Table 1 Aircraft characteristics

A/C No.	W/S, kg/m^2	C_L	V_{st}, m/sec
1	225	1.0	60
2	306	1.0	70

ficients not influenced by Mach number resulting in different values of stalling speeds (see Table 1).

The loft-ceiling characteristics of these two aircraft are depicted in Fig. 1, showing only an almost negligible difference at low energy levels which increase slightly with altitude. The Mach numbers at loft-ceiling altitude are also marked indicating that transonic speed is reached only at high altitudes.

The second example demonstrates the effect of Mach dependent maximum lift coefficient on the loft-ceiling. Aircraft with the same wing loading but with different maximum lift characteristics (see Fig. 2) were chosen, indicating the improvements due to modern aerodynamic design (strakes, leading-edge flaps, etc.).

The loft-ceiling characteristics of these two substantially different aircrafts in Fig. 3 show however only very slight variations.

Concluding Remarks

The loft-ceiling concept is of importance to show the possible dynamic extension of the flight envelope in aerial combat (see Fig. 4) and it is used as a criterion to determine capture in air combat modeling.[1-3] However, it seems that most fighter aircraft have similar loft-ceiling characteristics. This observation indicates that requirements for loft-ceiling advantage at the same specific energy level may be difficult to implement.

References

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Reply by Author to Shinar, Levin, and Marari

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THE results reported in the preceding technical comment are of interest, and it is indeed true that comparisons between fighter aircraft characteristics at equal loft ceilings tend to be generally much the same as equal-energy comparisons, at least when the aircraft are conventional, i.e., neither has thrust-augmentation-of-lift features. Loft ceiling appears in "energy" approximation treatment of aircraft flight dynamics as a state-dependent control bound, viz. the upper bound on altitude, a control variable, dependent upon the state, specific energy. It represents the highest altitude that can be sustained in a short-term sense, i.e., ignoring any energy loss that may result from insufficient thrust to maintain energy, with the roller-coaster altitude-velocity interchange dynamics omitted from the model (which omission is the crux of energy approximation).

It is interesting that in a more sweeping approximation, a different ceiling quantity appears (see the section of Ref. 1 subtitled "Tactics with Models Further Reduced in Order"). It might be called "composite ceiling" and consists of either the loft ceiling or the power ceiling (determined as the horizontal-equilibrium bound), whichever is lower at the energy under examination. For typical fighters, it is comprised of the loft ceiling up to a certain energy, the power ceiling at higher energies. There is, of course, a certain artificiality in the distinction between loft ceiling and power ceiling whenever the power ceiling is higher, i.e., one should not take simplified drag models very seriously at high angles of attack, as lift saturation is usually accompanied by drag build-up much faster than quadratic.

Reference

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Received Dec. 16, 1976.
Index categories: Aircraft Performance; Military Aircraft Missions.
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