MEANS II Bidder Conference

3 May 04

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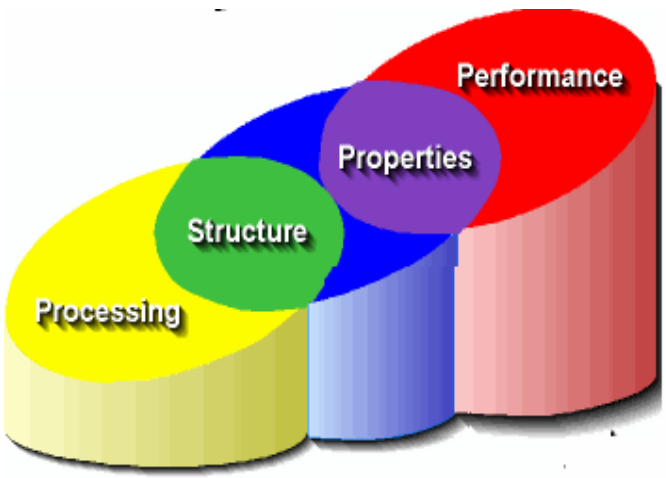
AFOSR/NA

RATIONALE

- Now is the time for an ***interdisciplinary effort*** to expand the present approaches to integrating materials and systems design.
  - to develop robust collaborative strategies, improved physics-based modeling techniques and selectively use experiments to verify the accuracy of predictions.
  - Goal is the creation of a spectrum of interoperable materials models extending from *ab initio* principles to the development of information required for systems design processes, creating a seamless interface with databases required for engineering design applications.
  - Ultimately, techniques for uncertainty modeling, lifetime assessment and prediction must accompany this development as an integral part of the overall design strategy.

- Strategies developed will employ ***generic*** techniques for coupling calculations and measurements of thermodynamic, structural and kinetic properties of materials with models of microstructural entities that determine macroscopic behavior.

Invest in the fundamental research necessary to discover novel, high performance materials through the elucidation of the <u>mechanical property - microstructure - processing relationship.</u>



VISION

- This program envisions the development of robust materials systems design processes driven by *product requirements*.

http://www.afrl.af.mil/index2.html

Review and Evaluation of the Air Force Hypersonic Technology Program

Committee on Review and Evaluation of the Air Force Hypersonic Technology Program
Air Force Science and Technology Board
Commission on Engineering and Technical Systems
National Research Council

http://books.nap.edu/books/0309061423/html/index.html

Flight Conditions			Combustor Maximum Pressure Location			Combustor Maximum Temperature Location		
Cruise Number	Mach	Dynamic Pressure (psf)	P_{max} (psf)	T_{total} (°F)	$T_{wall\ cooled}$ (°F)	P_{local} (psf)	T_{total} (°F)	$T_{wall\ cooled}$ (°F)
6		1,500	6,300	4,000	1,400	1,400	4,400	1,300
8		1,500	4,100	5,000	1,600	1,100	5,100	1,400

Note: This table shows static pressures (pounds per square foot) and total temperatures in the engine combustor for the nominal Mach 8 and Mach 6 missiles shown in Figures 1-1 and 1-2. Total temperatures and cooled-wall temperatures are given. Both missiles are assumed to use the same propulsion system and endothermic fuels for cooling, although endothermic fuels may not be necessary for a Mach 6 missile.
Source: Air Force Hypersonic Technology Program Office, United Technologies Corporation (Pratt & Whitney), and Boeing North American.

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EVALUATION OF THE NATIONAL AEROSPACE INITIATIVE

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Committee on the National Aerospace Initiative

Air Force Science and Technology Board
Division on Engineering and Physical Sciences

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Appendix C

NAI Hypersonics Programs and Technologies

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

X-43A Hyper-X

The first demonstrator vehicle in NASA's "Hyper-X" series of experimental hypersonic ground and flight test vehicles, the X-43A will demonstrate "air-breathing" engine technologies for future hypersonic aircraft and/or reusable space launch vehicles, achieving speeds above Mach 5, or five times the speed of sound. The X-43A is intended to dramatically increase payload capacity or reduce vehicle size. A successful flight could mark the first time a nonrocket, air-breathing supersonic-combustion ramjet—or "scramjet"—engine has powered a vehicle in flight at hypersonic speeds. The next flight test of the X-43A is scheduled for January 2004. (NASA, 2003a)

X43-B

The X-43B will be the first reusable vehicle in the X-43 series of X-planes. Not requiring a booster, it will be air-launched from NASA's new B-52H aircraft, in a manner similar to the X-15, and then flown to Mach 7 under its own power. It is an ambitious undertaking and will go a long way toward advancing technology readiness levels for future hypersonic aircraft and air-breathing space access vehicles.

http://books.nap.edu/books/0309091756/html/index.html

Potential Applications of Ultra-High Temperature Ceramics

- Revolutionary concepts in propulsion will require materials that can operate over a wide range of ultra-high temperature combustion environments for both long-term operation (e.g., >1000 hrs. at >1550°C for combustion liners in gas turbine engines) and short-term operation (e.g., <200 sec. for rocket nozzle throats at temperatures up to 3000°C).

- Future space vehicles will require sharper leading edges and resilient skins in order to improve both vehicle performance and safety. Specifically, the use of sharper leading edges will result in (i) increasing propulsion capabilities through decreased drag, (ii) increasing vehicle maneuverability, and (iii) increasing time during ascent to safely abort the flight and increasing the cross range available to safely land the vehicle.

- design of processes for producing ceramic materials and components for application at ultra high temperatures
  - Modeling at all levels must be accompanied by critical experiments designed to verify analytical predictions and techniques for estimating the reliability and scatter of the computed properties.
  - Emphasis throughout will be on the reduction of empiricism and *ad hoc* assumptions and the compatibility of each model with those for adjacent length and time scales.