Midé Technology Corporation

Technologies Relevant to DARPA Mission Adaptive Rotor

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Mr. Attila Lengyel
alengyel@mide.com

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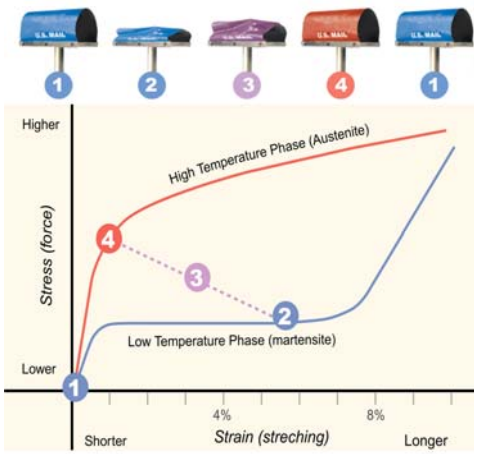
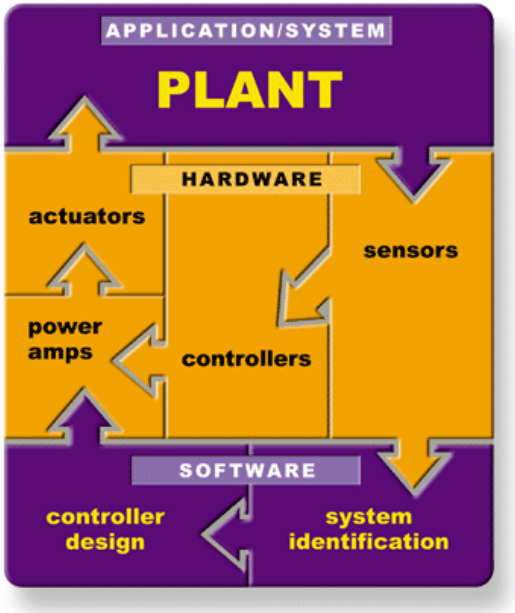
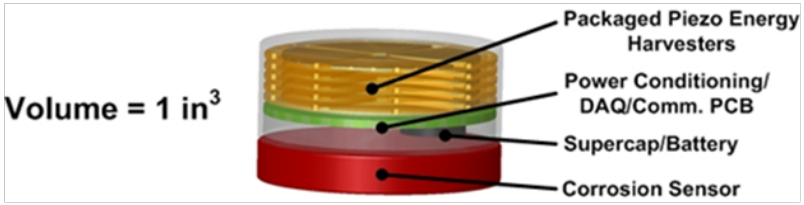
Midé – A Leader in "Solid State" Actuators

- Development of Engineering Systems
  - We understand systems
  - System application of Smart Materials
- Shape Memory Alloys
  - High energy density
  - Demonstrated under realistic rotor centrifugal loads
- Packaged Piezoelectric Wafers
  - Actuators and sensors
  - Energy harvesting
    - 100 μW – 100 mW
  - Health monitoring and damage detection







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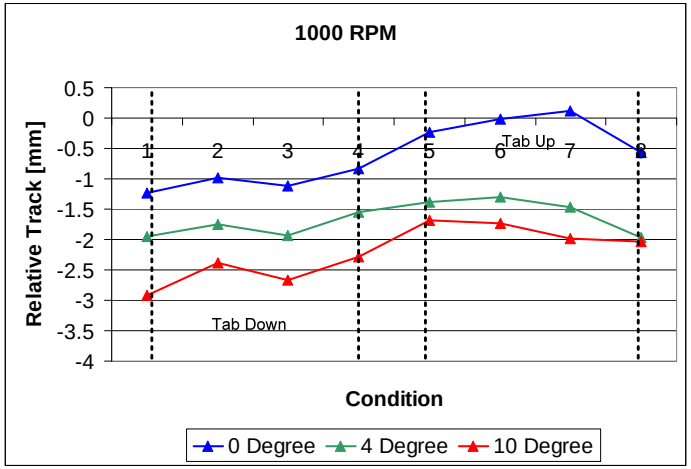
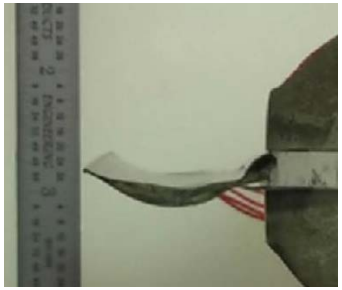
SMA Based Active Trim Tabs

Industry Partner – Sikorsky Aircraft

- Slight manufacturing and in-service variations in blades and rotor head components cause lift and dynamic response to vary among blades
  - Current solution is adjust tab, fly in forward flight, land, and manually adjust tab
- Use SMA sheets to build automated trim tabs to maintain track and balance
  - No embedded actuators, the tab *is* the actuator
- Demonstrated in CF field at Sikorsky





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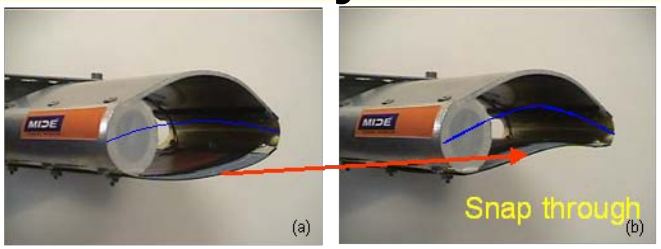
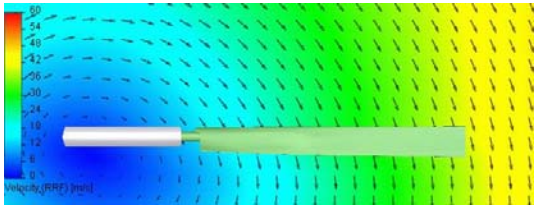
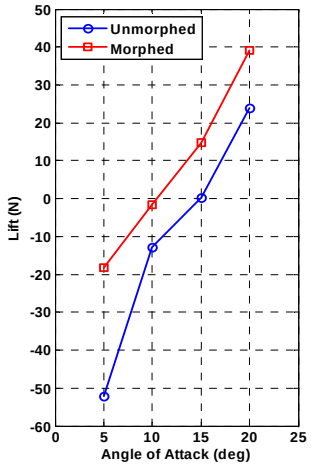
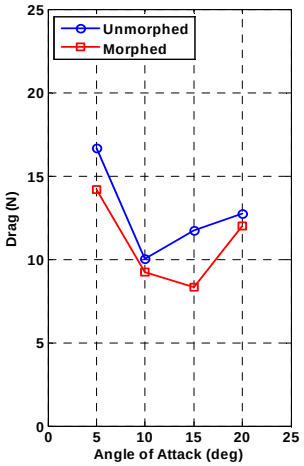
Morphing of Tilt-Rotor Blade

Industry Partner – Bell Helicopter

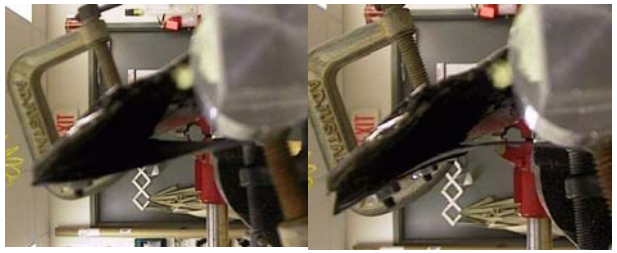








- Tilt-rotor blade twist is a compromise between helicopter hover “mode” and airplane “mode”
- Wind tunnel and whirl tests were successful but change in lift limited by
  - Active section being inboard
  - Small scale of blade
- CFD (linear and rotational) predicts better performance if whole blade can morph



Nominal **Morphed**

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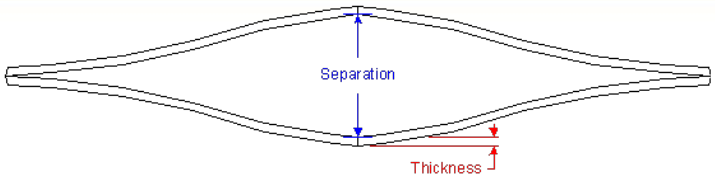
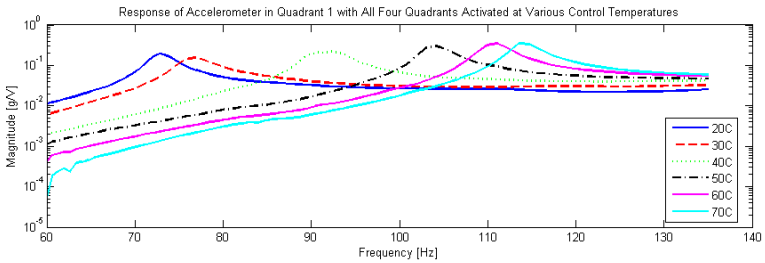
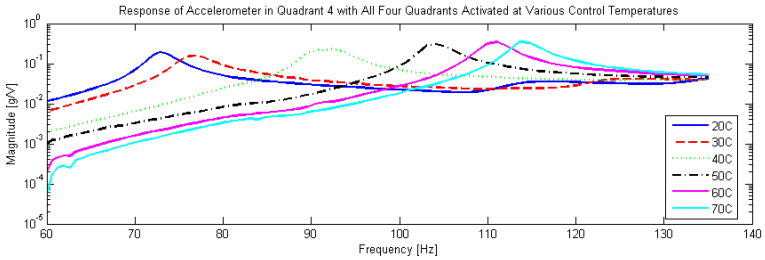
Morphing Structures to Reduce Vibration

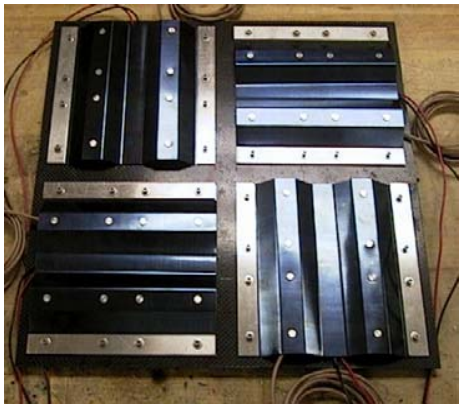
- Modify panel stiffness by SMA morphing
  - Move modes to create mismatch between driving frequency and aircraft structure
- Increase in the static stiffness
  - Significant increase in resonant frequencies
- Good match between model and tests

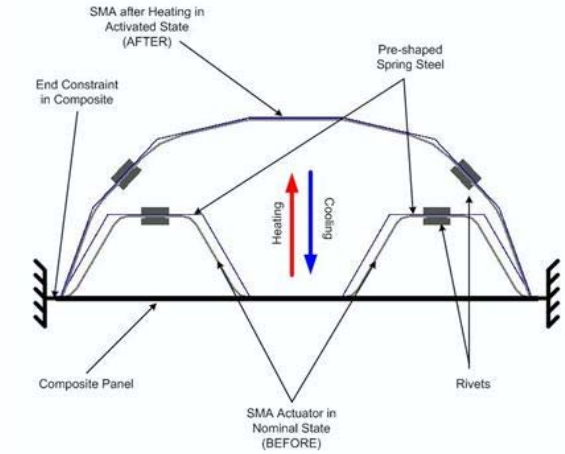


Actuated Quadrants	Model 1st Mode (Hz)	Measured 1st Mode (Hz)
None	75.43	72.54
1	91.34	85.06
1,2 (Adjacent)	103.30	96.11
1,3 (Diagonal)	104.40	93.68
1,2,3	113.98	103.81
1,2,3,4	135.08	114.65









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Active Rotorhead Systems Industry Partner - Sikorsky

- Programs currently funded by SBIR through AFDD
- Automated Rotor Track and Balance (RT&B)
  - Adjust pitch rods on ground or in flight as required
  - Adjust mass balance of rotor on ground or in flight as required
  - Long term goal to integrate with Active Trim Tab and have a fully automated RT&B system to significantly reduce maintenance costs
  - Secondary goal of wireless, self-powered system using vibrational energy harvesting
- Individual Blade Control (IBC)
  - Develop a fully integrated system on the rotorhead to improve overall rotor performance
  - Both rotor performance and reduced vibration are targeted
- Traditional actuation schemes as opposed to Smart Materials

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