# THE ASM-LRN-007 SECTION

A few months back we described an airfoil specifically designed for F3B, the DU 86-084/18. This month we take a look at a section suitable for thermal duration events, the ASM-LRN-007. This section was described in some detail in a recent issue of the Journal of Aircraft[1].

As is now commonplace, the ASM-LRN-007 is a computer designed section. The computer program, by Mark Drela of MIT, is the same used by Michael Selig and John Donovan during the Princeton wind tunnel tests. Please note the ASM-LRN-007 has not been wind tunnel or flight tested. With a computed section $c_l/c_d$ of up to 166 and a maximum $c_l$ of 1.5, however, it appears to be a very high performance section worthy of some experimentation. The ASM-LRN-007 is for conventional tailed aircraft.

The ASM-LRN-007 is the result of a quest for an airfoil capable of high lift with low drag within the Reynolds number regime of 250,000 to 500,000, with minimum laminar separation. The condor and albatross both soar at the lower end of this range - the condor as a static soarer, the albatross as a dynamic soarer. They were thus of great interest to the investigators, and the ASM-LRN-007 has several characteristics which reflect this heritage: an undercut front lower surface and relatively sharp leading edge, an undercut trailing edge (aft loading), and a requirement for turbulation. The thickest portion of the airfoil extends from about 25% to nearly 50% chord, allowing for a substantial spar system. In fact, the ASM-LRN-007 is very similar to a bird-like airfoil described previously in RCSD[2]. The ASM-LRN-007 was designed for a 16% flap capable of both positive and negative deflection.

The undercut front lower surface adds additional positive lift and decreases the airfoil's pitching moment. This narrows the low-drag bucket, but the benefits derived are felt to outweigh this. Aft loading is compatible with full chord laminar flow on the lower surface during high $c_l$. Reducing the front lower surface undercut and/or reducing the aft-loading would result in a significantly lower $c_l/c_d$. The low-drag bucket, on the other hand, is expanded through the use of flaps. Laminar flow to 67% chord on the upper surface is possible. Laminar separation is prevented through use of a zig-zag turbulator strip. Unfortunately, the actual location of the turbulator is not given in the article. The implied location is at about 70% chord. Moving the turbulator on one wing at a time and comparing flight performance (looking for yaw and/or roll) could quickly lead to an optimum position.

The performance chart was derived from the published polars, the coordinates are from C.S. Vemuru, courtesy of Michael Selig.

An added note: Pfenninger and Vemuru suggest the zig-zag turbulator is more effective than a two-dimensional "trip strip" and can thus be made thinner, with an accompanied drag reduction of significant proportions. (Birds use a series of reversed "zig-zag" turbulators as their wing feathers form a series of rounded backward facing steps.) Even more effective, however, is turbulation by means of one or several rows of very small suction holes. Pfenninger and Verumu claim this method to have zero drag, and in some cases negative drag! This too might be worthy of some additional experimentation, as the air volume which needs to be moved is extremely small.

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[1] Pfenninger, W. and Vemuru, C.S., "Design of Low Reynolds Number Airfoils: Part I," Journal of Aircraft, Volume 27, March 1990, pp. 204-210.

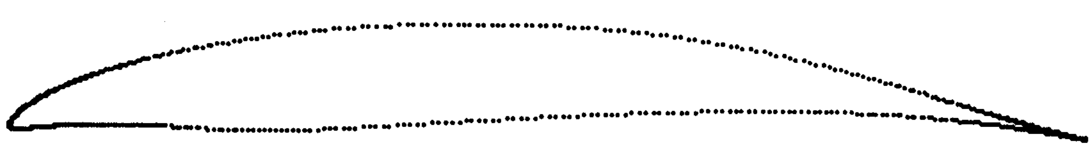
[2] Gray, J., "Interesting Airfoil Information," RC Soaring Digest, July 1988, pp. 4-5).

COMPUTED PERFORMANCE, ASM-LRN-007

| Flap Deflection | Reynolds Number | Angle of Attack | Lift Coefficient | $c_l/c_d$ |
|---|---|---|---|---|
| -10 | 250,000 | 5.4 | .85 | 87 |
| -10 | 500,000 | 5.4 | .85 | 125 |
| -5 | 250,000 | 4.5 | .96 | 103 |
| -5 | 500,000 | 6.8 | 1.20 | 142 |
| 0 | 250,000 | 6.0 | 1.37 | 117 |
| 0 | 500,000 | 5.2 | 1.30 | 160 |
| +5 | 250,000 | 5.5 | 1.50 | 120 |
| +5 | 500,000 | 4.2 | 1.42 | 166 |

ASM-LRN-007

| | | | |
|---|---|---|---|
| 1.000000 | -0.006579 | 0.000492 | -0.001132 |
| 0.994687 | -0.005338 | 0.004292 | -0.002574 |
| 0.988839 | -0.003987 | 0.008768 | -0.002421 |
| 0.982359 | -0.002438 | 0.013597 | -0.001911 |
| 0.975104 | -0.000636 | 0.018847 | -0.001293 |
| 0.966870 | 0.001460 | 0.024602 | -0.000607 |
| 0.957377 | 0.003934 | 0.030971 | 0.000083 |
| 0.946221 | 0.006923 | 0.038092 | 0.000734 |
| 0.932783 | 0.010609 | 0.046143 | 0.001376 |
| 0.916105 | 0.015282 | 0.055373 | 0.001992 |
| 0.894667 | 0.021415 | 0.066137 | 0.002530 |
| 0.866143 | 0.029672 | 0.078956 | 0.002893 |
| 0.827779 | 0.040997 | 0.094608 | 0.003024 |
| 0.778224 | 0.054996 | 0.114295 | 0.002730 |
| 0.719972 | 0.069342 | 0.139812 | 0.001708 |
| 0.657036 | 0.081643 | 0.173498 | -0.000644 |
| 0.591956 | 0.090680 | 0.217161 | -0.003214 |
| 0.525878 | 0.096436 | 0.270294 | -0.001942 |
| 0.459409 | 0.099113 | 0.330209 | 0.001573 |
| 0.393043 | 0.098902 | 0.393431 | 0.005701 |
| 0.327604 | 0.095744 | 0.457841 | 0.009758 |
| 0.264873 | 0.089960 | 0.522511 | 0.013417 |
| 0.208407 | 0.081988 | 0.586986 | 0.016355 |
| 0.162190 | 0.073203 | 0.650839 | 0.018230 |
| 0.127258 | 0.064945 | 0.713009 | 0.018826 |
| 0.101455 | 0.057634 | 0.770989 | 0.018063 |
| 0.082011 | 0.051260 | 0.820959 | 0.016064 |
| 0.066869 | 0.045668 | 0.860395 | 0.013220 |
| 0.054708 | 0.040666 | 0.890146 | 0.010177 |
| 0.044686 | 0.036112 | 0.912677 | 0.007508 |
| 0.036255 | 0.031908 | 0.930215 | 0.005145 |
| 0.029056 | 0.027967 | 0.944316 | 0.003078 |
| 0.022843 | 0.024219 | 0.955985 | 0.001276 |
| 0.017441 | 0.020616 | 0.965876 | -0.000314 |
| 0.012756 | 0.017081 | 0.974423 | -0.001738 |
| 0.008715 | 0.013574 | 0.981920 | -0.003063 |
| 0.005297 | 0.010045 | 0.988584 | -0.004305 |
| 0.002573 | 0.006412 | 0.994570 | -0.005481 |
| 0.000512 | 0.002732 | 1.000000 | -0.006579 |



ASM-LRN-007