wing with full leading-edge separation can only support a normal force. If the normal force coefficient in this case is C_N, then the lift coefficient must be $C_L = C_N \cos\alpha$ and the induced drag coefficient $C_{Di} = C_N \sin\alpha$; therefore, $C_{Di} = C_L \tan\alpha$. However, as Hunt[4] already pointed out, the modeling of a lifting surface by a discretized vortex lattice permits "leaks" through the surface, so the flow parallels the surface at the collocation points only. The flow over the bound vortices themselves (where the lift and induced drag were computed) does not parallel the surface. The induced drag must, therefore, differ from $C_L \tan\alpha$ even in the converged solution. Luckring erroneously attributed this result to lack of convergence. The result is fully converged, as can be seen in Fig. 1 of his Comment, but C_{Di} can never converge (in this method) to $C_L \tan\alpha$. Reference 1 points this out as a shortcoming of the method, suggesting the use of $C_L \tan\alpha$ as a better approximation.

Finally, Luckring's questioning the general utility of the free vortex filament formulation is completely out of place. Luckring is certainly right when he says that for wing applications the linear vortex-lattice method coupled with Polhamus' leading-edge suction analogy (his Ref. 6) is faster, simpler, and less expensive. This method is, however, applicable to wings only, accounting for leading-edge and trailing-edge separation. It was extended, with great difficulties, to wings with strakes (Luckring's Refs. 7 and 8), but it still cannot handle interactions between separate lifting surfaces (canard-wing, wing-tail, etc.) and between bodies and wings. Even the simple problem of a single vortex filament (such as a tip vortex or one filament out of the trailing-edge vortices of a leading wing or of a canard) passing close above another trailing wing is insurmountable for this method. However, the filament formulation of Ref. 2, which is criticized by Luckring, was developed for just such cases, which it handles with great success. Even the higher order formulations cited by Luckring (his Refs. 12 and 13) are still unable to cope with the complex problems that were solved in Ref. 2.

The authors wish to emphasize again that their free vortex filament formulation was developed for the prediction of the overall nonlinear aerodynamic coefficients of complete vehicle configurations. The surface load distributions, although "less than satisfactory" and not accurate, were more than what the vortex-lattice/leading-edge suction analogy could do. (It cannot estimate the surface load distribution even for a wing, and for a complex configuration it cannot estimate even the integral coefficients.) The higher order formulations can do better for the surface load distribution but are limited to simpler configurations.

In conclusion, the free vortex filament formulation of Refs. 1 and 2 is currently the only method that can predict the nonlinear aerodynamic coefficients of complete complex configurations. The authors are now in the process of developing a new idea that seems to promise also a correct or, at least, a better estimate of the surface load distributions over such configurations.

References

[1]Rusak, Z., Seginer, A., and Wasserstrom, E., "Convergence Characteristics of a Vortex-Lattice Method for Nonlinear Configuration Aerodynamics," *Journal of Aircraft,* Vol. 22, Sept. 1985, pp. 743-749.

[2]Rusak, Z., Wasserstrom, E., and Seginer, A., "Numerical Calculations of Nonlinear Aerodynamics of Wing-Body Configurations," *AIAA Journal,* Vol. 21, July 1983, pp. 929-936.

[3]Rusak, Z. and Seginer, A., "An Analytical Parametric Investigation of Numerical Nonlinear Vortex-Lattice Methods," *Proceedings 27th Israel Annual Conference on Aviation and Astronautics,* Tel-Aviv and Haifa, Israel, Feb. 1985, pp. 13-22.

[4]Hunt, B., "The Mathematical Basis and Numerical Principles of the Boundary Integral Method for Incompressible Potential Flow over 3-D Aerodynamic Configurations," *Numerical Methods in Applied Fluid Dynamics,* Academic Press, London, 1980, pp. 49-135.

ERRATA

•"Is Any Free Flight/Wind Tunnel Equivalence Concept Valid for Unsteady Viscous Flow?," Vol. 22, No. 9, 1985, pp. 915-919. The title of the article should have read: "Is Any Inviscid Free Flight/Wind Tunnel Equivalence Concept Valid for Unsteady Viscous Flow?" Also, on page 917, the figures quoted under the heading "Free Flight/Wind Tunnel Equivalence" should be Figs. 1-6, not Figs. 7-9.