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Flying Squirrels

Gliding-Wing Designs

Nature-Inspired Inventions

Volume 012 of 255

WealthSphere Labs

Flying Squirrels: Gliding-Wing Designs

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About this book. This is an educational guide to biologically inspired engineering. The invention concepts in it are design ideas for study and experimentation, not tested or certified products. Worked numbers illustrate methods unless a source is named. Nothing here is engineering certification, legal advice on patents, or a substitute for qualified professional review of anything that will carry people, loads or risk.

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Introduction: Flight Without Wings

A flying squirrel does not fly. It glides. Launching from a high branch, it spreads its legs and stretches a fold of furred skin between its wrists and ankles into a square, flexible wing. It sails between trees, steering with its limbs and tail, then pitches up sharply just before landing to slow down, touching the target trunk with all four feet.

Gliding has evolved independently many times: in flying squirrels, sugar gliders, colugos, flying lizards, flying frogs, flying snakes and flying fish. Each has found a way to turn a body not built for flight into a controlled glider. These animals show that useful gliding does not require a large, efficient wing. A small, low-aspect-ratio, deployable surface can be enough to travel, escape and land precisely.

For engineers, gliding mammals inspire wingsuits, deployable wings on drones and packages, compact gliding munitions and delivery systems, and landing techniques that use high-angle braking. This volume explains how gliding mammals fly, the aerodynamics of low-aspect-ratio gliding surfaces, the history of wingsuits and deployable wings, and how designers can apply gliding principles to compact systems.

How this book is organized

Chapters 1 and 2 cover gliding mammals and their anatomy. Chapter 3 explains the aerodynamics of low-aspect-ratio gliders. Chapter 4 surveys the history of wingsuits and deployable wings. Chapters 5 to 7 cover translation, structures and control. Chapter 8 presents ten design concepts. Chapters 9 to 13 cover testing, failure modes, approval, a workbook and a case study.

Figures for real animals and devices are rounded and typical. Worked numbers are illustrations unless a source is named.

Chapter 1: How Gliding Mammals Fly

Who glides

- **Flying squirrels** live in forests in North America, Europe and Asia. There are dozens of species, from small northern and southern flying squirrels of around 100 grams to giant flying squirrels of over a kilogram.
- **Sugar gliders** and other gliding marsupials of Australia and New Guinea evolved gliding independently.
- **Colugos** of Southeast Asia have the most extensive gliding membranes of any mammal, stretching from neck to fingertips to tail.

Why glide

Gliding lets these animals travel between trees without descending to the ground, where predators wait, and saves energy compared with climbing down and up. It can also be an escape: a sudden leap and glide moves the animal far from danger quickly.

Glide performance

Gliding mammals typically achieve glide ratios of roughly 1.5 to 3 — travelling 1.5 to 3 metres horizontally for every metre of height lost. Some colugos and large flying squirrels can do better on long glides. This is modest compared with birds or sailplanes, but it is enough for travel between trees.

Landing

Flying squirrels land by pitching up sharply just before reaching the trunk, increasing angle of attack and drag to slow down, and touching first with their legs. Research by Kristin Bishop, published in the *Journal of Experimental Biology* in 2006 on southern flying squirrels, examined how glide kinematics changed through the glide

and at landing. The landing maneuver resembles a bird's flare or an aircraft's stall landing, and is a key part of gliding success.

Chapter takeaways

- Gliding evolved many times in mammals and other animals.
- Glide ratios of 1.5 to 3 are typical.
- High-angle braking before landing is essential.

Chapter 2: Anatomy of a Gliding Mammal

The patagium

The gliding membrane, or patagium, is a fold of skin stretched between the forelimbs and hindlimbs. When the animal spreads its limbs, the membrane forms a roughly square wing. When the limbs are tucked, the membrane folds against the body.

Wingtip support

Flying squirrels have a cartilage rod extending from the wrist, called the styliform cartilage, that supports the leading edge of the membrane at the outer corners. This extends the wing area and helps control the shape of the wingtip, possibly reducing tip losses.

Muscles in the membrane

Muscles run through the patagium, letting the animal tension the membrane and control its edges. Tension control affects camber and stability, much as in bat wings.

The tail

The flattened, bushy tail of flying squirrels acts as a stabilizer and control surface, helping with pitch and yaw.

Limb control

By moving its limbs, a gliding mammal changes the shape, area, angle and tension of its wing. Moving one forelimb more than the other produces turning forces. The limbs are the entire control system.

Chapter takeaways

- The patagium forms a deployable, flexible wing.
- Cartilage rods extend and shape the wingtips.