Course: **Aircraft Design and Operation AE4-211**
Date: **05-01-2004**
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1. Aerodynamic design means finding a shape that will give a desired pressure distribution in a parallel flow (blz:33).
    a. <u>The two main requirements to be imposed upon a desired pressure distribution:</u>
        –   If no resultant forces are required: Minimize local supervelocities.
        –   If resultant forces are required: Optimize pressure distribution at the relevant flight conditions such that minimum momentum loss in the boundary layer and behind the shockwave occurs.
    b. <u>Third requirement to be imposed on the geometry as a consequence of the actual pressure distribution:</u>
        On components which must tolerate a large variation in local flow direction: find leading edge shapes and design pressure distributions which allow for this variation

2. A preliminary design is depicted of a high-subsonic jet transport, driven by liquid hydrogen. Due to the low hydrogen density, extra large fuel tanks are required which have been located on top of the fuselage and are embedded into a fairing.
    a. <u>What aerodynamic problems do you expect at the location of this fairing in which part of the speed regime? What is the precise location where these problems occur?</u>
        The fairing can be compared to a bulge, this creates a local change in curvature and therefore a change in pressure coefficient. The stronger the convex curvature, the higher the supervelocities and the more negative C_p-values. At the start of the bulge the pressure coefficient thus becomes positive, on the bulb negative and at the end of the bulge positive again. The supervelocities will reach a maximum (C_p min) on top of the bulge. And thus the drag increases. Speed regime: during cruise.

    b. <u>What possible measures could help prevent these problems?</u>
        A more gradual transition between fuselage and fairing. Further in the design process shapes should therefore be pursued such that proper interposition of the various components leads to a favourable summation of supervelocities. This means that if one component has a negative pressure coefficient, the intersecting component should at that location have a low negative or even positive pressure coefficient. This can be done by shape modifications. The shape of the fuselage could therefore be adapted such that the supervelocities become smaller.

3. The pylons of two different series of the Douglas DC-8, the -30 and -55 on the one hand and the -61, -62 and -63 on the other hand are compared.
    a. <u>Explain the differences in the isobars between the two different series of the DC-8.</u>
        The first series has a peak in pressure coefficient at place where the pylons are. On the inboard side of the pylons the pressure coefficient reaches very high values compared to the outboard side of the pylons. This means that overspeeds and shockwaves will occur at the inboard side of the pylons. To stop the pylons from acting as a fence, they were cut back to below the stagnation point resulting in the isobars of the second series. This wing had a much lower drag. (blz.165 reader)

    b. <u>What might have been the primary reason for changing the pylons?</u>

To reduce drag that is caused due to the overspeeds and shockwaves that occur at the inboard side of the pylons.

c. <u>What could be an undesirable side-effect in a different speed regime of this modification?</u>
The pylons in the original design acted as fences and improved the low-speed stalling characteristics, so getting rid of these fences resulted in a lower maximum lift coefficient. Therefore this aircraft could not take the same amount of fuel for the same runway length as the original design.

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