Beyond Rigid Body
Integrated Structural Control of Extremely Lightweight Flexible Aircraft

Why?
Reduced weight is fundamental to aerospace design
Many years of aerospace development has resulted in extremely efficient lightweight structures
Advancement now requires a new paradigm
- Retain strength but allow for reduced stiffness
- Provide apparent stiffness with integrated active structural control
Side Benefit: Advancement of full-authority adaptive flight control for realistic full-scale vehicles will not proceed until methods for sensing and accounting for structural limitations are developed

Development Areas
- Modeling
  - High order models with structural interactions and unsteady aerodynamic effects required
  - MODAF elastically tailored structures
- Sensors
  - Fiber Optic Shape Sensing (FOSS)
  - Fly-by-feel (hot films and beyond)
  - Others...
- Actuation
  - Potentially very high bandwidth requirements
  - Piezoelectric, mems, others...
- Control Algorithms
  - Balance structural shape, structural load, dynamic interaction suppression, with rigid body performance requirements

X-56A Multi-Utility Technology Testbed (MUTT)
AFRL funded
Designed & Built by Lockheed Martin Skunk Works
Complete Research System
- 2 Center Bodies
- 1 Stiff Wing Set
- 3 Flexible Wing Sets
- 1 Ground Control Station
- With Simulation and SLL Capabilities

Conclusions
Integrated structural control will enable breakthroughs
- New class of extremely lightweight vehicles
- Advance feasibility of full authority adaptive flight control
The X-56A MUTT vehicle provides an excellent tool to explore this technology

References

X-56A
Multi-utility Aeroelastic Demonstrator
Removing the Flutter Barrier