INTEGRATED AIRFRAME DEMONSTRATIONS

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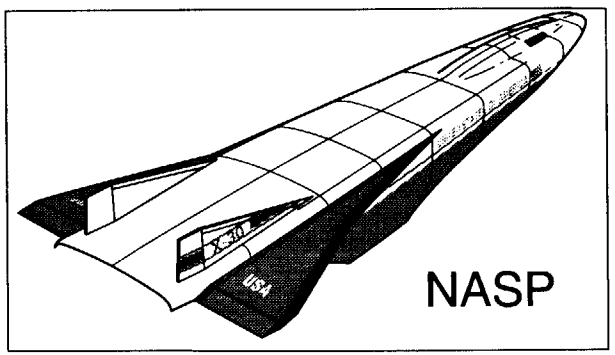

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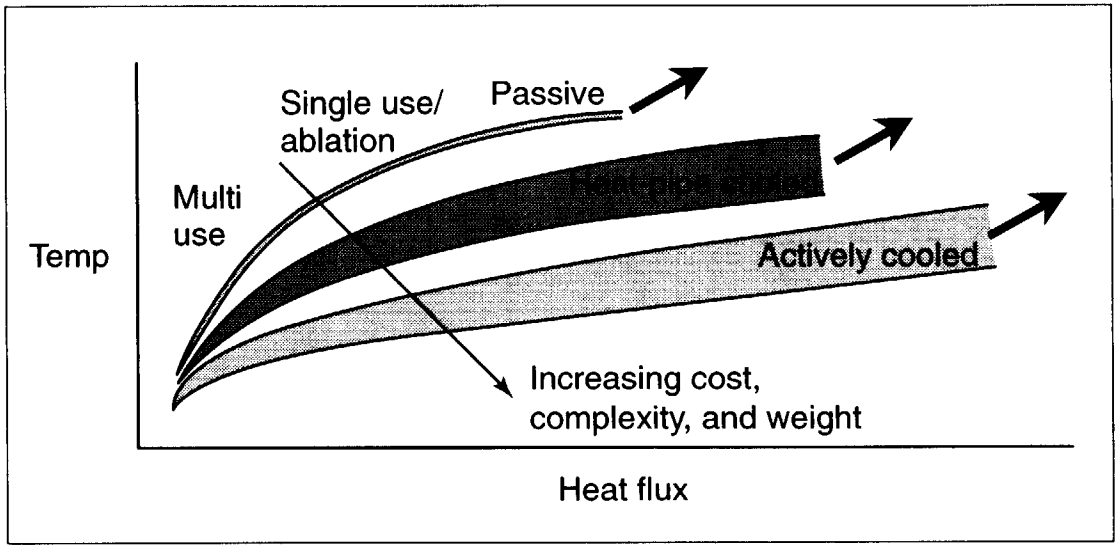
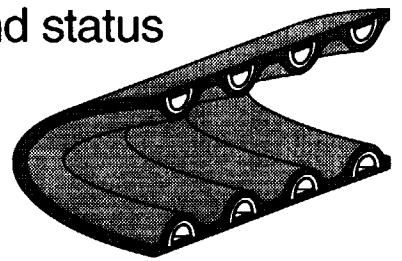
- Evolution of technology
  - Increase heat flux/ temperature capability
  - Decrease cost, complexity and weight
  - Increase size



- Control surfaces
  - Accomplishments and status
    - C/C elevon (NASP)
    - Ruddervator and flaperon (X-37)
  - Next step
    - Full size orbiter body flap

- Heat-pipe-cooled leading edges (HPCLE)
  - Accomplishments and status
    - Metallic (Shuttle)
    - C/C (NASP)



  - Next step
    - C/C HPCLE segment for radiant heating test and orbiter flight experiment

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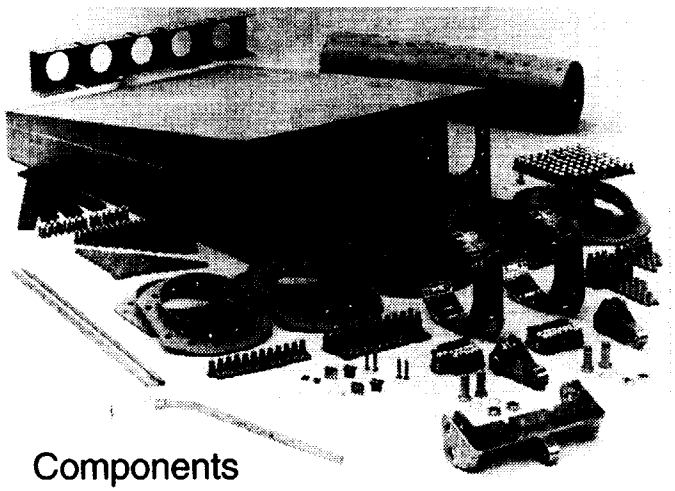
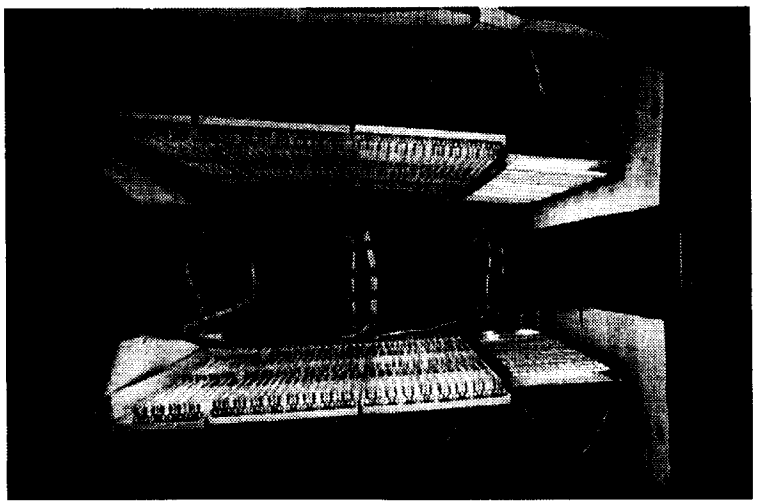
HOT STRUCTURE COMPONENTS FOR POTENTIAL FLIGHT DEMO

- Objective
  - Develop and verify the technology required for application of minimal weight control surfaces that meet NASP vehicle requirements
- Approach
  - Develop design and fabrication concepts
  - Verify concept design through sub-component fabrication and tests
  - Design and fabricate full-scale segment of C/C control surface
  - Verify design and fabrication technology by thermal/structural tests
- Payoff
  - Vehicle enabling
  - Reduced structural weight



Components

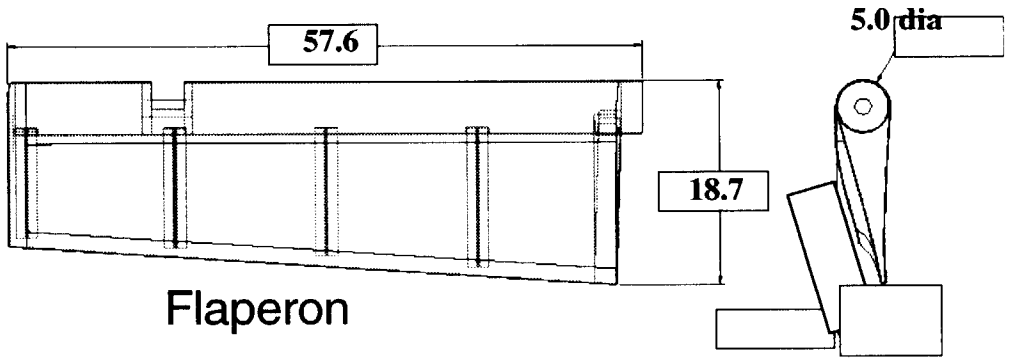


CONTROL SURFACES

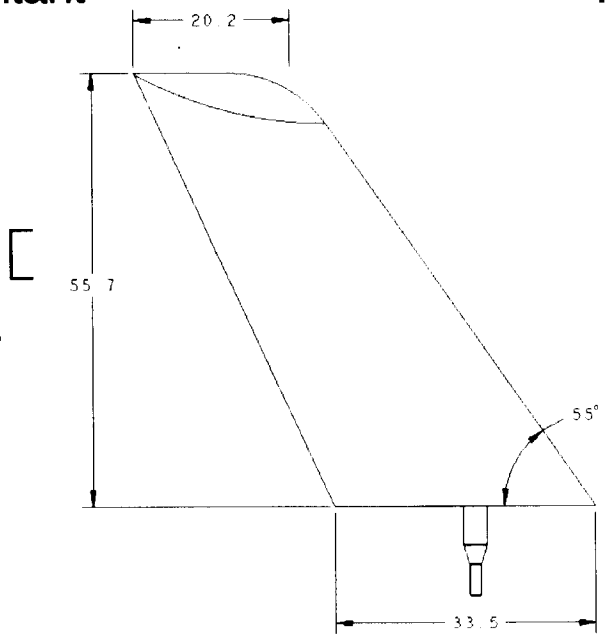
C/C CONTROL SURFACE FOR NASP

- Objectives
  - Develop and validate C/SiC control surfaces for the X-37
  - Deliver 2 flight approved flaperons and 2 moveable ruddervators for installation on the flight vehicle

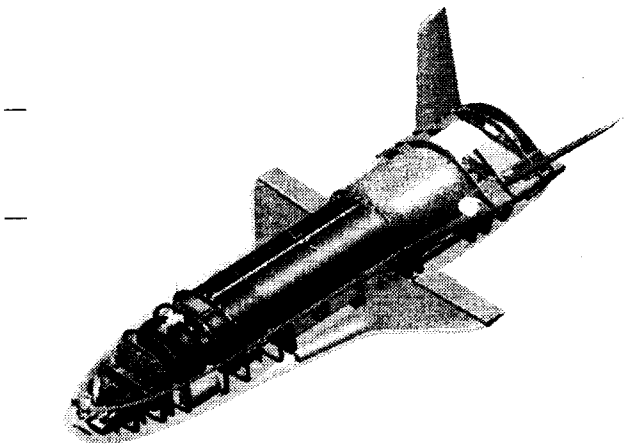
- Team members
  - LaRC - lead
  - Boeing - requirements
  - BF Goodrich - C/SiC fabrication
  - MR&D - consultant
  - AFRL - test



Flaperon



Ruddervator



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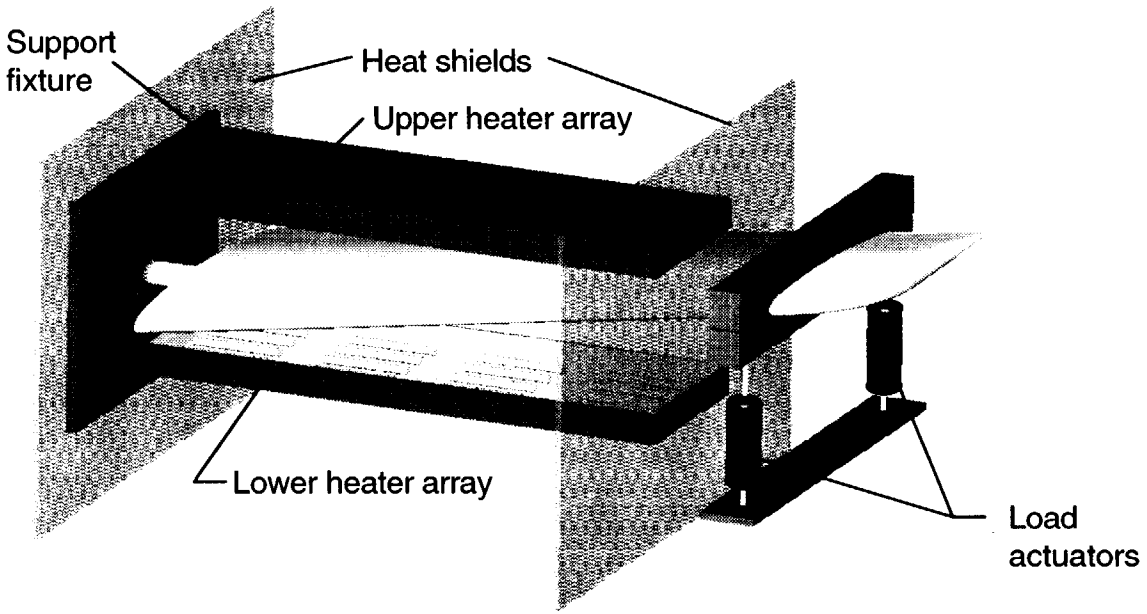
CONTROL SURFACES
X-37 FLIGHT COMPONENTS

- Material property and sub-element (RT - 2800°F)
- Subcomponent (RT)
- Full scale thermal/structural test component
- Proof test of flight article (RT)



Schematic diagram of ruddervator thermal/structural test at AFRL

CONTROL SURFACES

X-37 FLAPERON AND RUDDERVATOR VALIDATION

- Status
  - Design, analysis, and fabrication validated through thermal/structural tests and analysis of large full-scale segment of C/C control surface for NASP

  - Design, analysis, and fabrication will be validated through thermal/structural tests and analysis and through flight of small full-scale flaperons and ruddervators for the NASA/Boeing X-37 vehicle and small full-scale body flap for the X-38 vehicle

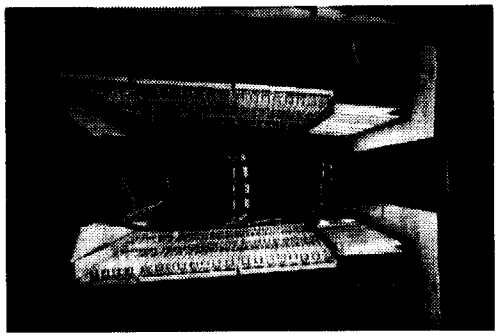
- Issues
  - Validation of major load bearing structural joints in C/C or CMC structures

  - Technology required for the fabrication of large multi-part components using C/C or CMC materials

  - Life cycle performance of large hot structures components

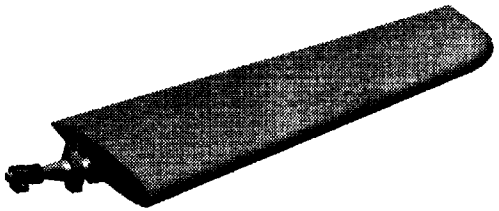
CONTROL SURFACES
STATUS & ISSUES

Hot Structures Control Surfaces



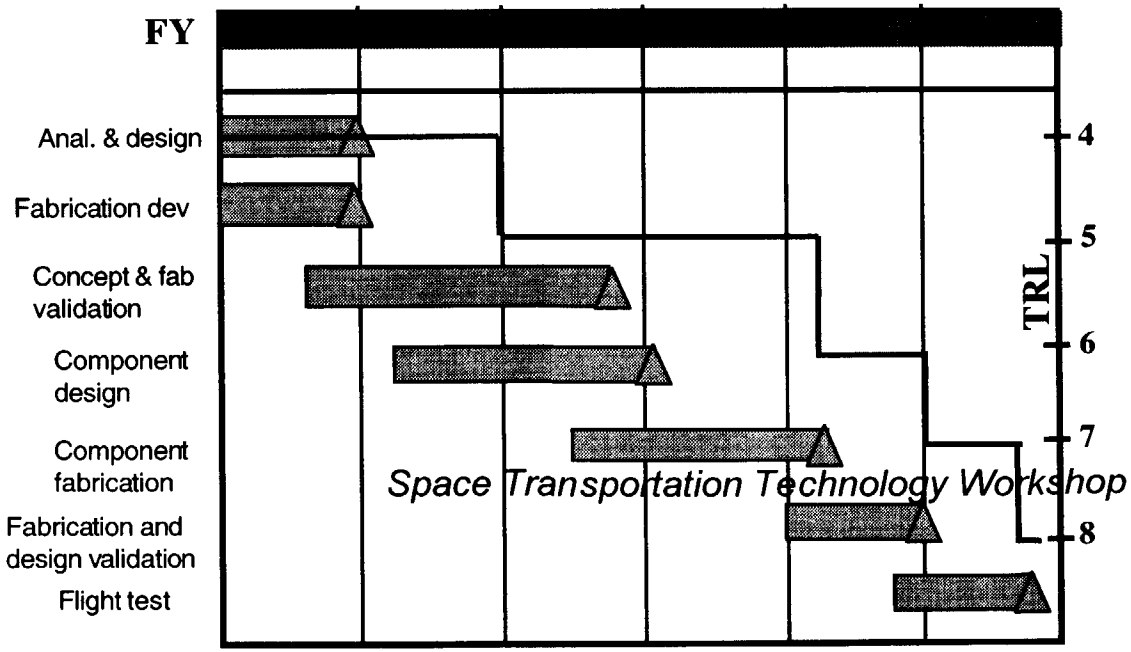
C/C control surface for NASP

Ceramic matrix composite flap for X-37

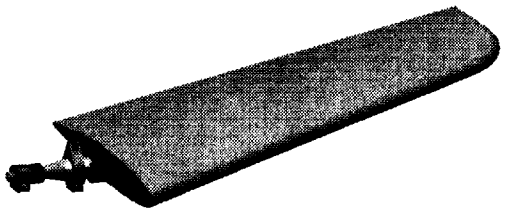


- Phase I
  - Design concepts developed
  - Fabrication plan developed
  - Sub-component test articles designed
- Phase II
  - Sub-component test articles fabricated
  - Design/fabrication validated through sub-component analysis and tests
  - Full-scale component (shuttle or RLV size) design developed
- Phase III
  - Full-scale control surface fabricated
  - Design/fabrication validated through thermal/structural analysis and tests
  - Flight test

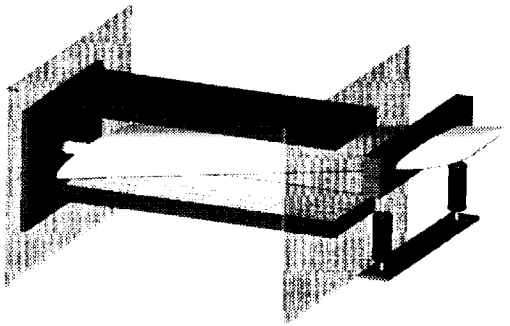
- **Current State of the Art**
  - Aluminum or low-temperature composite structure with ceramic tile TPS
- **Performance Metrics**
  - Reduced weight, more durable and less maintenance and operating costs than current Space Shuttle control surfaces
- **Potential risks**
  - Higher initial cost
- **Participants**
  - LaRC, DFRC, industry



- Design and fabricate large full-scale C/C or CMC control surface component for Space Shuttle or RLV size vehicle



- Validate the design and fabrication procedure through static thermal/structural tests and analysis



- Evaluate life-cycle performance through simulated mul reentry thermal/structural load cycles

- Flight test on Space Shuttle or RLV size vehicle

CONTROL SURFACES

POTENTIAL TASKS FOR FLIGHT DEMO

♦ 12:45 - 1:00 Introduction 2nd Gen RLV Airframe	S. Welch
♦ 1:00 - 1:20 Airframe Design and Integration	S. Scotti
♦ 1:20 - 1:40 Aerothermodynamics	C. Miller
♦ 1:40 - 2:00 Structures and Materials	T. Johnson
♦ 2:00 - 2:20 Tanks	D. Smith
♦ 2:20 - 2:40 Thermal Protection Systems	M. Rezin
♦ 2:40 - 3:00 Integrated Airframe Demonstrations	D. Glass
♦ 3:00 - 3:05 BREAK	
♦ 3:05 - 3:30 Introduction 3rd Gen RLV Airframe	D. Bowles
♦ 3:30 - 3:55 Integrated Design and Analysis	T. Gates
♦ 3:55 - 4:20 Integrated Thermal Str. & Materials	B. Jensen
♦ 4:20 - 4:45 Thermal Protection Systems	S. Johnson

3rd Gen Airframe/TPS:

3rd Generation Agenda