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Technical Comments

Brief discussion of previous investigations in the aerospace sciences and technical comments on papers published in the Journal of Aircraft *are presented in this special department. Entries must be restricted to a maximum of 1000 words, or the equivalent of one* Journal *page including formulas and figures. A discussion will be published as quickly as possible after receipt of the manuscript. Neither the AIAA nor its editors are responsible for the opinions expressed by the correspondents. Authors will be invited to reply promptly.*

Myth of the High-Order Lifting-Surface Method

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THE concept of the high-order lifting-surface (HOLS) method has been proposed by Chen et al.[1] to explain the differences between the subsonic lifting surface method ZONA6 and the vortex-lattice method (VLM) (the steady case in N5KQ, Ref. 2). It is suggested that the VLM is *only* a low-order lifting-surface (LOLS) method. This leads to the question of what constitutes high and low order. No answer is provided in Ref. 1, but it is claimed that ZONA6 is HOLS and that the VLM is LOLS. To answer the question, let us consider the parameters in each method. Both methods assume a pressure distribution and a collocation point. ZONA6 has two parameters: It assumes a constant pressure on each panel (box) and places the collocation point on the centerline at 85% chord of the box. The VLM also has two parameters: It assumes that the pressure is concentrated at 25% chord of the box and places the collocation point on the centerline at 75% chord of the box. What is the difference in order? There is no difference. They each have two parameters. One does not have a higher (or lower) order than the other. The question of accuracy is another matter. Rodden[3] has shown the poor convergence of ZONA6 and the clear superiority of the VLM in calculating the aerodynamic center location, the critical parameter in predicting subsonic flutter and divergence speeds.

In the interest of forcing ZONA6 to agree with the VLM, a new parameter, the force point (FP) location, was introduced in Ref. 1, but no discussion of its selection or implementation is offered. The initial assumption in the development of ZONA6 was a constant pressure on each box *that must act at its 50% chord in accord with elementary static principles*. How, then, can the *constant* pressure act at 25% chord (or 70% chord)? It *cannot*, and the calculations presented in the two tables of Ref. 1 cannot have much accuracy. In Table 1, the results for a rectangular wing are not improved: With $FP = 0.25$, the aerodynamic centers are now too far forward, whereas with $FP = 0.50$, they were too far aft. In Table 2, the aerodynamic center for a delta wing calculated by the classical theory[4] is quoted as exact at 59.34% chord. This result is not theoretical but *computational*, and it is not *exact* because it comes from a series solution using assumed pressure loading functions. That it is not even a converged solution is seen in Tables 3–5 of Ref. 4 in which Truckenbrodt's value of 59.34% is shown along with the value of 60.40%. Wagner's value was obtained from an extension of Truckenbrodt's method using five chordwise pressure loading functions. The exact result may well be 58.40% chord as obtained by N5KQ!

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[2]Rodden, W. P., Taylor, P. F., and McIntosh, S. C., Jr., "Further Refinement of the Nonplanar Aspects of the Subsonic Doublet-Lattice Lifting Surface Method," *Journal of Aircraft*, Vol. 35, No. 5, 1998, pp. 720–727.

[3]Rodden, W. P., "Methods for Calculating the Subsonic Aerodynamic Center of Finite Wings," *Journal of Aircraft*, Vol. 40, No. 5, 2003, p. 1003.

[4]Schlichting, H., and Truckenbrodt, E., *Aerodynamics of the Airplane*, McGraw–Hill, New York, 1979, p. 152.