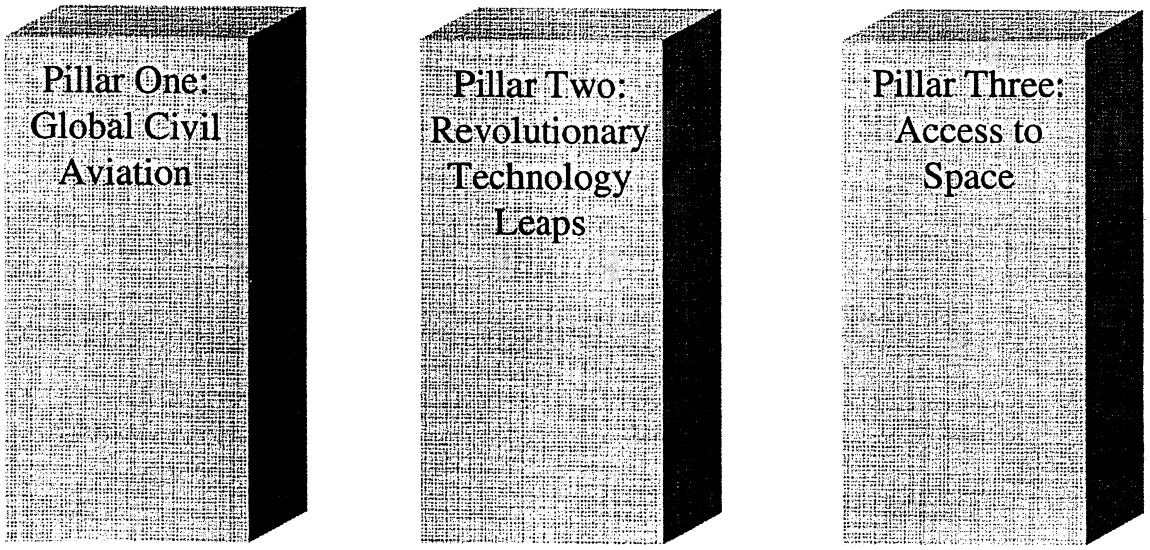
THE TRAILBLAZER PROGRAM

Charles J. Trefney
NASA Glenn Research Center
Cleveland, Ohio

"Three Pillars for Success"

Established in 1997 by the Office of Aeronautics and Space Transportation Technology (OASTT) NASA Headquarters, Washington D.C.



http://www.hq.nasa.gov/office/aero/

Pillar Three: "Access to Space"

The Challenge

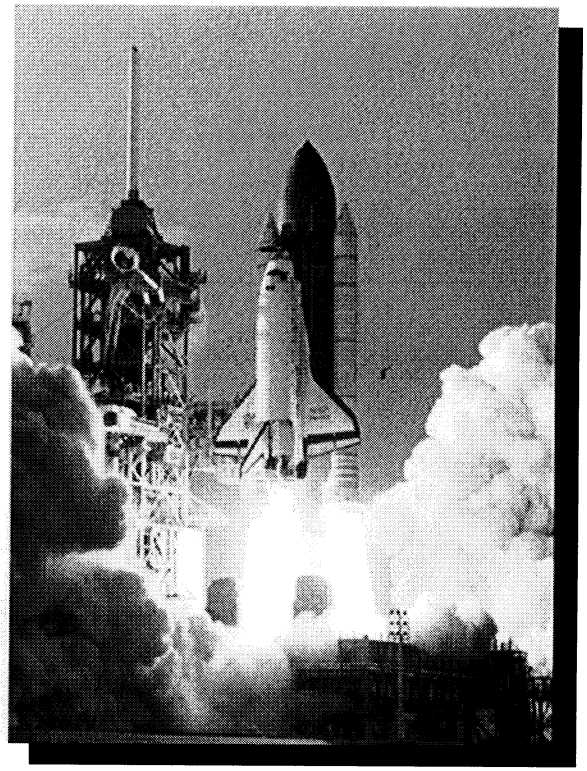
"Without affordable and reliable access to space, the future of the space program is hindered by the high cost, low reliability, and poor operability of payload launch..."

"The cost of space access is roughly $10,000 per pound of payload delivered to low-Earth orbit."

http://www.hq.nasa.gov/office/aero/

Why is Space Access So Costly?

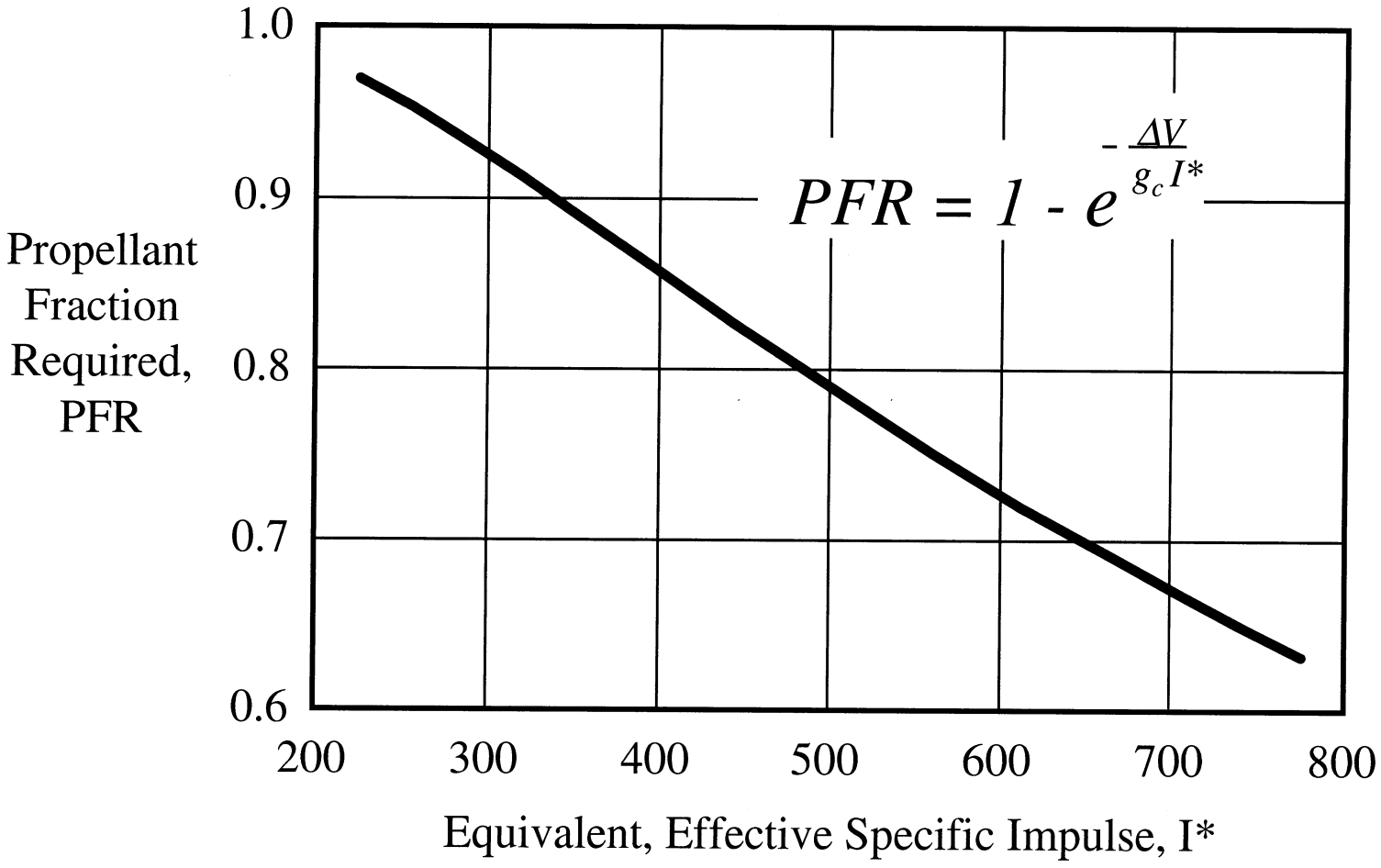
- Expendable components
- Expendable vehicles
- Vehicle re-assembly
- Refurbishment
- Supply and demand



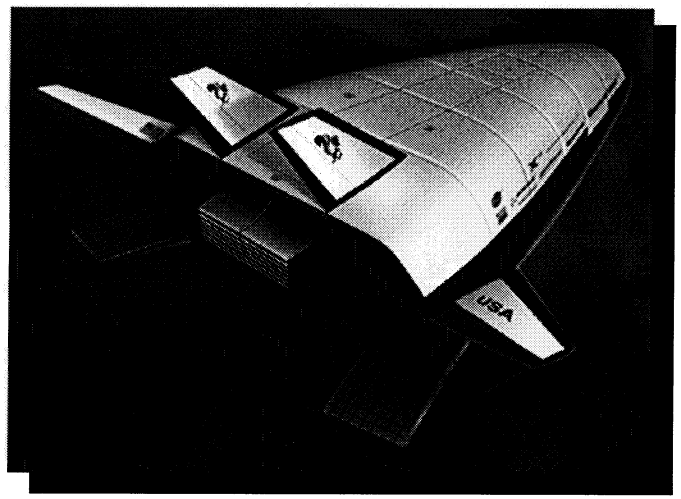
A highly-reusable, single-stage-to-orbit (SSTO) launch vehicle would dramatically reduce the cost of space access...

The "Rocket Equation" for SSTO

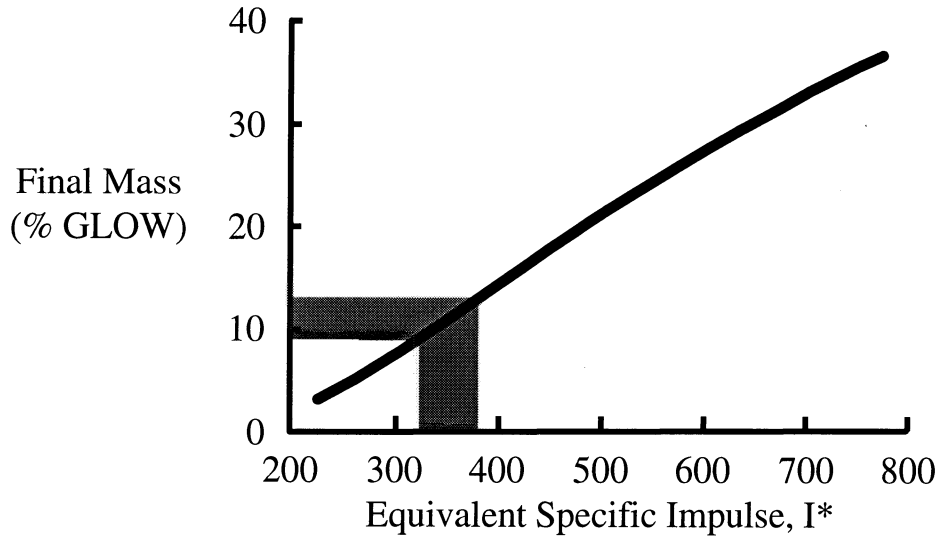
The amount of propellant required to achieve orbit is governed by Newton's second law...

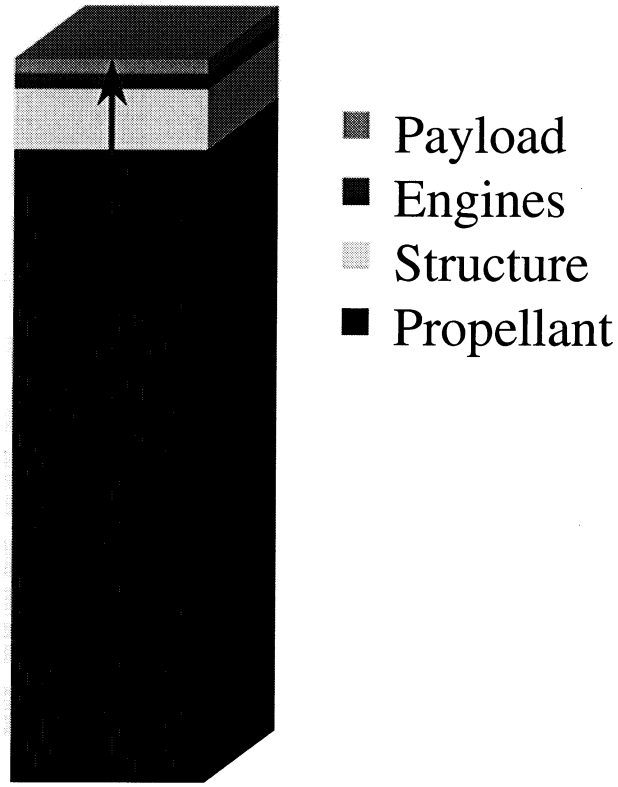


The Rocket I* "Barrier"



Rockets are limited to I values below 400, leaving only 10-12% of the gross lift-off weight for reusable structure and engines*

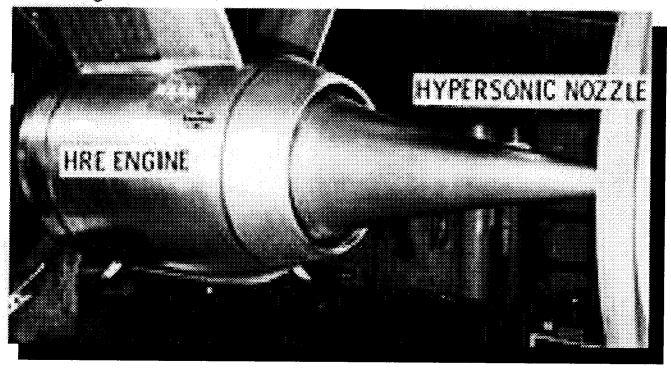




Rocket-Based Combined-Cycle Engine

RBCC engines combine the desirable features of the rocket and ramjet cycles in a single, highly-integrated propulsion system

Ramjet

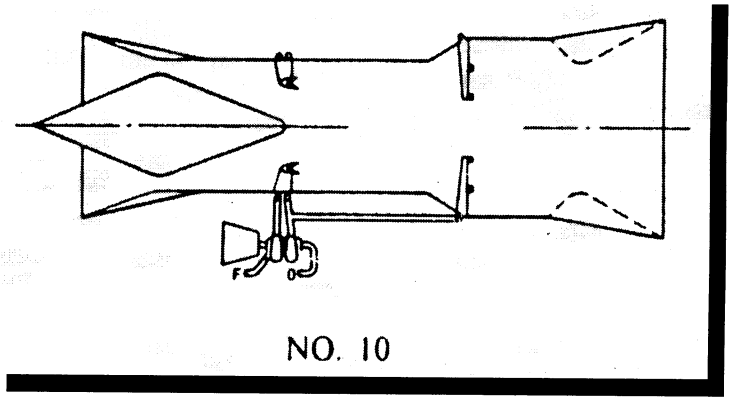


- *High efficiency at supersonic speed*
- *Cannot generate static thrust*
- *Low thrust-to-weight ratio*
- *Requires atmospheric oxygen*
- *Uncertain hypersonic performance*

Rocket

- *Thrust at any speed*
- *Light weight*
- *Low efficiency*

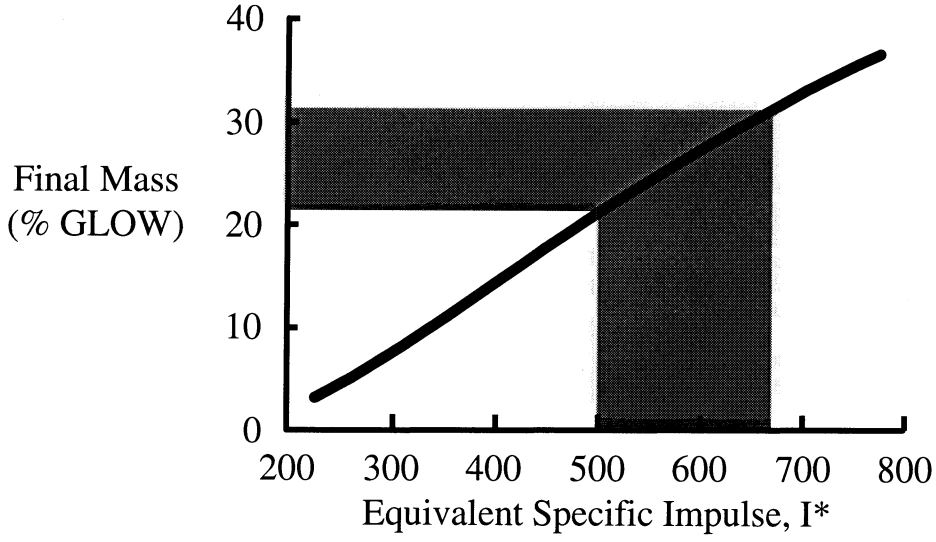
Rocket-Based Combined-Cycle
(Escher, Circa 1966)

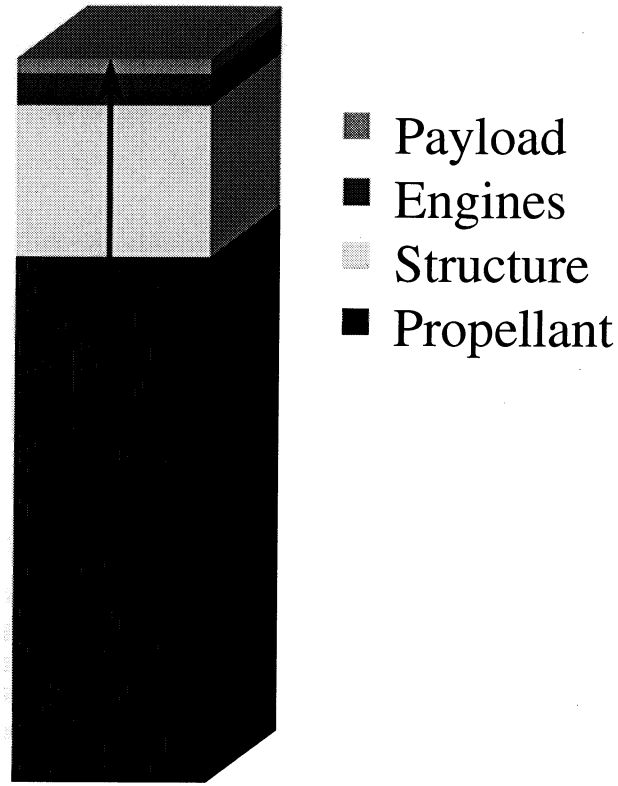


- *High thrust at lift-off*
- *High overall efficiency*
- *Operates from lift-off to orbit*

Potential for Reusability

RBCC propulsion provides the potential for reusable SSTO by reducing the fraction of propellant required





Factors Mitigating RBCC Performance

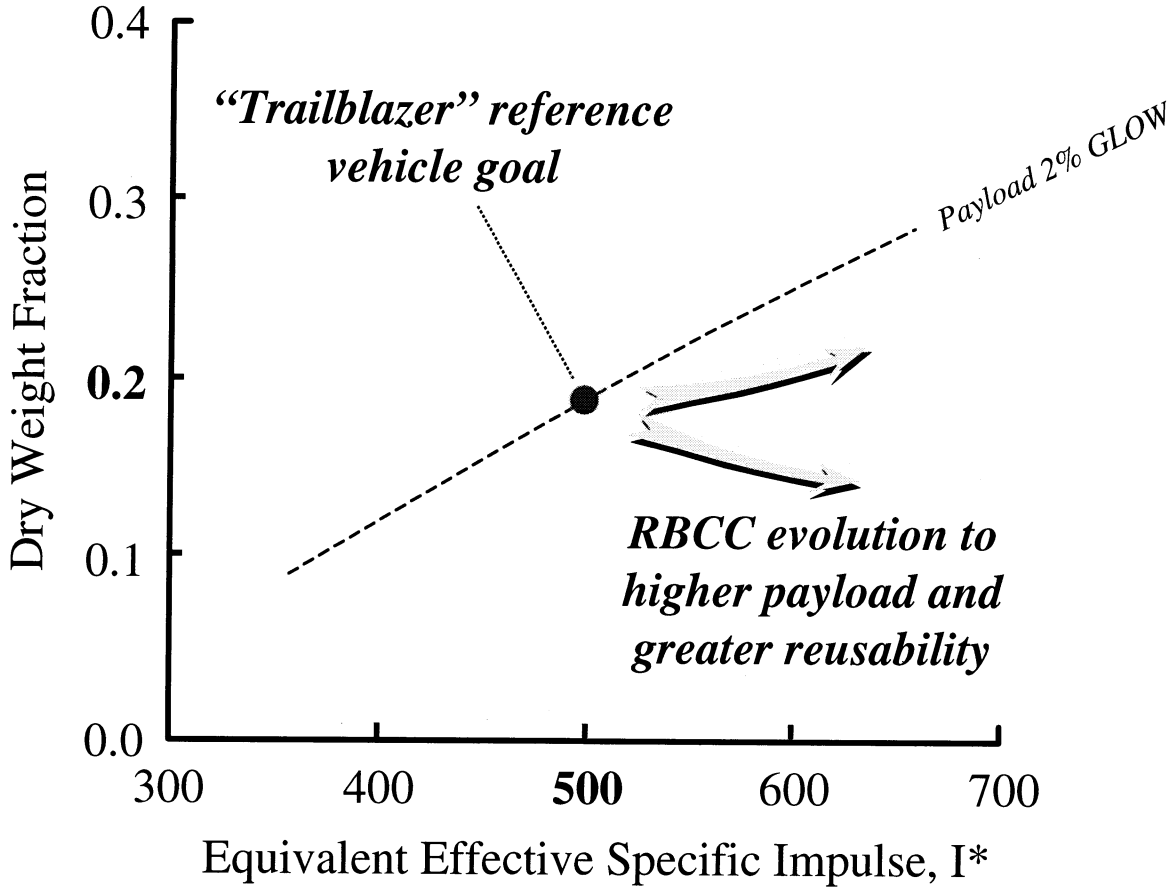
- Weight and complexity of added propulsion components
- Burden of high speed flight within the atmosphere on the vehicle
- Increased fraction of low density hydrogen propellant

The "Trailblazer" Program

- NASA Lewis Research Center is developing RBCC engine technology in its "Trailblazer" program
- An objective of the program is to *manufacture* and *fly* a sub-scale, sub-orbital X-vehicle to demonstrate *system* performance goals
- Experiments and analysis are currently underway to mature the technologies required for this demonstration, and subsequent application of RBCC engine technology to the third pillar goals

Trailblazer Performance Goals

RBCC-Powered SSTO Launch Vehicles can evolve to higher levels of performance after the first successful demonstration



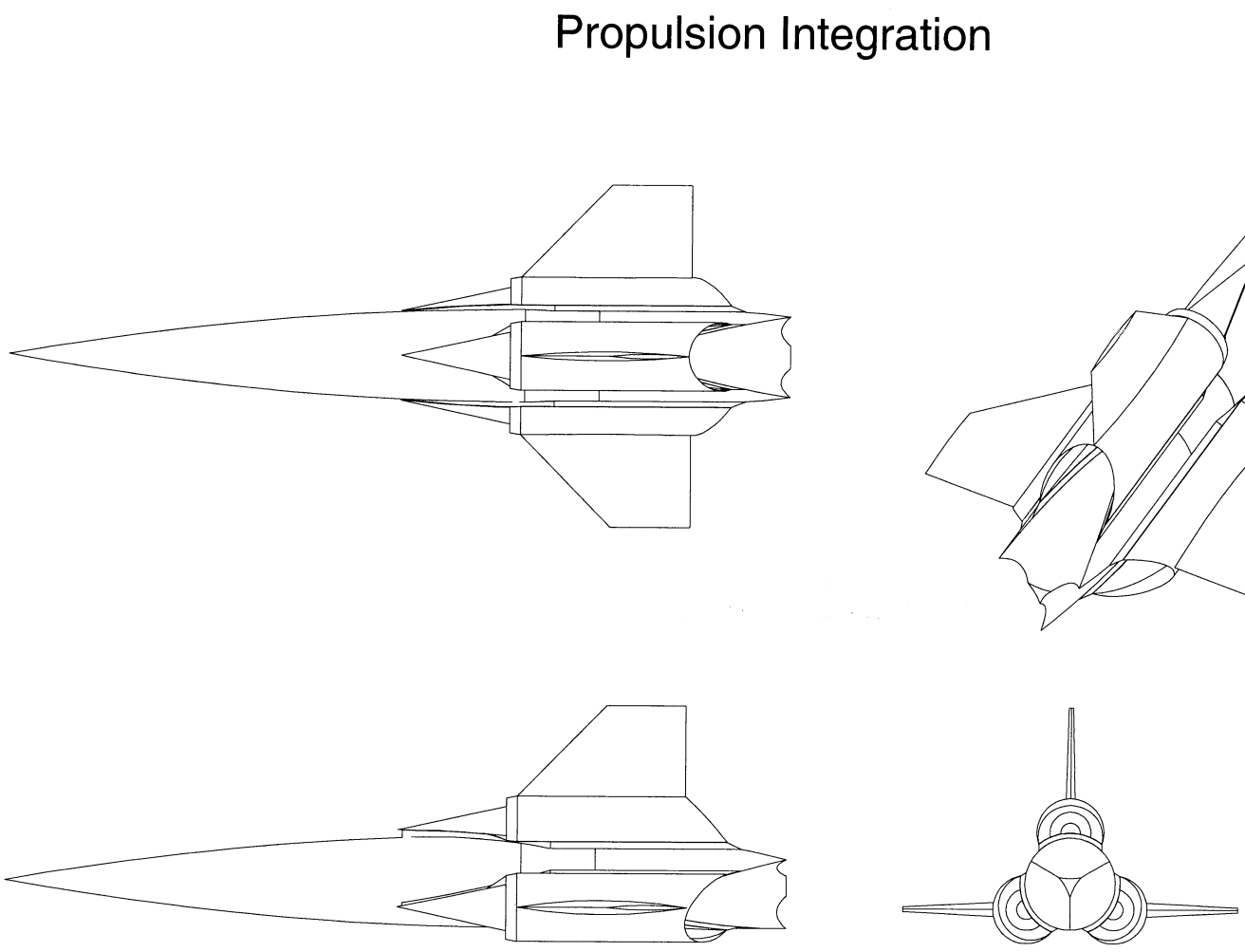
Trailblazer Reference Vehicle

Conceptual Design

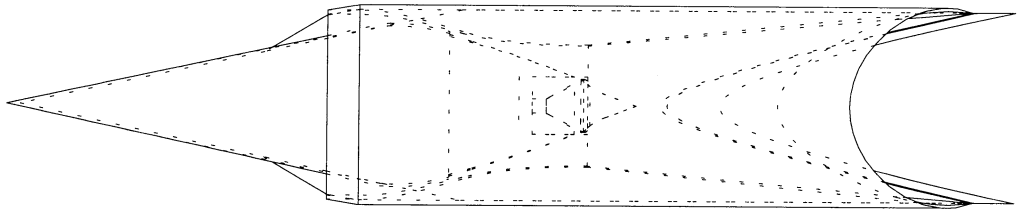
- Single stage to orbit
- Reusable
- Vertical lift-off
- Horizontal, unpowered landing
- LOX / LH2 Propellants
- 300 lb payload

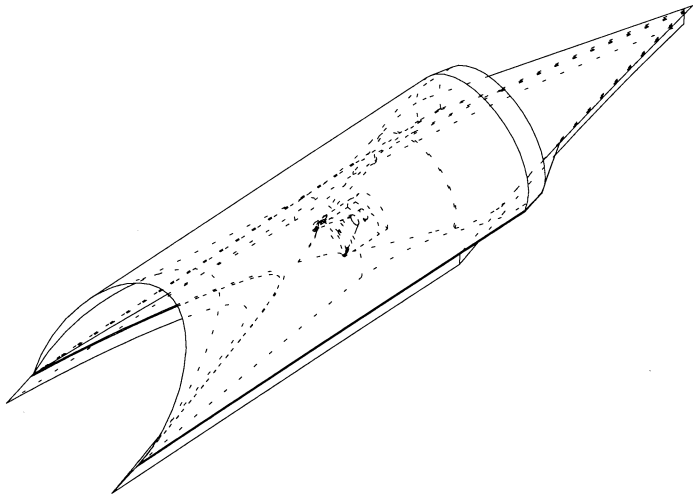
Trailblazer Reference Vehicle

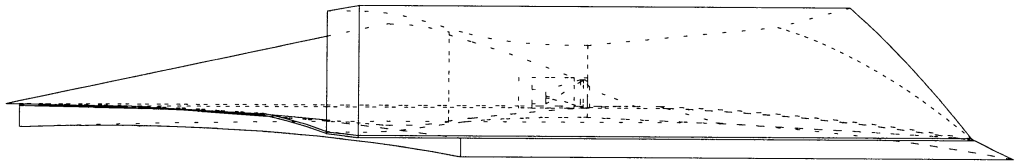
Propulsion Integration

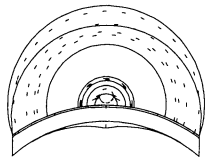


Trailblazer Reference Vehicle Propulsion Pod

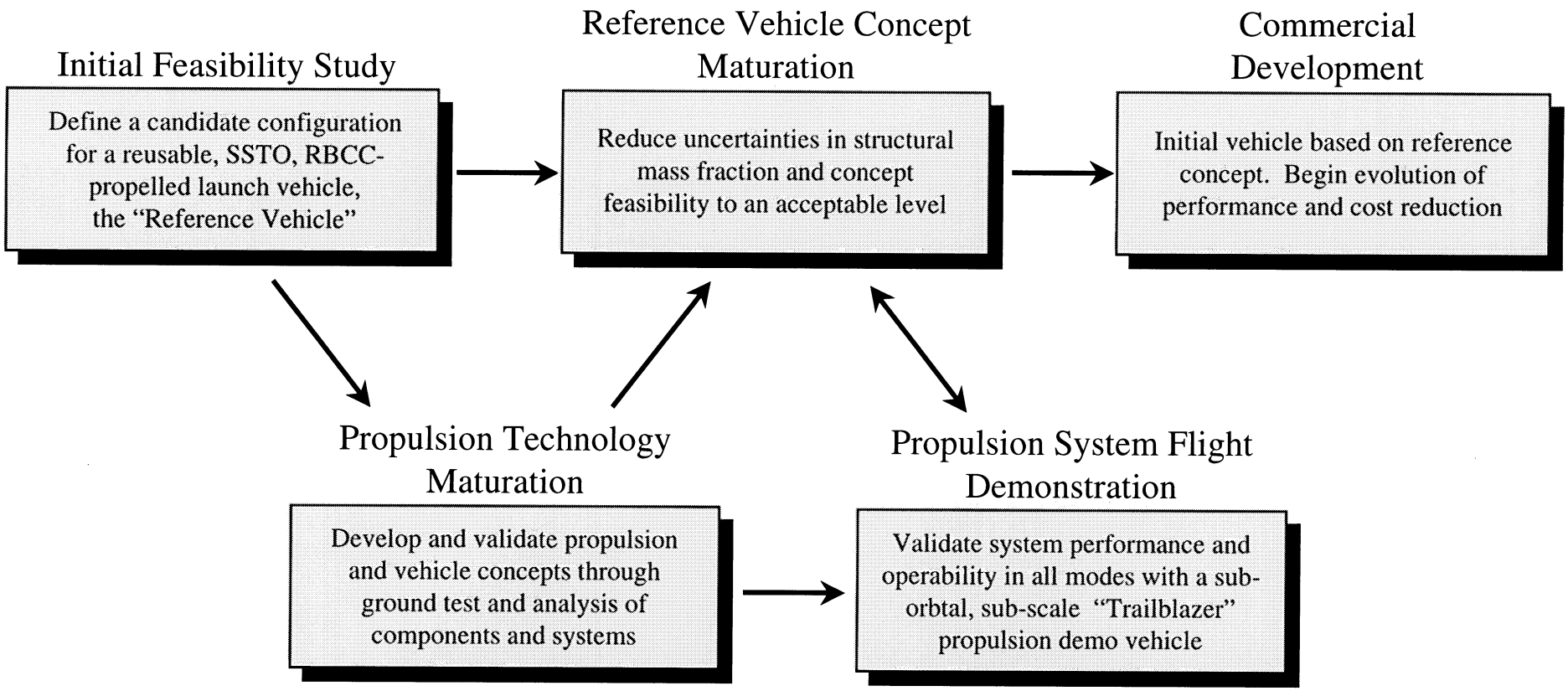








Trailblazer Program Architecture



For more information contact:

Dr. Charles J. Trefny
Mail Stop 86-6
NASA Lewis Research Center
21000 Brookpark Rd
Cleveland, OH 44135

(216) 433-2162
Charles.J.Trefny@lerc.nasa.gov