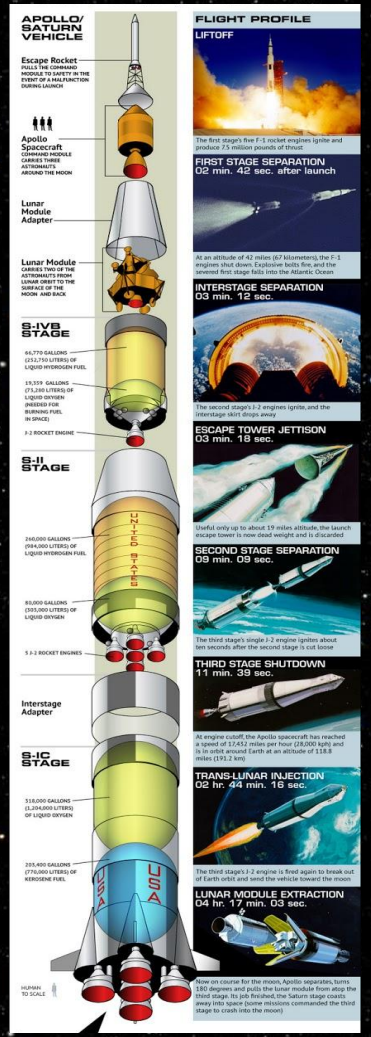
FIGURE 3-6. TOTAL INERTIAL ACCELERATION - ASCENT PHASE

compare and contrast

	True Value	Calculated Value	Absolute Error	Relative Error
Altitude	190,000	233,333	43,333	22.8%
Velocity	8400	1798	6,600	78.6%
Acceleration	38	33	5	13.2%

reasons for error

- Phase 1 only
  - 3 stages in reality
  - differing thrusts
- Air Density
  - assumed constant
- 2D model vs. 3D model
  - orbit
  - vertical only



conclusion

- Multiple parameters change during rocket flight
- MATLab allows a much easier way to model such simulations
- The data from our preliminary script gave us fairly accurate results
- Possible error came from the fact that we are not NASA
- Yes we actually did rocket science