

# Air Force Research Laboratory

---

*Defending America by Unleashing the Power of Innovative Aerospace Technology*

## Ensuring the Structural Integrity of Tomorrow's Air Platforms – The Long-Term Challenge



**Ravi Chona**

*Senior Scientist & Director*

*Structural Sciences Center*

*Air Vehicles Directorate, WPAFB, Ohio  
ravi.chona@wpafb.af.mil; (937)-904-6787*

*ASIP Panel Discussion; 2006-11-29*

**U.S. AIR FORCE**

---

*Integrity - Service - Excellence*

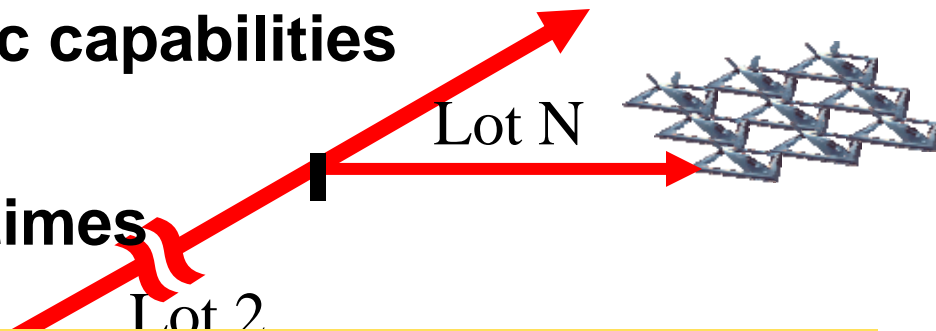


# Tomorrow's World The New Acquisition Paradigm



- Unique requirements for each buy
- Requirement specific capabilities
- Small buy numbers
- Short development times

ities



**Calls for a fundamentally different mindset ... and new paradigms for development and sustainment!**





# Tomorrow's World

## Integrated Hot Structures w/o Full-Scale Tests



**The Need:** New platforms that can be fielded quickly, **do things that we cannot do today ... and do them again and again!**

### YESTERDAY/TODAY (The Shuttle)

- Turn Time: 2 flights/yr
- 48,000+ Man-Hrs/Flt TPS Maintenance

### TOMORROW (USAF-ORS)

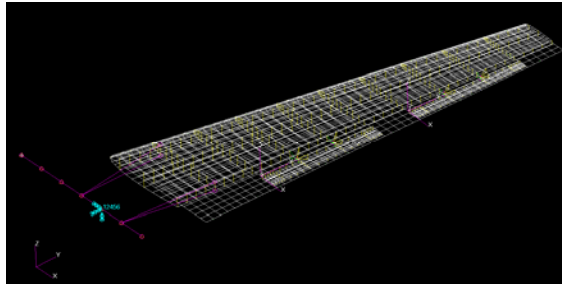
- Turn Time: Multiple flights/wk
- No Add-on TPS
- Condition-Based Maintenance
- ==> Robust Hot Structures

## The Roadblocks:

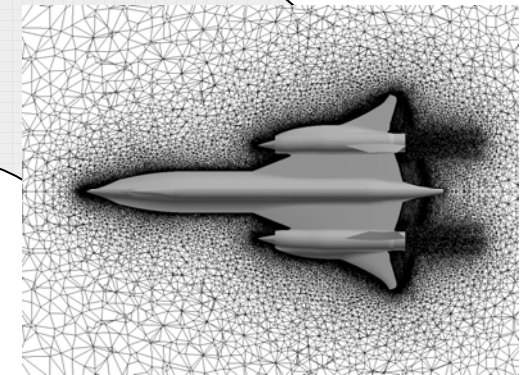
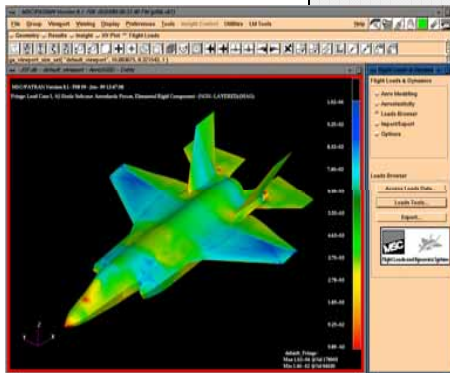
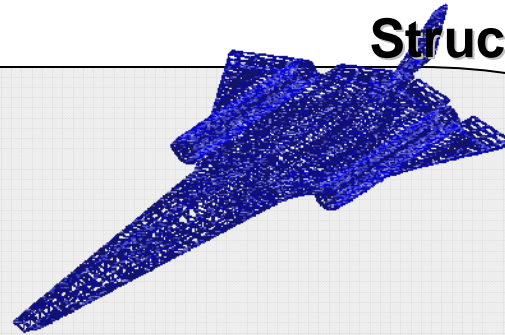
- **Full-scale structural tests** are **multi-year efforts** costing **multi-millions of dollars** ... if they can be done at all
- **Operating environments** are **not well-understood** ... and **cannot easily be replicated** during ground tests
- **Multi-scale Physics** of combined environments and the micro-macro connection **has to be understood** ... and captured **at the structural scale** ... so that **structural simulation capabilities can be realized**



# The New Frontier



**Validated, High-Fidelity,  
Structural-Scale Simulation**



**Risk-Quantified  
Structural Assessment**



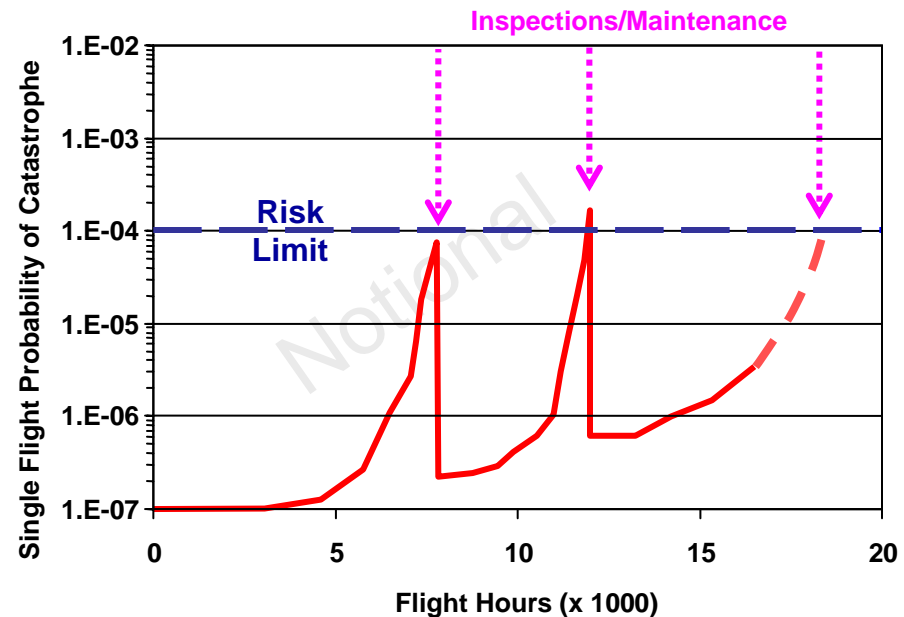
**Rapid Acquisition; Efficient Certification;  
Condition-Based Maintenance!**



# Can Structural Integrity be Assured without Full-Airframe Tests?



- Extreme operating conditions cannot be replicated during full-vehicle ground tests ... so don't do them!
- Quantify risk of structural failure ... and thus certify structural integrity
  - Learn from the offshore oil production and nuclear power industries
- Exploit high-fidelity simulation tools
  - Validate and refine tools using flight test data





# The Need



## **More Efficient Ways of Acquiring an Improved Understanding of:**

- Structural Response
- Structural Limit States
- Possible Failure Modes
- Applicable Failure Criteria

## **for:**

- New structural concepts
- New manufacturing/fabrication technologies
- New materials/material systems
- Unfamiliar operating environments
- Far lower levels of maturity and experience



# Impacts on the Air Force



Cost



**Risk-Based Methods for  
Structural Design &  
Evaluation**

Range



Life



Reliability



Payload



**New Paradigms for Structural Assessment  
and Structural Management**