Lecture F18 Mud: Expansion Fans

1. **Can you see expansion waves like you can see shocks?** (1 student)
   Yes, but not as easily. Supersonic flow viz techniques sense first or second gradients of the air density. The gradients in a wave are much smaller in an expansion wave than in a shock.

2. **Do you have any pictures of a supersonic razor blade?** (1 student)
   No, but you can find pictures of supersonic flows around various other shapes which show shocks and waves. The one I showed in class is one good example. A great book for showing all sorts of flow viz photos is
   "An Album of Fluid Motion", by Milton Van Dyke, Parabolic Press,
   ISBN 0-915760-02-9 (paperback),
   ISBN 0-915760-03-7 (hardcover)

3. **Does the change in zero moment location (center of pressure) affect the design of supersonic aircraft?** (1 student)
   Yes, a great deal. The shift in center of pressure must be trimmed out with substantial tail loads. This causes additional drag, among other problems.

4. **Does the sign of α matter when calculating the airfoil pressures?** (1 student)
   By the convention used in our notes (and Anderson), θ is positive "into the flow" for an oblique shock, and positive "away from the flow" for a wave. So for the airfoil, $\theta = +\alpha$ on both sides.

5. **Is an expansion fan a series of shock waves?** (1 student)
   In effect, yes, but they are "negative" shock waves, with the pressure decreasing rather than increasing as the flow goes through them. Each one is also infinitesimally weak.

6. **Does the expansion fan contribute to wave drag, or just the shock?** (1 student)
   Only the shock causes disspation, so in that sense the wave does not contribute to the drag. However, it's not possible to have only expansion waves on a body in a supersonic freestream — some shocks must be present as well. So there's always nonzero wave drag.

7. **No mud** (3 students)