Focus of NASA’s Spaceliner 100 Investment Area

Uwe Hueter
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Transportation . . . Opened Our Frontiers

International Commerce
6 1/2 Generations of Airliners in a Century

Boeing 777 (Today)

Wright Flyer (1903)

1st Generation Reusable Launch Vehicle (1981 - Today)
Reusable Launch Vehicles Evolutionary Path

Today: Space Shuttle
1st Generation RLV
- Orbital Scientific Platform
- Satellite Retrieval and Repair
- Satellite Deployment

2010: 2nd Generation RLV
- Space Transportation
- Rendezvous, Docking
- Crew Transfer
- Other on-orbit operations
- ISS Orbital Scientific Platform
- 10x Cheaper
- 100x Safer

2040: 4th Generation RLV
- Routine Passenger Space Travel
- 1,000x Cheaper
- 20,000x Safer

2025: 3rd Generation RLV
(Spaceliner 100)
- New Markets Enabled
- Multiple Platforms/destinations
- 100x Cheaper
- 1,000x Safer
SL100 Technology Focus

Goals

100x Cost Reduction & 10,000x Safety Increase by 2025

Technology Objective

- Increase System Performance Margin
- Drive Down Operations Costs
- Drive Down Manufacturing and Production Costs
- Drive Down Design, Development, Test and Evaluation Costs

Challenge

- Increased Engine Thrust/Weight
- Increased Mission Specific Impulse
- Improve Mass Fraction
- Increased Range (Cross and Down)
- Increased Margin
- Increased Reliability
- Increased Life
- Increased Vehicle Health/State Knowledge
- Reduced Labor
- Reduced Processing
- Reduced Facilities/GSE
- Reduced Maintenance
- Reduced Facilities
- Reduced Tooling
- Reduced Material Cost
- Reduced Labor
- Reduced Design Cycle Time
- Reduced Weight
- Reduced Complexity
- Increased Technology Readiness Level @ Insertion
3rd Generation Technology Drivers

♦ Dramatic Propulsion Performance Improvement
  • RBCC/TBCC - Dual Mode Ramjet/Scramjet
  • Pulse Detonation Rocket Engine/Combined Cycle Engine
  • 500 mission propulsion component life
  • Magnetic Launch Assist

♦ Low Drag aerodynamic structures
  • SHARP ultra-high temperature ceramics
  • Integrated smart/adaptive thermal-structures
  • Morphing structures
  • Drag modulation through electromagnetics and flow physics

♦ Adaptive Intelligent Systems
  • Adaptive, self-diagnosis, self-healing thermal protection systems
  • Structurally integrated, wireless, micro/nano sensors and avionics
  • Regenerative sensors and system healing
  • Autonomous, adaptive control

♦ Spaceport Range Operations
Space Transportation Across NASA

Ames Research Center
- Non-Metallic Thermal Protection Systems
- Computational Tools
- IVHM

Stennis Space Center
- Propulsion Testing

Kennedy Space Center
- Spaceport Operations
- Range Safety
- Launch Assist

Dryden Flight Research Center
- Atmospheric Flight Operations

Johnson Space Center
- Crew and Passenger Systems

Marshall Space Flight Center (Lead Center)
- System Integration
- Propulsion Systems
- Avionics Systems
- Combined-Cycle Propulsion Demo
- Vehicle Definition
- Structural and Mechanical Design and Integration
- Advanced Manufacturing

Langley Research Center
- IntegraAirframe Design
- Integrated Thermal Structures
- Materials Research
- TPS
- Aero/Aerothermal Enh.

JPL
- Microelectronics/Sensors

Glenn Research Center
- Power Systems
- Advanced Propellants
- Propulsion Materials
- Combined-Cycle Propulsion Flowpaths

Air Force Research Lab
## ASTP Program Overview

### Organization Based Around 4 Investment Areas

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Funded by 2nd Generation RLV Program
Propulsion Projects

- **Aireathing Propulsion**
  - Rocket-Based Combined Cycle (RBCC)
  - Turbine-Based Combination Cycle (TBCC)
  - Pulse Detonation Engine (PDE) Combined Cycle
  - Technology Test Bed
- **Rocket Propulsion**
  - High Thrust-to-Weight/Long-life Advanced Rocket Engines
  - Turbo-rockets
  - Pulse Detonation Rocket Engine (PDRE)
  - Technology Test Bed
- **Cross-cutting Technologies**
  - Tools for Design & analysis
  - Materials
  - Turbomachinery, Combustion Devices, Nozzles, Valves
  - Instrumentation
Airframe Project

Integrated Airframe Design
- Tools for Rapid Design & Analysis-Including Safety, Uncertainty

Integrated Thermal Structure & Materials
- PMC s, Insulation, Sealants & Manu f
- Metal & MMC Structures, Mat Is & Manu f for Hot structures & Cryotanks
- CMC for Integrated Airframe Structures

TPS
- Adaptive Intelligent, Emergency and Acreage TPS
- Multifunctional Metallic Integrated TPS/Aeroshell
- Superthermal Insulation TPS
- Ultra-high Temperature Sharp Leading Edges
- Advanced Control Surfaces Seals

Aero/Aerothermal Enhancements
- Revolutionary Flow Control Through Plasma Aerodynamics
- Aerodynamic Morphing
IVHM Project

Informed Maintenance

Smart Self-Healing Sensor System

Self-Learning, Self-Healing Systems
Launch Systems Project

Avionics & Flight Control

- High Performance GN&C
- Advanced Evolvable Hardware
- Scalable, Fault Tolerant Intelligent Network of Transducers
- Robust, Low Cost Avionics Architecture

Power

- Advanced Electric Actuation Devices & Subsystem Technologies
- Hybrid Power Source
- High Power, High Temperature Power Electronics
- Intelligent Internal Thermal Control
ASTP Accomplishments

- Advanced MMC rocket thrust cell chamber fabricated at MSFC

- Completed over 2000 2-D unsteady CFD runs for optimization of turbine performance at MSFC. Gained 10 points of efficiency at design conditions over standard design practice baseline.

- Development of an Automated Tape Placement Device (ATP) with attached E-Beam Gun for ply-by-ply, cure on the fly fabrication capabilities of E-Beam curable resins.

- Successfully manufactured two PMC LH2 ducts using the MSFC hand lay-up method. These ducts have passed ambient proof tests to 150 psi.

- Rocketdyne RBCC A-5 engine logged over 1 hour of accumulated test time at GASL

- Completed assembly and initiated testing on LOX densification unit at GRC

- Successfully hot-fired the TRW Ultra-Low Cost Engine (Pintle) at SSC

- Rocketdyne, Pratt and Whitney and Aerojet formed a consortium for RBCC
6 Year SL-100 Budget Distribution

- Propulsion: 66%
- Launch Technology: 7%
- IVHM: 6%
- Operations & Range: 5%
- Airframe: 16%
Major Milestones

SRR for 1st Airbreathing Demonstrator in FY01

Initial Release of 0-D Propulsion System Simulation in FY01

Demonstrate Resin Transfer Molded PMC with 550°F Use Temp in FY02

Develop Advanced Adhesives for Non-Autoclave Processing in FY02

Submit Proposal for A/B Flight Demonstrator in FY03

First test of A/B Demonstrator Engine System in FY04

First A/B Flight Demonstrator in FY06
SL100 Investment Area Summary

Not A Vehicle, But An Investment Approach To Mature Technologies To Achieve The Following Goals

- Reduction In Launch Cost By A Factor Of 100
- Improvement In Safety By A Factor Of 10,000
- Operational Around 2025

Technology Development Activity

- Propulsion
- Airframe Systems
- IVHM
- Launch Systems
- Operations & Range

Keep Options Open As Long As Technologies Continue To Show Feasibility
Transportation . . .

... The key to unlocking the final frontier.