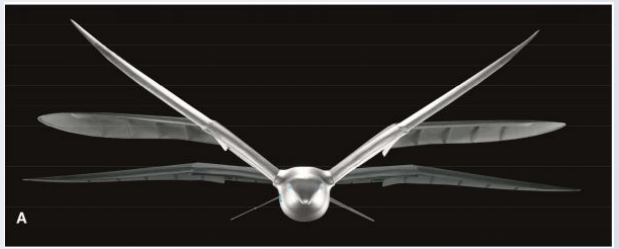
Is it possible to create a biodegradable wing using foldable mechanisms to create net-positive lift?

Team 3: BIRB (Biodegradable Inspired Robotic Bird)
Chris Breaux, George Muhn, and Lien White

Biomechanics-Driven Inspiration

- Mallard Duck *(anas platyrhynchos)* [1]
  a. Long-distance migratory bird
  b. Inspired wing radius and chord length
- Take-off Analysis of a Starling and Quail [2]
  a. Kinematics analysis of wings, feet, and body
  b. Inspired force calculations based on body mass
- SmartBird [3]
  a. Servo-actuated 5-bar robotic wing
  b. Inspired flap frequency, motion, and power consumption
- Quadrotor UAV [4]
  a. Inspired mass of electronic components

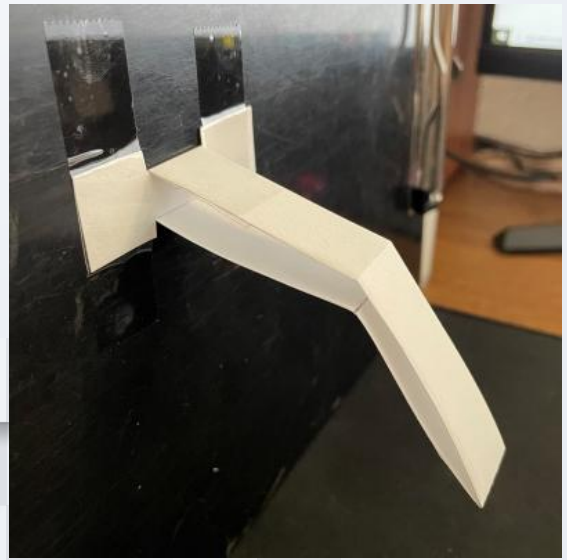
Specifications		
Wing Radius	0.4 m	[1]
Chord Length	0.2 m	[1]
Flap Frequency	2 Hz	[3]
Robot Mass	500g	[4]
Flap ROM	45 deg	[3]
E.E Force	9.81 N	[2]
Power Consumption	23 W	[3]

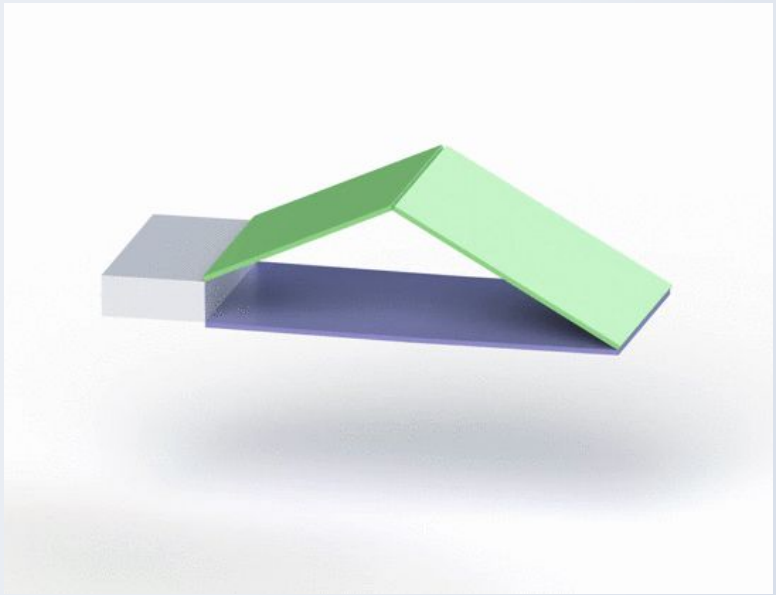


Proposed Mechanism

Goal: Produce flapping gait with net positive lift on a static test stand

- 5-bar Mechanism
- 2 angle inputs at the base
- (x, y) position output at the tip

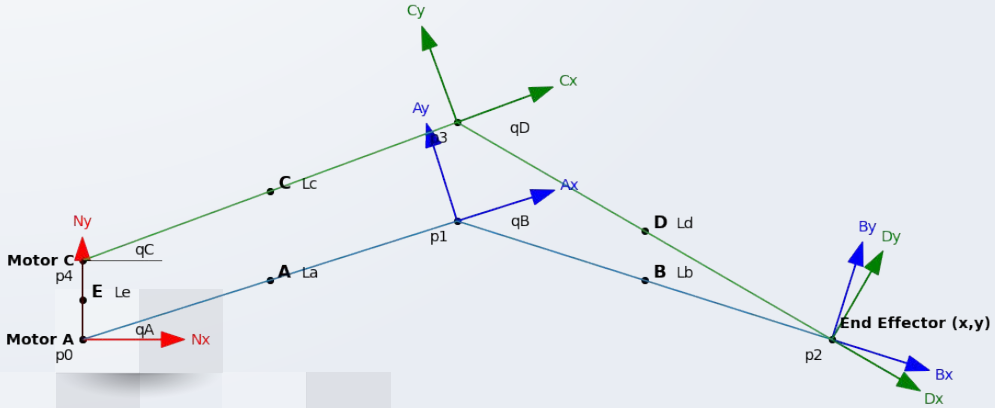




Kinematics

- Two 2-bar linkages in parallel
- Ends are constrained together

- Force: mass goal and 1g acceleration
- Velocity: stroke length and frequency



Fully Extended, Horizontal, Downward Beat	
End Effector Force	-9.81 N * Ny
MotorA Torque	-0.18 Nm
MotorC Torque	-2.89 Nm
End Effector Velocity	-1.26 m/s * Ny
MotorA Velocity	-6.28 rad/s
MotorC Velocity	-3.87 rad/s
Total Power Draw	12.32 W

Future Plans

- Reconsider: relative link lengths, trajectory, constraints, motor selection, joint limits
  - Maximize thrust output
  - Minimize motor torque and velocity input requirements
  - Minimize total system mass
- Identify degradable material that meets mass and force requirements
- Identify logic and energy storage components
- Create test bench to measure thrust