on the same airplane each time something is changed, you can draw pretty good conclusions. For instance, if you didn't work on your engine or change the rpm it's running and didn't do any work on the propeller, then any increase is due to drag changes. Likewise, if you didn't change the airframe or propeller and you're burning more fuel at the same rpm, then any increase is from hp gain.

A couple more useful formulas I have used are:

hp = torque x rpm / 5252

hp required / object = (dynamic pressure) x (sq ft of the object) x (drag coefficient of object) x (TAS in FT/sec) / (550 ft lb sec/ hp x prop efficiency)

hp required/object is the hp required to drag any protruding object on your plane through the air: i.e., exposed hinges or an antenna

Dynamic pressure (Q) is in pounds/square feet where:

Q = ½ PV squared

P = air density 0.00238 (sea level standard day)

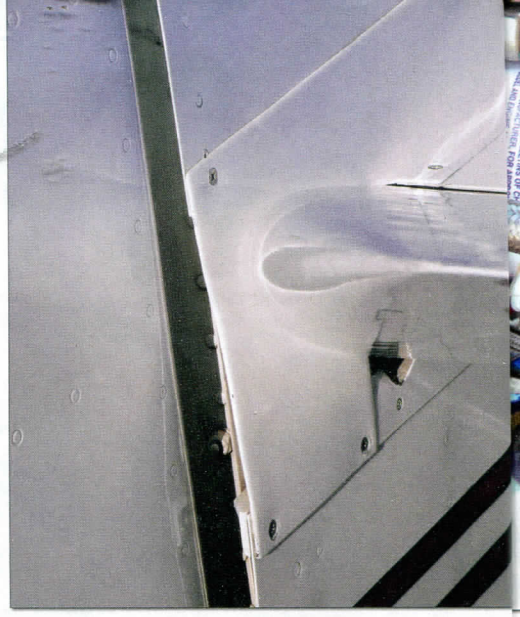
V = TAS (in feet/second) (1 mph = 1.467 feet/second)

Drag coefficient is a number that represents the force of the wind as compared to what you would expect. For example, a 1-square-foot plate moving perpendicular to the path of the air has a greater drag coefficient than 1, actually about 1.3, due to increases from edge and wake turbulence. A good simple source to see shape effects on drag coefficients is to Google "Drag Coefficient Wikipedia."

The use of the hp/object formula proved it took about 2.4 hp to pull the unfaired aileron hinge bracket through the air at top speed and only about 0.1 hp when they had canoe fairings placed. So by going back to the previous formulas, an increase of 2.3 hp would amount to about 1+ mph in max speed. It's just good science though you probably can't demonstrate that small of a performance increase.

The thing that may interest some people is the efficiency increase that came along with the modifications. By using the formulas above, 24.5 mph came from drag reduction, which for my plane was about a 27% decrease in total airframe drag. Another way to look at it is that in 2500 hours, I may have saved $16,000 in fuel due to burning about 22% less fuel than the day I first flew my plane. In the October 1997 issue of *The RVator* from Van's Aircraft, Dick VanGrunsven calculated that, as he put it, the "Anders Airframe" was responsible for 18.2 of the mph increase. By 2000 the airframe increased an additional 6.3 mph by further drag reduction alone.

In 2006 I was asked to give a talk at the Golden West Fly-in in California about my RV-4 performance increases. I prepared some notes for the talk, which were later reproduced by the Sacramento RVators, and can be found at *www.sacrvators.com* or by searching "Dave Anders aircraft efficiency." They may not be easy to interpret because some are in my kind of shorthand, but the ideas still apply.



Inboard elevator fairings, made from one layer of boat deck glass and one layer of Rutan glass, are very lightweight.

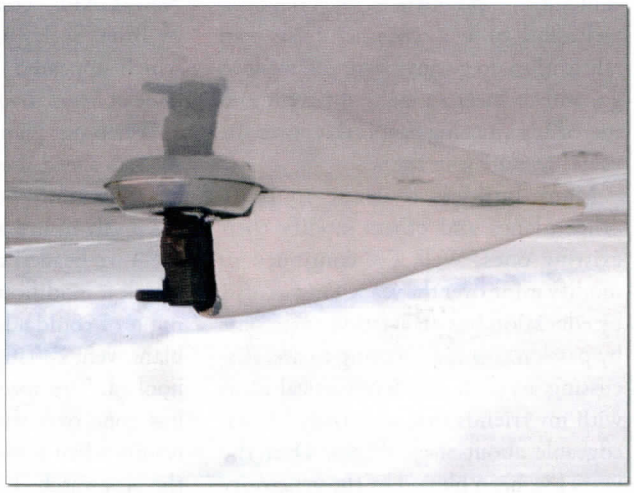
There is one thing I would like to add: If anyone uses any of the modifications I did, but starts at a different total airframe drag than I had at the time of my modification and/or does the modifications in a different order, the performance increase may not be the same due to the drag ratio reduction being different.

Mods for Speed and Efficiency

Over the life of our plane we have made over 30 modifications, some major and some not. The propeller was twisted and then re-twisted according to Hartzell's



Canoe fairings were added to the aileron hinges.



Even with an afterbody fairing, the fuel drain is still too draggy.