

## 6) RIDE QUALITIES

### NASA Question:

As the early inhibitors to GA revitalization are diminished (affordability, ease-of-use and safety), will comfort become the next big issue? What alternatives should be on our list for ride quality advancements?

### Roskam's Response:

Yes, ride qualities will be an issue and should be taken into account. The following simple analysis shows clearly what might be done.

The gust sensitivity of an airplane can be thought of as the product of load-factor-to-angle-of-attack sensitivity,  $n_\alpha$ , and the gust induced angle of attack at a given speed-altitude combination. The parameter,  $n_\alpha$ , can be written as follows:

$$n_\alpha = \frac{C_{L_\alpha} \bar{q}}{W/S} \quad (8)$$

where:  $C_{L_\alpha}$  is the airplane lift-curve slope in 1/rad

$W/S$  is the wing loading in psf

$\bar{q}$  is the dynamic pressure in psf

The gust induced angle of attack,  $\alpha_{gust}$ , can be written as:

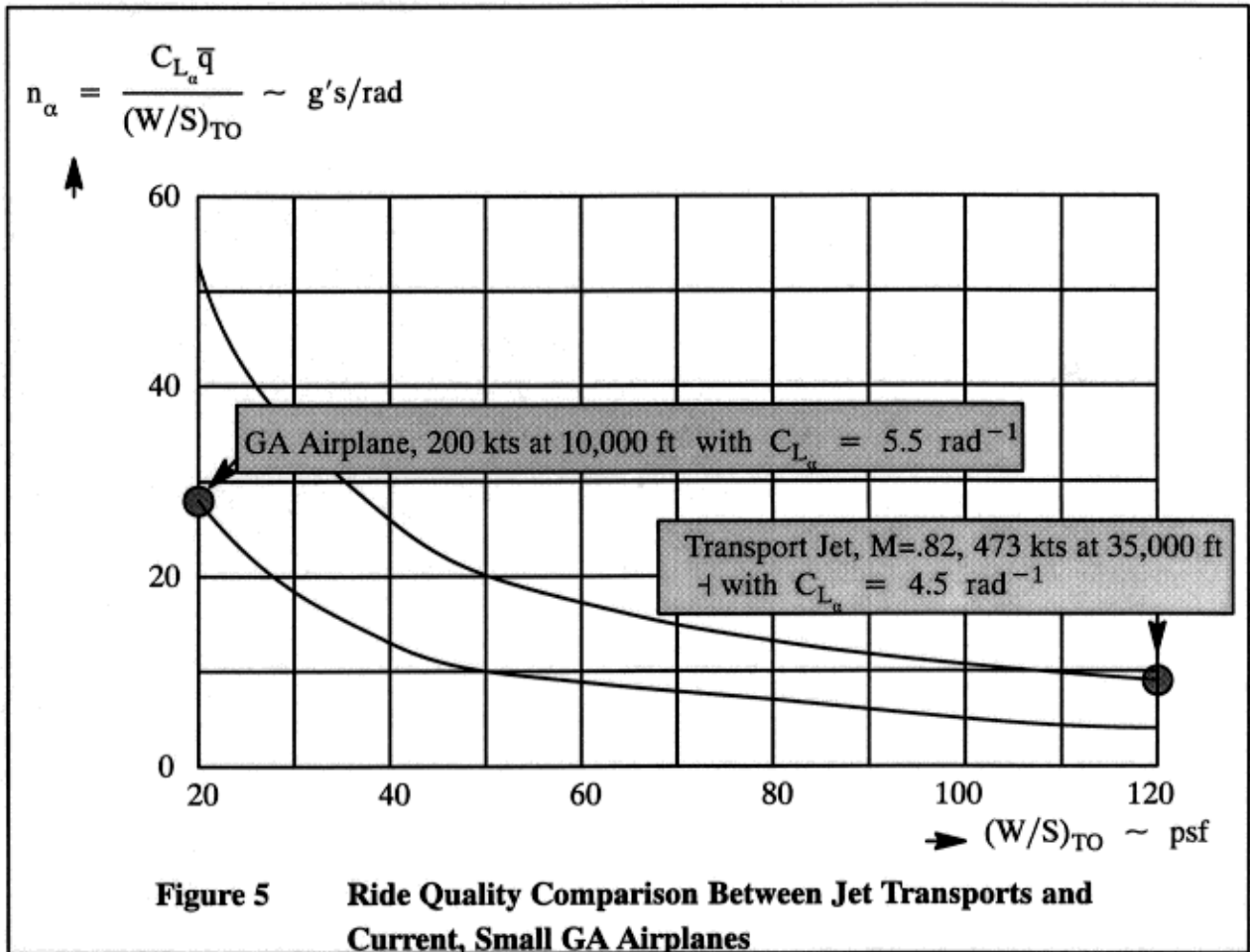
$$\alpha_{gust} = U_{gust}/U \quad (9)$$

Figure 5 shows how gust sensitivity,  $n_\alpha$ , varies with wing loading for typical transport jets and for typical, small, general aviation airplanes.

Things are even worse when the effect of altitude on gust magnitude is considered. At 10,000 ft the design gust is 50 fps. For the GA airplane this yields a gust induced angle of attack of 0.15 rad.

At 35,000 ft the design gust is 37.5 fps. For the jet transport this yields a gust induced angle of attack of 0.05 rad. The jet transport therefore enjoys a factor of about 9 in lower sensitivity to turbulence.

The lesson is clear. To achieve the same ride comfort as that of the transport jets the design wing loadings and the design cruise altitudes have to be increased. These design trends are synergistic with the high lift observations made under item 5.



Obviously, by using the right combination of sensors, computers, actuators and control surfaces the ride of an airplane can be improved. The B1 bomber is a good example of an airplane with a ride augmentation system. However, I believe that it is far more cost-effective to use the inherent good ride quality approach over any systems approach.