3rd Generation Technology Prioritization Process

- Inter-center 3rd Generation team ranked over 70 technologies for
  - Potential payoff to cost and safety
  - Technological risk

- Ranking process included study of technology activity, open discussion and consensus
  - Analytical Hierarchy Process (AHP) used in final ranking

- Technologies prioritized by
  - A combined score of potential system payoff and technological risk
    Technology score = (cost + safety) * risk

- Technologies coordinated with Aero-Space base activities

- Efforts underway to make this annual process
Pathway to Safety and Affordability

Increase Payload

Horizontal Launch

Crew Escape

Robust Design

Effective
Redundancy

Operational

Rédex

Reduced Variability

Development

Design Cycle

Operations

Safety

Cost

System

Contractor Interfaces

Accessibility

Range Operations

Payload
Example 3rd Gen. Propulsion Candidate Investments

Spaceliner Requirements

|------------------------|------------------------|----------------------------|---------------|----------------------------|-------------------------------|--------------------------------|---------------|---------------------|-------------------|------------------------|-----------------------------|--------------------------|------------------------|-----------------|--------------------|-------------------------|

Building Block Projects

- HC AirBreathing Testbed/Flight Experiment
- ART
- Reusable Altitude Compensating Engine
- Pulsed Detonation Engine
- Integrated Powerhead Development RACE
Hydrogen RBCC
Recent Accomplishments

♦ ART (Advanced Reusable Technologies)
  • Aerojet & Rocketdyne Flowpath Tested
    • Test Conducted From M 0 to Mach 8
    • Total Of 253 Test Conducted
    • Good Overall Performance
  • Several Firsts In Testing
    • Dynamic Trajectory Simulation (AAR -> RAM and RAM-> SCRAM))
    • SCRAM Testing @ High Dynamic Pressure (M8 @ 1,200 Psf)
    • Rocketdyne A-5 engine has logged over 1 hour of accumulated test time
  • Parametric Test Performed By Pennsylvania State University

♦ Trailblazer Concept Development
  – Lead By Glenn Research Center
  – Currently Testing @ GASL

♦ System Studies
  – Various Vehicle/Engine Combinations Being Studied
    • RBCC
    • TBCC
    • PDE
  – Sensitivity Trades Being Made
    • Trajectories
    • Fineness ratio
    • Payload capability
RBCC Focused Concept Flowpaths

Aerojet Flowpath

Rocketdyne Flowpath
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* Direct-Connect Tests
ART Future Plans

♦ Fabricate flight weight components
  • Rocketdyne combustor
  • Aerojet combustor
  • Aerojet ceramic ram/scram injectors
♦ Test selected components
♦ Document ART project

ART is scheduled to conclude in 2001
RAPTOR

(Revolutionary Airbreathing Propulsion Technology demonstrator)
Combined Cycle Propulsion Testbed

- Take the next logical step in combined cycle propulsion development
- Develop a flight-weight rocket based combined cycle engine system ground testbed
  - Sized capable of accelerating a self powered vehicle from Mach 0.8 to Mach 7
- Demonstrate RBCC engine system operation for air-augmented rocket, ramjet, and scramjet modes
- Provide testbed for evaluation of candidate innovative components
- Demonstrate flight weight engine system design and fabrication
- Evaluate engine system operational characteristics
- In test in 2004
- A testbed, not a prototype of an operational engine
- One of several airbreathing engine system testbeds leading to operational engine development(s) beginning in the 2010 - 2015 timeframe
The Hydrocarbon RBCC Engine Systems Demonstrator Provides Traceability to an Operational Launch Vehicle by ...

- Developing a flight like, thermal & power balanced RBCC engine system

- Demonstrating the operation of an RBCC engine system by testing from Mach 0 through Mach 7 in ground test

- Performing vehicle design and propulsion system integration studies to show the applicability of RBCC to earth-to-orbit propulsion systems
On-Going Activities

♦ Industry Team is Key to Development - HYPAR
  • Preserve U.S. high speed propulsion industrial base
  • Rocketdyne - Management Lead
  • Pratt & Whitney - Technical Lead
  • Aerojet - Systems Integration Lead
  • MOA signed
  • FTC concurrence 8/4
  • Teaming agreement to be signed by 10/15
  • Program planning underway
  • Engine System Study final report week of 10/30

♦ Flowpath Selection Team
  • Team has been convening since June
    – Two representatives from each of the engine companies
    – One representative from Boeing Phantom Works
    – One representative from each participating NASA center (DFRC, GRC, LaRC, MSFC)
  • Data sharing initiated 7/24
  • Selection made 9/1 - Aerojet Strutjet Flowpath
'01 Plans

- Perform planning activity 11/00 - 4/01
- Put HYPAR consortium under contract
- Demonstrator vehicle activity led by LaRC
  - Feed requirements for engine system
### Long Term RAPTOR Schedule

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*Flight experiments not part of the RAPTOR project*
Milestones

- 10/00 - Engine system study final report
- 9/01 - System Requirements Review (SRR)

Prioritized List of Activities

- Perform detailed project planning
- Implement system engineering framework
- Refine selected flowpath, engine systems concept, and structural approach
- Iterate propulsion/airframe integration