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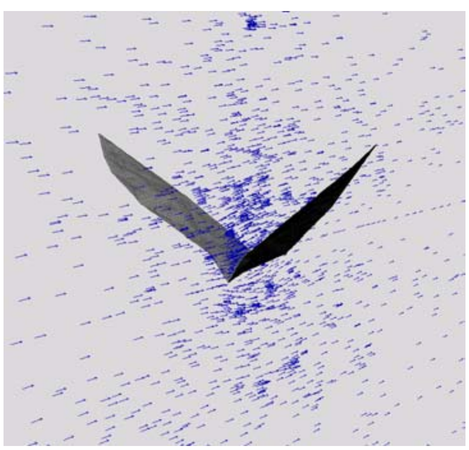
Brown University Uses Gridgen to Simulate Bat Flight

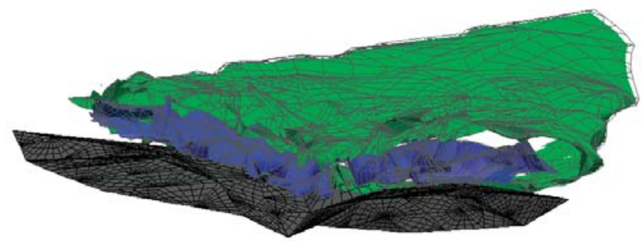
People use computational fluid dynamics (CFD) for the battiest things, literally! Recently, researchers at Brown University used Gridgen to simulate and visualize airflow around a flying bat (the small nocturnal mammal, not the baseball hitting instrument). Their research is helping scientists better understand the aerodynamics of bat flight. The researchers hope to make discoveries in areas such as biomechanics, aerodynamics, and evolutionary biology.

One of the problems the Brown University researchers faced was determining the shape of the bat in flight. When bats fly, their wings undergo large amplitude motions and deformations. Plus, they move rapidly, making measurements difficult. The researchers devised a series of procedures to obtain the data needed to better understand bat flight.

In order to start, data were needed to create a geometric model. For this study, small-bodied (3-5 gram) bats from the species *Rhinolophus megaphyllus* were used. By flying more than 20 bats through wind tunnels, researchers were able to obtain motion capture data of the bat's shape in flight. Two high-speed digital cameras tracked reflective markers under infrared illumination (nocturnal bats don't like bright light!) on the left side of the bat and software interpolated the camera data into 3D coordinates. The data was mirrored across the animal's midline to get the right side shape.



Flying bat in upraised wing position with velocity vectors shown.



Iso-surfaces around a bat in flight.

The motion capture data was used to create a polygonal geometric model for each of 160 poses during a single wingbeat. Each bat wing was represented as a tessellation of triangles. An outer volume of approximately 10 x 10 x 20 wing chord lengths was created around the bat, and Gridgen was then used to create a mesh in the volume around the bat for each pose. Using Gridgen's Glyph scripting language the Brown researchers were able to quickly create 160 different grids for different poses. About ten of the meshes are used to represent the flow through the entire cycle; meshes are replaced as they deform too much. Together, they can be used to calculate a time-varying simulation of the flow through an entire wing beat.

The CFD code NEKTAR, developed at Brown University, was used to simulate the flow. For the present study, which serves as a proof-of-concept for a full, unsteady simulation, several static poses were modeled. The resulting flow was visualized in a 3D stereo virtual reality environment known as a CAVE.

Researchers noted several interesting flow features, including small vortices emanating from the trailing edge of the bat's wing. They successfully demonstrated their approach to bat flight modeling and laid the groundwork for future unsteady simulations. Look for new, more efficient bats to begin appearing in your backyard soon!

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App Sheet—Brown U Bats

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