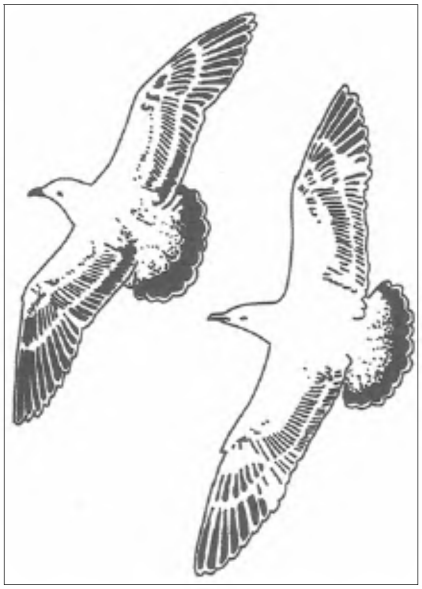
The Simple Science of Flight: From Insects to Jumbo Jets. Henk Tennekes. The MIT Press, 55, Hayward Street, Cambridge, MA and London, England. 2009. 215 pp. Price: US$ 21.95.

This is a revised and expanded edition of a book whose English version (with the same title) first appeared in 1996. It was enthusiastically reviewed by Satish Dhawan in this journal (*Curr. Sci.*, 1997, **73**, 822–823), and by me in the *Journal of the Indian Institute of Science* (*JIISc.*, 1997, **77**, 389–391). I estimate (after allowing for the change in format between editions) that the second is about a quarter longer than the first. As there is still a fair overlap in the material presented in the two editions it is worthwhile to touch on these earlier reviews.

Briefly, then, Dhawan called the book unusual, lively, fresh, informative, almost unique, and noted the author's ability to produce reasonable numbers with little effort. But he also noted that it was 'curious that "circulation" and "vorticity" or Reynolds number do not appear' – that the different principles on which moths (for example) and aircraft fly are not noticed. I had written something similar, calling the volume a delightful little book that spoke about ducks, dragon flies and the Boeing 747 in the same breath, using the same rules – rules that set out the arithmetic of flying performance. I had recommended the book to professional, layman or the inquisitive young who wished to understand flight. I too noted that there was however something missing – somehow the book could leave a reader with the impression that insects, birds, the 747 and the Concorde all fly on the same (aerodynamic) principles – which of course is not true. All the praise and the comment are valid for the present edition too.

Perhaps similar remarks about aerodynamics were made in other reviews of the book too, for in the Preface to the present edition the author notes that 'professional criticism concentrated on my decision not to delve into the details of aerodynamics'. He justified sticking to flight performance (as my earlier review had noted, this was common to all flyers), and makes no change in approach in this new edition except in his presentation of a novel treatment of induced drag and trailing vortices.

In the last dozen years or so since the appearance of the first edition the world of aviation has changed a great deal, although the arithmetic of performance remains pretty much the same. For one, technology has changed: structures are lighter because of the use of composites, flight controls are becoming completely digital, computers play a much greater role than ever before, air traffic has grown greatly across the world but especially in Asia, and performance goals have changed. Whereas in earlier decades (oversimplifying matters somewhat) greater speed was a major goal, today it is no longer so: maximum flying speeds have hardly changed for quite some time. This is highlighted by the demise of the supersonic Concorde. The volatile price of oil, concerns about climate change and the globalizing economy – all these have put a premium on cutting down fuel consumption, reducing CO_2 and other emissions, and taking passengers from point of departure to destination with fewer or no intermediate stops and greater comfort at lower cost. But while business goals keep changing, the arithmetic of performance that is the theme of Tennekes does not change a great deal. So, the kind of considerations that the book brings to analysis of flight remains the same. His object of admiration, the Boeing 747 that to the author represents the triumph of ruthless engineering logic, is phasing out, and is being replaced slowly by the bigger Airbus 380 on the one hand and Boeing's own 777-ER on the other. Meanwhile the much older and very familiar 737 is still in demand, and has now become the largest selling passenger jet ever in the history of civil aviation. So the question that arises is: what was the 'engineering logic' of the 737 that persuades the world to keep buying it in such numbers, and Boeing to know that it still has many more years of life left – an incredible 43 years after its first flight?



Herring gulls (*Larus argentatus*).

The questions about aerodynamics and changing business goals in the industry of course are not in principle within the scope of the book that the author has defined for himself, but they arise only because of the word 'science' in his title, and of the detailed comparisons he makes in the book between the actual performance of an aircraft and that given by his rules. But the questions are not irrelevant. For example, his Great Flight diagram (figure 2, p. 15) shows that at a cruising speed of about 9 ms^{-1} the weight of the flying object varies from a few millinewtons for the little stag beetle through a few newtons for the goshawk to a few kilonewtons for MaCready's Solar Pathfinder – a range of a million straddling across the author's trend line. It would have been interesting if the book did touch a little bit on the 'logic' of this extraordinary spread.

But these are nit-picking comments, and I once again warmly recommend this enjoyable book, with its sustained and pleasant argument, to anybody who wishes to understand the logic of flight performance – from insects to jumbo jets.

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