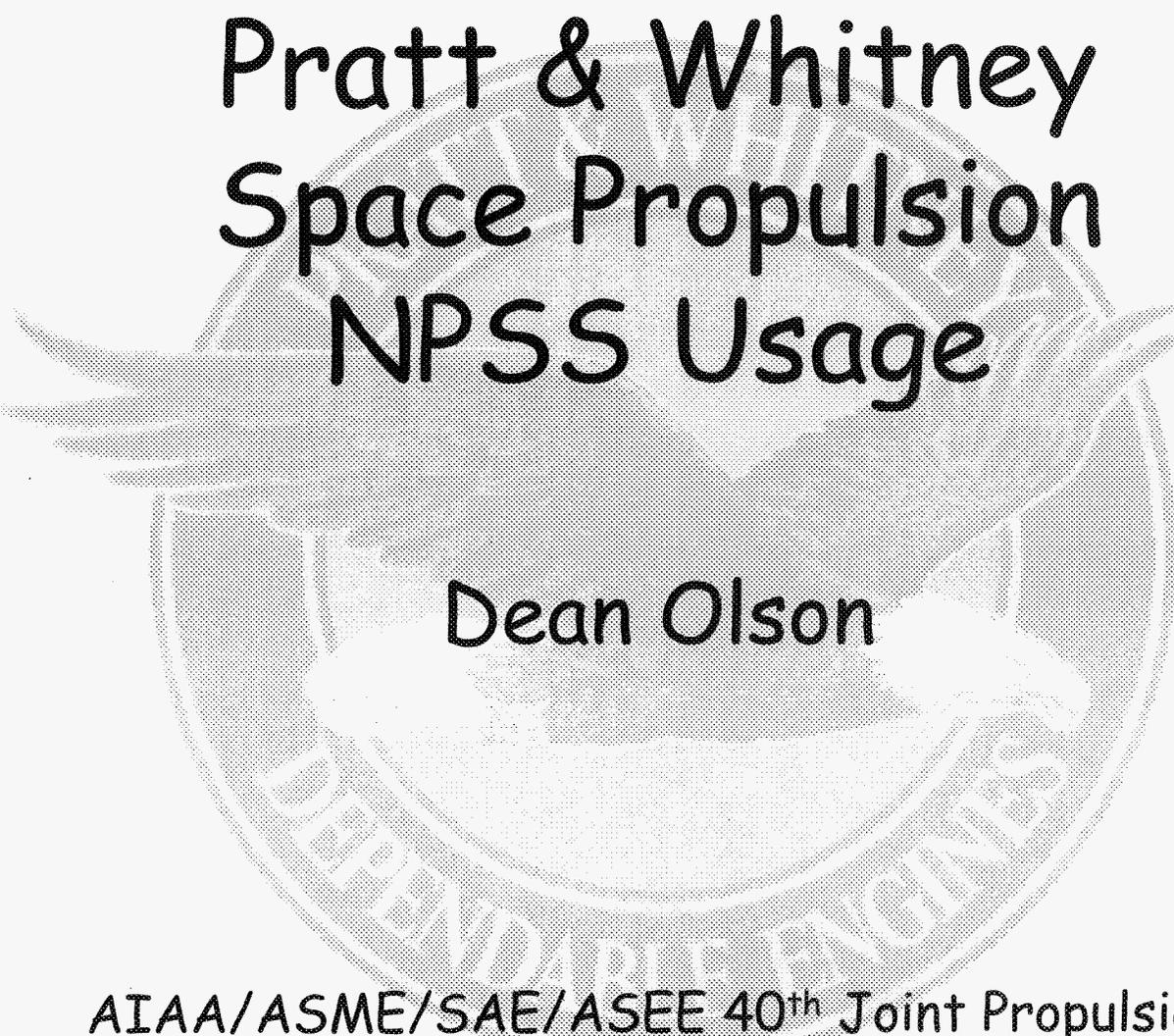


Abstract:

This talk presents Pratt and Whitney's space division overview of the Numerical Propulsion System Simulation (NPSS). It examines their reasons for wanting to use the NPSS system, their past activities supporting its development, and their planned future usage. It also gives an overview how different analysis tools fit into their overall product development.

A large, faint watermark of the Pratt & Whitney logo is centered in the background. It features a circular emblem with a stylized eagle and the text 'DEPENDABLE ENGINES' around the bottom edge.

Pratt & Whitney Space Propulsion NPSS Usage

Dean Olson

AIAA/ASME/SAE/ASEE 40th Joint Propulsion Conference

Session 42-ABP-7 Room Palm B

July 13, 2004



Outline



Pratt & Whitney
A United Technologies Company



- Reasons for using the NPSS
- Past activities supporting the NPSS development
- Planned future development / usage



P&W SP Diverse Product Line

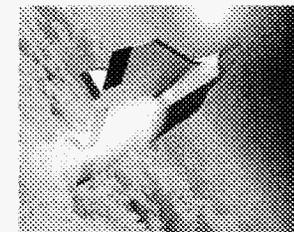
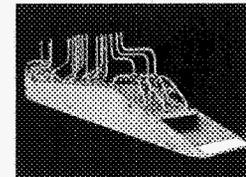
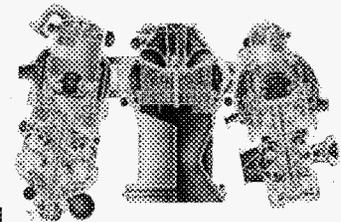
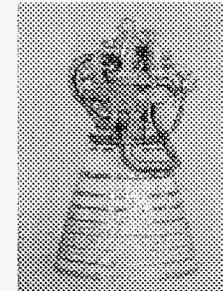
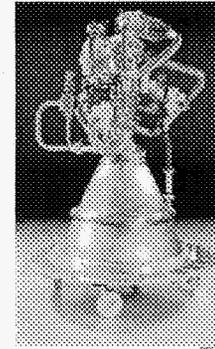


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P&W Space Propulsion is involved in the design and development of many different propulsion systems

- Liquid rocket engines
 - Upper stage - RL10 & RL60
 - Boosters - SSME turbopumps, COBRA, RD-180
- Hypersonic airbreathing engines
 - HYSET
 - SED
- Combined cycles
 - TBCC - Turbine Based Combined Cycle
 - RBCC - Rocket Based Combined Cycle
- Nuclear in-space engines



These systems are currently modeled in different simulation environments



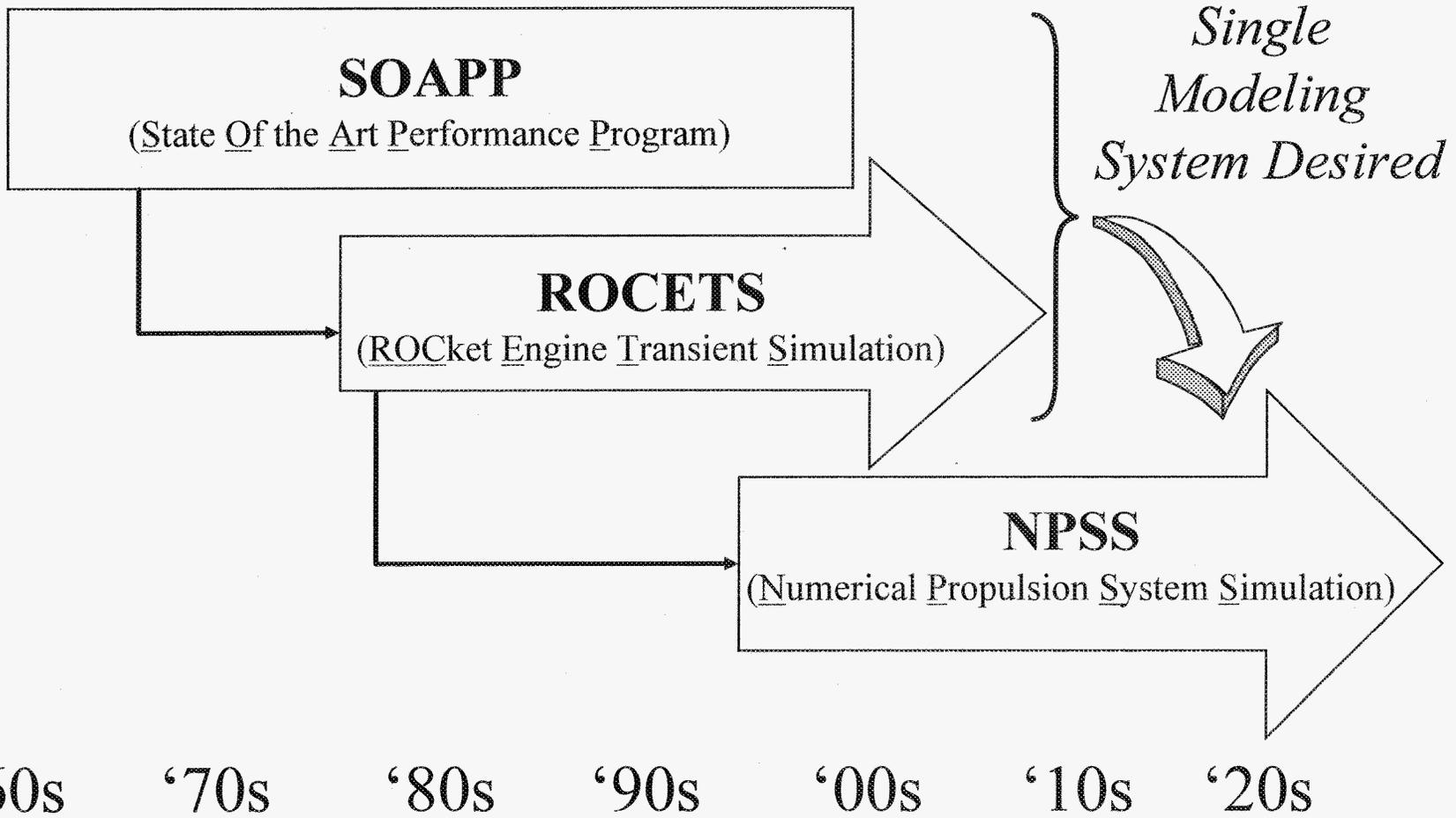
Various Legacy Tools Used



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NPSS provides a single environment for modeling Airbreathing and Rocket propulsion systems





NPSS Benefits



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- NPSS would be a Corporate-wide application (P&W Jets, IFC, UTRC, etc.)
- NPSS would create a Common Rocket - Airbreathing modeling system
 - Enables RBCC, TBCC modeling within single architecture
 - Eliminates requirement for manual data transfer for systems integration
 - Enables overall system optimization
- NPSS should reduce Joint Venture long-term modeling and analysis costs and reduce potential for confusion between multiple models
 - Applicable to I^{STAR} type consortiums
 - No Need to Translate Methods Between P&W and other Propulsion or Vehicle Companies
 - No Need to Resolve Differences Between Multiple System Models
 - Enables Multi-site Real-time analysis
- NPSS has the Potential to become an Industry and DoD Standard
 - Lockheed & Boeing participating in NPSS Development
 - Aerojet & Rocketdyne participating in NPSS Development
- NPSS is a Flexible and Growth-Capable Architecture
 - Multidisciplinary "Zooming" inherent capability - single environment for 0-D through 3-D Analysis
 - Modern Object-Oriented programming that facilitates code re-usability



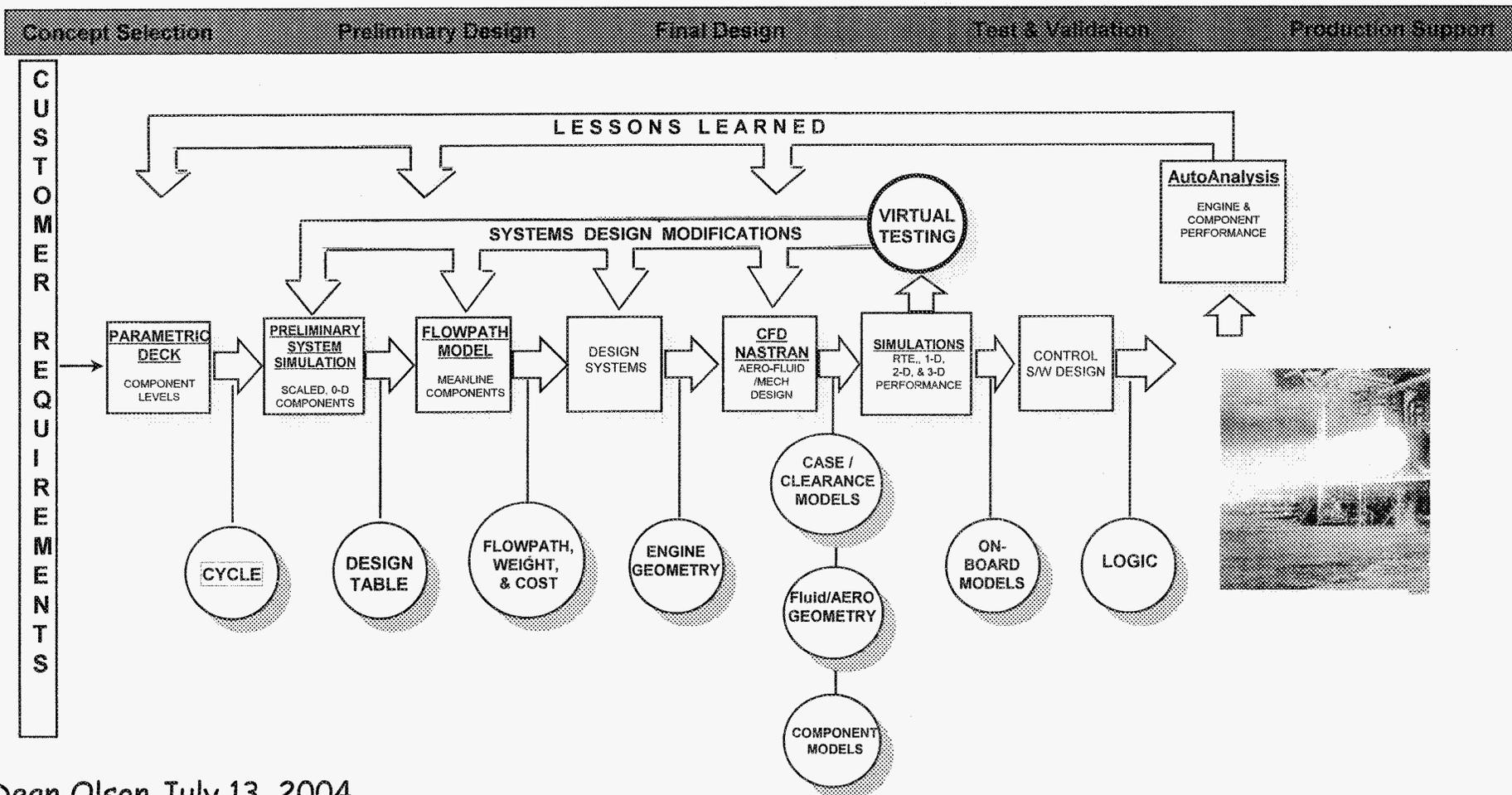
NPSS Useful Throughout the Product Life Cycle



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Tailor the fidelity (physical representation & resolution) as appropriate for the analyses required





Outline

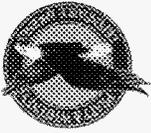


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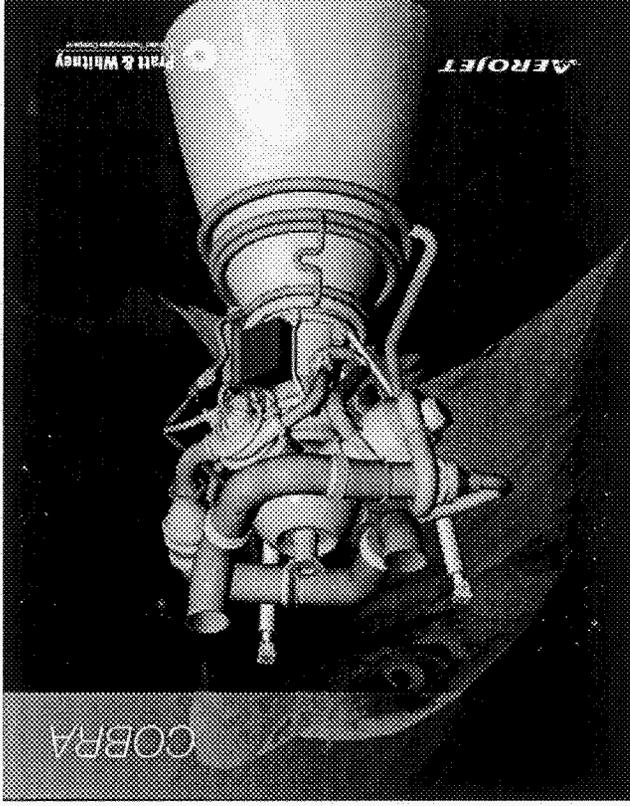


- Reasons for using the NPSS
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P&W SP NPSS Development Activities



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- Developed booster rocket engine model (2GRLV LH₂ / LO₂ COBRA engine)
 - Delivered Elements required to predict engineering characteristics
 - Steady State and Throttle Transient Capable
 - ~ 100 Solver balances required for physics
 - Additional balances required for Cycle Match Control



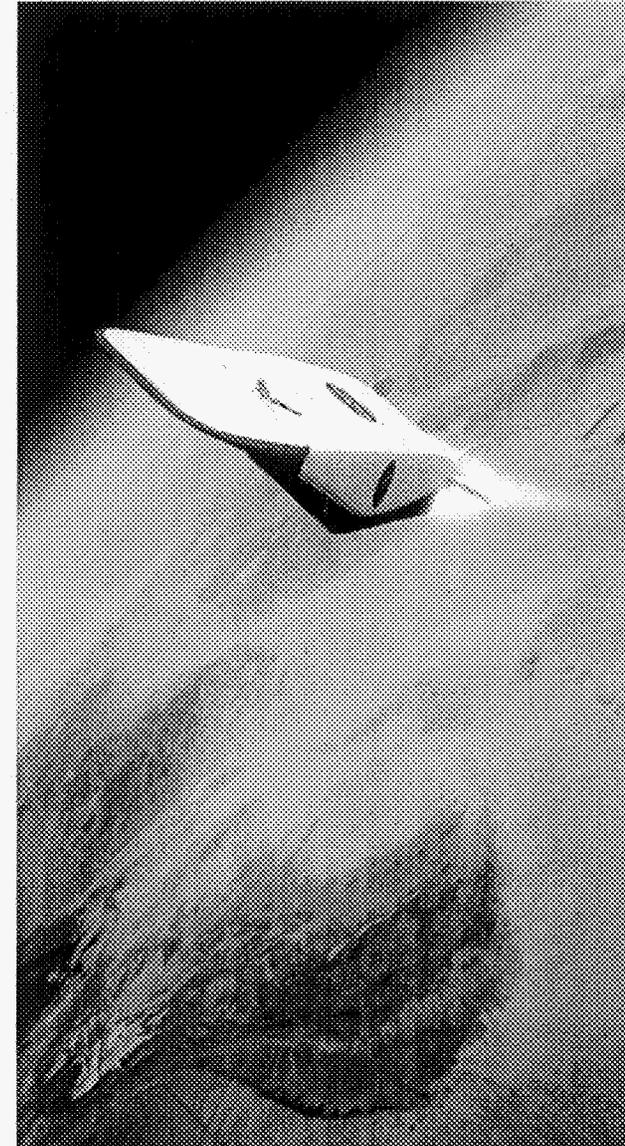
P&W SP NPSS Development Activities



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- Supported development of the Hypersonic I^{STAR} engine NPSS component elements to enable simulation of full trajectory performance
 - Created Combustor element which predicts RAM / SCRAM performance consistent with RJPA methodology
 - Created single Fuel Delivery System model with off-design capabilities





Outline



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- Reasons for using the NPSS
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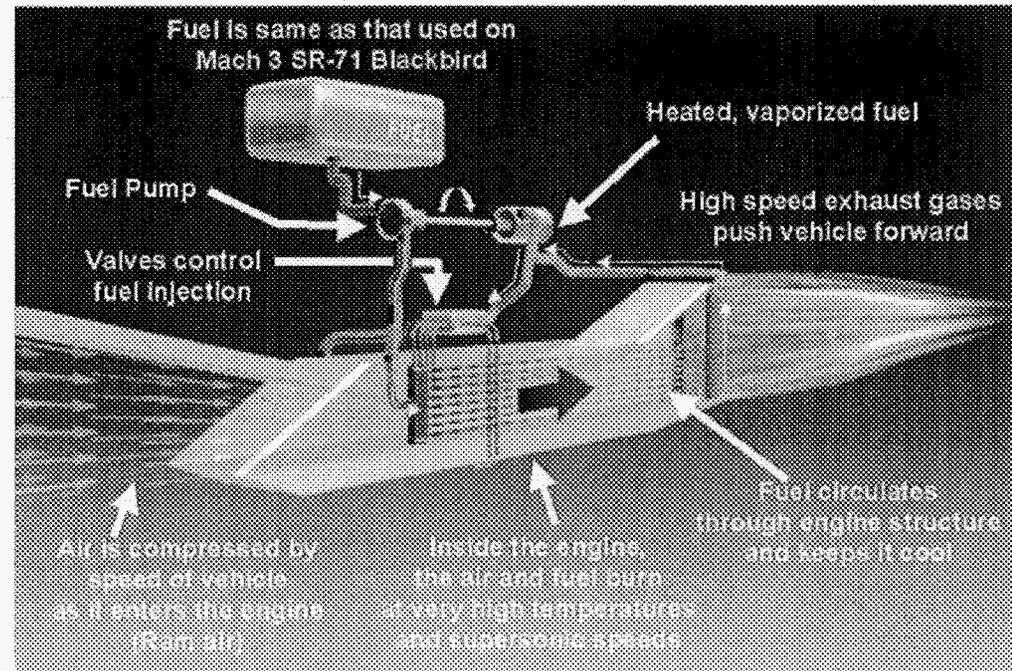
P&W SP Planned Activities



Pratt & Whitney
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- Evaluate creation of NPSS models of various Hypersonic propulsion systems
 - Models will be completely integrated
 - Hypersonic flowpath
 - Fuel Delivery System
 - Heat Exchangers
 - Digital Control
 - Control Laws
 - Control sub-systems





P&W SP Planned Activities



Pratt & Whitney
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- Evaluate creation of NPSS models of various Liquid Propellant Booster & Upper-stage Rocket Engines
 - Models will be completely integrated
 - Fuel & Oxidizer Delivery Systems
 - Heat Exchangers

