Relevant Technology to Mission Adaptive Rotors

C.L. Chen and Sergio Lucato – Teledyne Scientific & Imaging; cchen@teledyne.com
Rohit Janet – Hypercomp
Z.J. Wang – Iowa State University

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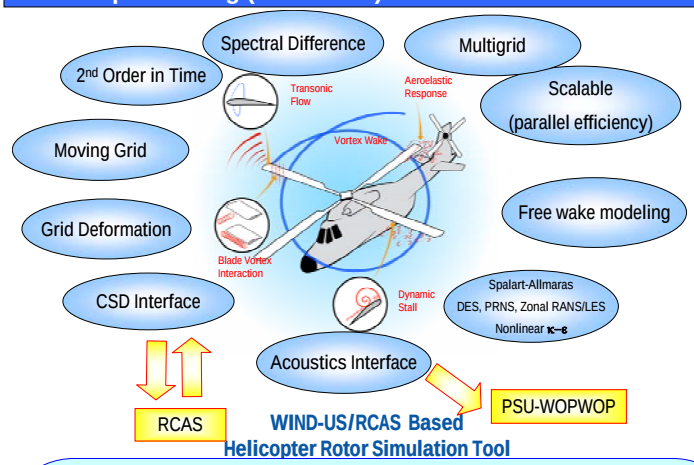
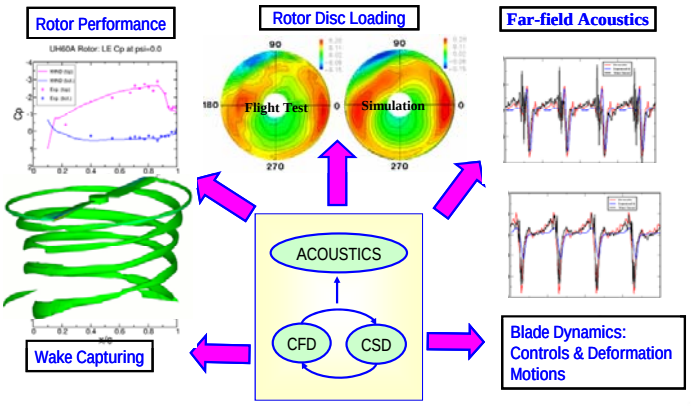
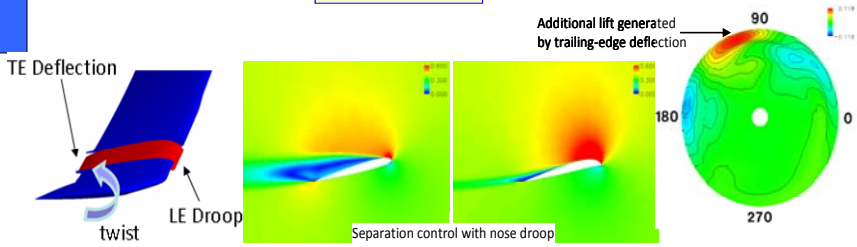
HQP tool (DARPA) + Morphing extension (Army)

- Fully 3D Navier Stokes modeling of Rotors
- Interfaces for industry standard comprehensive rotor dynamics codes (RCAS etc.)
- Interfacing with farfield acoustics computation
- Comprehensive post-processing for rotor aeromechanics
  - blade elastic deformations
  - blade aerodynamic loading
  - structural loads
- Morphing blade simulation capability: active rotor control simulation using combination of leading-edge droop, trailing-edge deflection, twist etc., can be modeled with fluid-structure interaction
- Automatic unstructured/hybrid grid generation
- Parallel processing (MPI-based)



WIND-US/RCAS Based Helicopter Rotor Simulation Tool

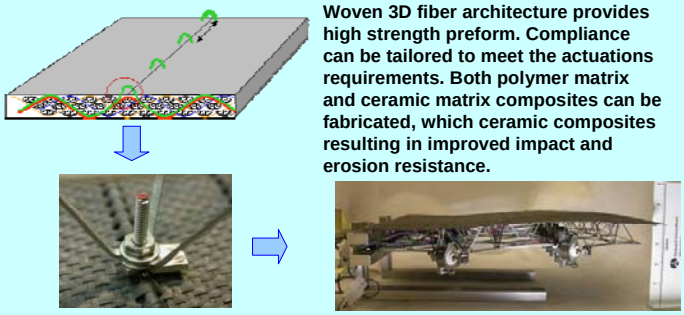




Simulation of actively controlled rotors

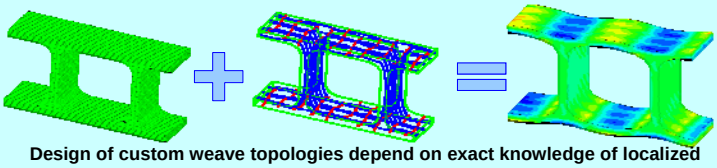
Template-based surface generation tool for morphing rotor blades

Integrally Woven Fiber Composites for Shape Morphing Applications

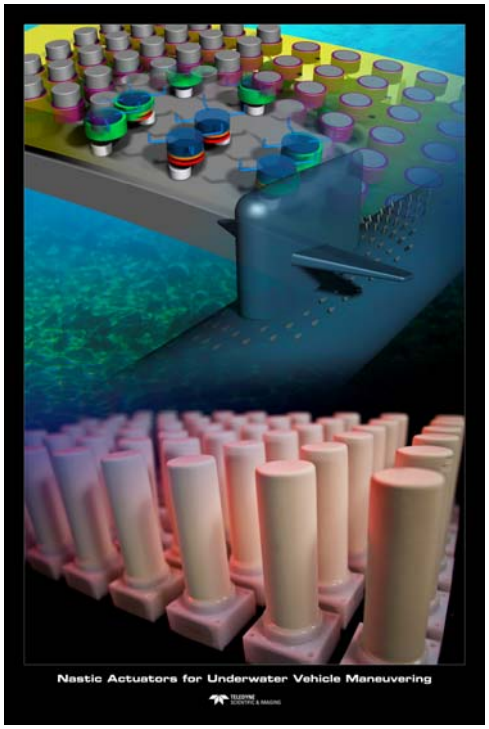


Woven 3D fiber architecture provides high strength preform. Compliance can be tailored to meet the actuations requirements. Both polymer matrix and ceramic matrix composites can be fabricated, which ceramic composites resulting in improved impact and erosion resistance.

Binary Model – The Simulation Tool for Fiber Reinforced Composites



Design of custom weave topologies depend on exact knowledge of localized conditions on a fiber tow scale. The *Binary Model* scheme has been developed to simulate thermo-mechanical problems with a tow level resolution while permitting full component size computer models on conventional hardware. Other methods rely on spatially averaging the material properties of the composite or rely on a periodicity. Thanks to the multi-scale approach of the *Binary Model*, the stresses in every tow and the local stresses in the matrix can be simulated with high accuracy for failure analysis and weave and geometry optimization.



Dynamic Bumps with Distributed Nastic Actuation