Simplifying Streamlining

By Lyndon Martin

Last summer my wife and I spent an evening on the Bear River Migratory Bird Refuge near Salt Lake City, Utah. As the setting sun bathed the marshes in amber glow, we watched pelicans dunking their heads in the water to catch fish. Great blue herons stood like long-legged statues in the water.

Overhead a tern flew back and forth. When he spotted a fish swimming below, he dived like a meteor into the water to snatch his prey. We marveled at his rapid dives.

Some birds dive even more rapidly. A peregrine falcon catches smaller birds by diving through the air, sometimes reaching more than 200 mph.

In the ocean, sharks pursue their prey, sometimes accelerating 12-30 mph in short bursts.

Did you know that men study how birds move through the air, and copy their shape in designing airplanes and cars? Did you know that they design boats and submarines with fish-like shapes?

Aerodynamics is the study of solid objects moving through fluids like water and air. Water and air are made up of tiny particles called *molecules*. Air molecules are much farther apart than those in water. When a solid object moves through a fluid, it pushes

trillions of tiny molecules out of its way. A car moving along a highway is pushing through air molecules. The air molecules are much smaller than the car and so give way to it.

However, since there are so many air molecules, they do resist the onrushing car. *Drag* is the force of resistance acting on solid bodies moving through air. Much of the engine power necessary to drive a car at moderate and high speed is used to overcome drag.

Streamlining is building an object with a smooth shape to reduce drag. To help a car slice through the air, designers copy a prominent feature of birds and fish—they round or point the front of the vehicle. Aircraft designers create pointed noses for their craft. Boat designers point the bow of the ship to achieve the same effect. One common type of submarine was designed with the shape of a particular fish called an *albacore*.

Front-end streamlining helps reduce the drag from air hitting the front of a blunt object. But streamlining the front isn't enough because the air moves back along the object. Look at a fish and you'll notice that its head tapers toward its mouth. This helps the water slip past the mouth and head and back the body. A bird's feathers give its body a smooth form that helps the air rush by its body. Aircraft, auto, and boat designers create sleek body lines for their craft also.

What happens when the air reaches the back end of the bird or the plane or the car? Does the air just slip on past without any trouble? Interestingly, most drag isn't caused by air hitting the front of an object. It's caused when the air tears away from the back of the object.

When air reaches the blunt back of an object, it just tumbles off the object. The tumbling air creates a partial vacuum just behind the object. Adjacent air rushes in to fill this vacuum and creates whirlpools of turbulent air that slow the object down.

God gave birds long, pointed wings and tails, and gave fish a thin tail fin to overcome drag. Aircraft are designed with tail fins, too, and the backs of vehicles are rounded.

You can observe the effects of streamlining on air flowing over an object. You'll need a thin candle about 5-6" tall, a rectangular box about 3"x 3"x 9" (like a cheese box), and a bottle 3" in diameter. (We used a lamp chimney.)

Light a candle in a holder. Next hold the rectangular box as a pillar, about 2½" away from the candle. From the side of the box opposite the candle, with your mouth 3" from the box and level with the flame, blow powerfully toward the box.

As air molecules from your breath reach the box, they part and flow around it. As the molecules reach the square corners on the back of the box, they tumble past it. This creates a partial vacuum that sucks the flame *toward* you!

Replace the box with the bottle and blow toward the flame again. This time air flows smoothly around the bottle and pushes the flame *away* from you.

Round objects experience only half the drag of square ones, and sleek, tapered objects like bird wings have even less drag than round objects. That's how the tern could dive like a meteor into the Utah marsh after his food. ◄