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Engineering a Homerun

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The Lab
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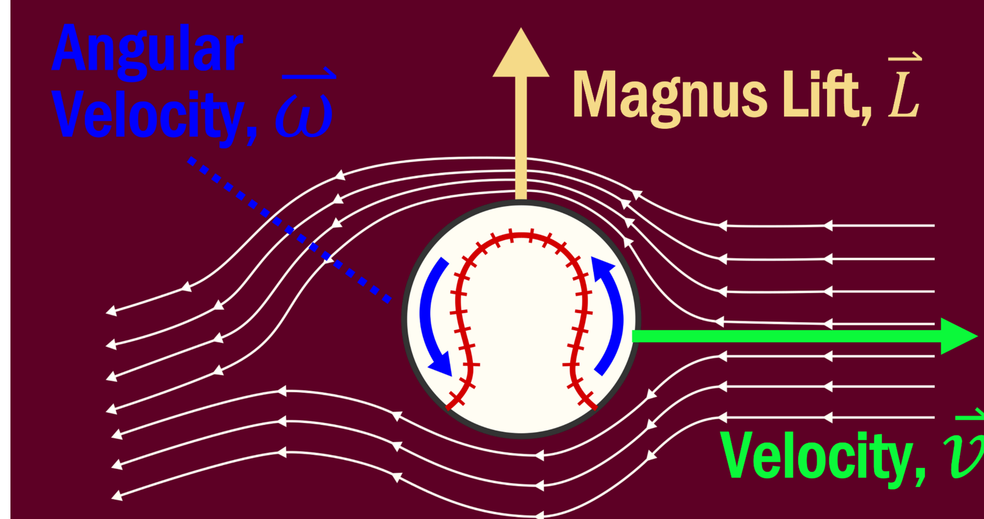
The Problem

Many baseball players try to hit a homerun by swinging upward at large angles (i.e., "getting under the ball"). However, slicing a ball, or making contact below the ball's equator with a flatter swing, imparts backspin that helps to keep the ball aloft as it moves toward the fence.

Lift on a Spinning Baseball

When a spinning baseball moves through the air, it generates an *aerodynamic force* called lift. The lift acts perpendicularly to both the ball's velocity and the axis of its spin. This behavior is explained by the Magnus Effect. When pitches curve, it is due to this Magnus Effect. The lift caused by the Magnus Effect is given by

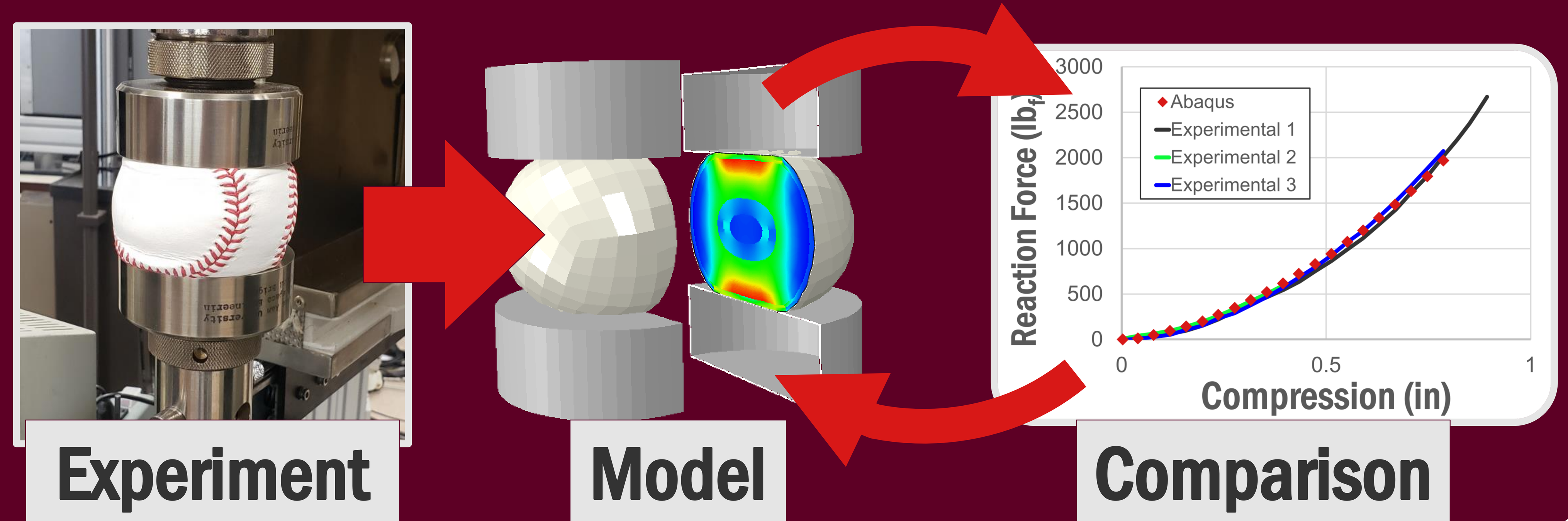


$$\vec{L} = \frac{1}{2}\rho A C_L ||\vec{v}|| \cdot \left(\frac{\vec{\omega}\times\vec{v}}{||\vec{\omega}||}\right),$$

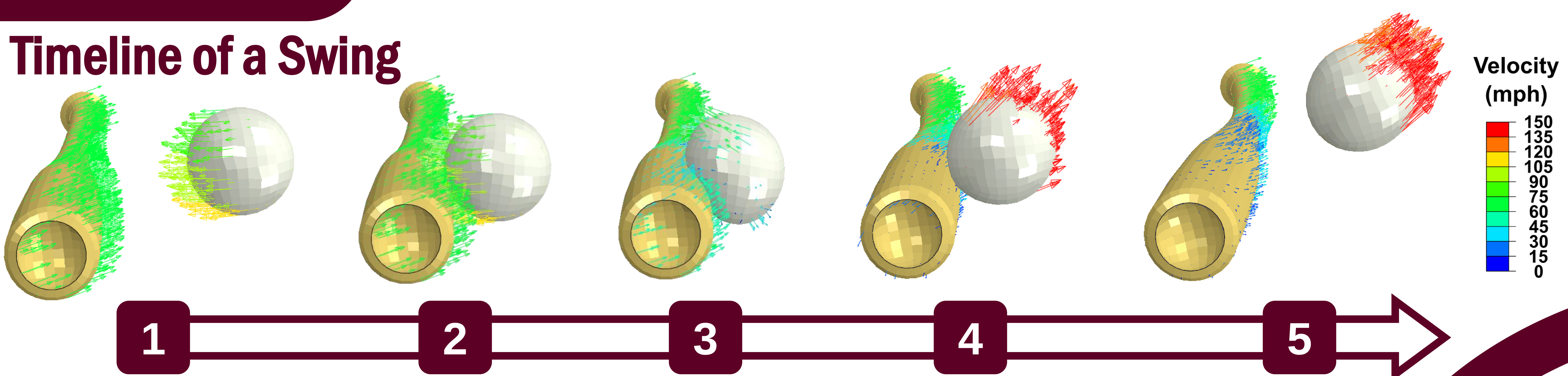
where ρ is the air density, A is the cross-sectional area of the baseball, C_L is the coefficient of lift, and $\vec{v}$ and $\vec{\omega}$ are the velocities shown in the diagram (Robinson & Robinson, 2013).

Material Testing & Calibration

Static and dynamic compression experiments were used to calibrate the material properties of a Finite Element Model (FEM). Properties were adjusted repeatedly until the model matched the experiments.

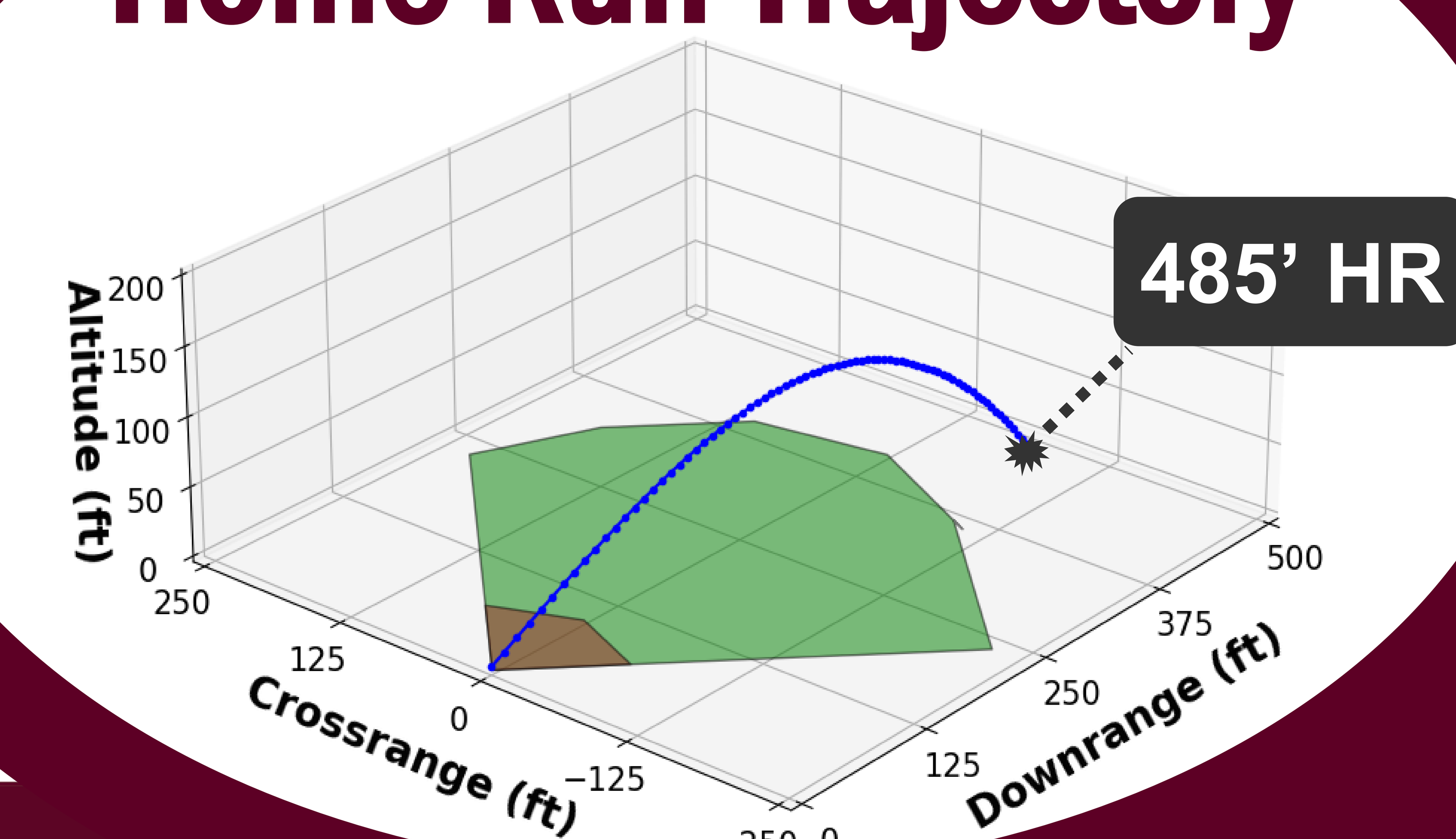


Timeline of a Swing

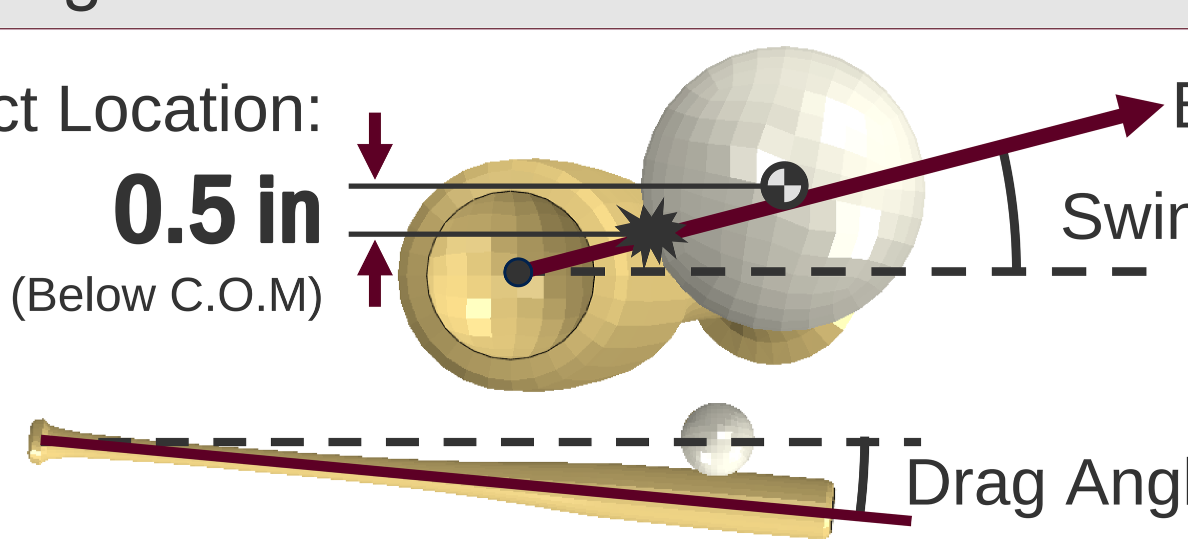


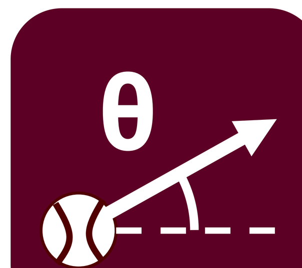
The exchange of **momentum** gives the ball its **exit velocity**

Home Run Trajectory



Hitting under the ball's **center of mass** imparts **backspin**





Launch Angle: **29.6°**

Exit Velocity: **121.5 mph**

Summary: To hit the ball far, swing **slightly** upward, making contact just below the ball's equator