Appendix G.
The Configuration Aerodynamicist's Bookshelf

Throughout the text we've referenced many, many reports. Here is a short summary of the references that a configuration aerodynamicist should keep handy.

A basic aerodynamics book:

John J. Bertin and Russell M. Cummings, *Aerodynamics for Engineers*, Pearson Prentice Hall, 5th Ed., 2009 (newer ones may be available).

Airfoils:

Ira H. Abbott and Albert E. Von Doenhoff, *Theory of Wing Sections,* Dover 1949. See also the pdf file "Summary of Airfoil Data," NACA R-824, 1945. Although I had been told the book was the same as the NACA Report, they are not. The are very similar, but highly complimentary. (beware that the Dover book has numerous typos)

C. D. Harris, "NASA Supercritical Airfoils," NASA TP 2969, March 1990. This report describes the Whitcomb airfoil work and the thinking and experience behind the design work. Watch out for the tables of airfoil coordinates. See my comments in Appendix A.

General Aerodynamic information:

Hoerner is well worth perusing as a great source of aerodynamic info: Sighard F. Hoerner, *Fluid-Dynamic Drag*, published by Mrs. Lisselotte A. Hoerner, 1967. Sighard F. Hoerner and Henry V. Borst, *Fluid Dynamic Lift*, published by Mrs. Lisselotte A. Hoerner, 1975.

Essential thinking for transonic transport design:

Frank T. Lynch, "Commercial Transports—Aerodynamic Design for Cruise Performance Efficiency," Douglas Paper 7026, Feb., 1981. Also, Chapter 2, *Transonic Aerodynamics*, ed. David Nixon, AIAA Progress in Astro & Aero series, Vol. 81, 1982, pp. 81-147. See also Shevell's Aerodynamic Bugs paper listed in the reading App. F. Read for the design philosophy and thinking.

Best recent surveys of high lift:

C.P. van Dam, "The aerodynamic design of multi-element high-lift systems for transport airplanes," *Progress in Aerospace Sciences*, Vol. 38, pp. 101-144, 2002.

Peter K. C. Rudolph, "High-Lift Systems on Commercial Subsonic Airliners," NASA CR 4746, Sept. 1996. Examines the high lift systems used on transonic transports.

High Alpha Aerodynamics:

Joe Chambers and Sue Grafton, "Aerodynamics of Airplanes at High Angles of Attack," NASA TM 74097, Dec. 1977.

Stability and Control: Invaluable lessons related to configuration stability and control issues:

Malcolm J. Abzug and E. Eugene Larrabee, *Airplane Stability and Control*, Cambridge University Press, 1997. Note there was a second edition of this book.

For computational considerations:

Russell M. Cummings, William H. Mason, Scott A. Morton and David R. McDaniel, *Applied Computational Aerodynamics: A Modern Engineering Approach*, Cambridge University Press, 2015.

Quick estimation methods

Most aerodynamics textbooks aren't aimed at providing "handbook" type methods to use in aerodynamic configuration development. There are several reasons that handbook oriented collections of aerodynamic methods are useful. First, they almost always identify the key parameters that contribute to the estimate and generally show the functional form. Second, you can shortcut making a big calculation to get a quick estimate, and finally they can provide a sanity check for your calculated estimates. Here we list a few handy resources:

Steven A Brandt, Martiqua L. Post, David Hall, Fred Gilliam, Timothy Jung and Thomas Yechout, "The Value of Semi-Empirical Analysis Methods in Aircraft Design," AIAA Paper 2015-2486, June 2015. (good recent collection, I found one key typo in a formula – easily fixed)

The next reports, from the U.S. Air Force, are available for free download:

The mother of all handbook methods is DATCOM (which stands for data compendium). This was originally a multi-volume paper handbook, with an emphasis on stability and control. It was eventually replaced with a computer program, the so-called Digital DATCOM. I suggest using the original paper version, it gives more insight into the methods and has numerous references supporting the methods. In particular many references are to reports of wind tunnel tests. There is also a Missile DATCOM. Formally the handbook is called USAF Stability and Control DATCOM. There are at least two versions available in electronic form. They are the 1965 and 1978 revisions.

Roy T. Schemesky and George Howell, "Aerodynamic Accounting Technique for Determining Effects of Nuclear Damage to Aircraft, - Volume I – Empirical Methods" DNA 4531F-1, Feb. 1978. DNA stands for Defense Nuclear Agency. This is the basic General Dynamics Fort Worth Division aero methods code with blast damage added. It describes the basic aerodynamic estimation methods as well as damaged aircraft methods, including illustration of the accuracy for the F-16, the FB-111 and a number of NASA models. The basic program is "Development of an Empirically Based Computer Program to Predict the Aerodynamic Characteristics of Aircraft, Vol. I, Empirical Methods," AFFDL-TR-73-144, 1973, also available on the web for download.

Charles E. Jobe, "Prediction of Aerodynamic Drag," AFWAL-TM-84-203, July 1984. This report formed the basis for Chuck Jobe's chapter in the AIAA book, *Thrust and Drag*. Again, this is a good practical summation of methods.

Thomas R. Sieron, Dudly Fields, A. Wayne Baldwin and David W. Adamczak, "Procedures and Design Data for the Formulation of Aircraft Configurations," WL-TR-93-3068, August 1993. This report includes lots of data from existing aircraft, and has supersonic cases. The title is a little misleading, it's actually an aerodynamics report.

Next, several aircraft design textbooks have excellent collections of aerodynamic methods. These include"

Leland M. Nicolai and Grant E. Carichner, *Fundamentals of Aircraft and Airship Design, Volum I – Aircraft Design*, AIAA Reston, 2010. This book contains a wealth of aerodynamics methods and data. There is also a second volume covering airships and including case studies.

Daniel P. Raymer, *Aircraft Design: A Conceptual Approach*, AIAA, Reston. Dan has lots of info and explanations of aerodynamic configuration issues and geometry.

Egbert Torenbeek, *Synthesis of Subsonic Airplane Design*, Delft University Press, 1982 (now available for free electronically). Although the book covers many aircraft design topics, it has a very good collection of aerodynamics material, including many references. As the title suggests, the emphasis is on subsonic transport aircraft. He also wrote a second book, *Advanced Aircraft Design* which covers modern design procedures and configuration studies.

Jan Roskam. Professor Roskam has written numerous books with aerodynamic methods and configuration information. These include the eight volume Aircraft Design series, an Aerodynamics and Performance book, and a Flight Dynamics and Automatic Flight Controls book. All of these are available through DARCorp.

From a quick methods perspective Professor Roskam compiled two relatively short paperback books: *Methods for Estimating Drag Polars of Subsonic Airplanes*, and *Methods for Estimating Stability and Control Derivatives of Conventional Subsonic Airplanes*, both initially printed in 1971 and now apparently out of print and unavailable. These are quite handy and were largely compiled from DATCOM.

Remember when using estimates from these sources to be sure to compare the estimates with existing data before using them for your project of interest. Sometimes the methods aren't very accurate (if they were really good we wouldn't need CFD!). But it is also possible you don't understand exactly how they are supposed to be used.

Performance Methods

Doing configuration aerodynamics frequently requires performance estimates. The aircraft design books include this information. Books I use for performance include:

Richard S. Shevell, *Fundamental of Flight*, 2nd Ed., 1989, Prentice-Hall. A couple of good chapters on performance, especially for transonic transports.

Jan Roskam and Chuan-Tau Edward Lan, *Airplane Aerodynamics and Performance*, 1997, DARCorp. Detailed procedures for computing performance, emphasizing general aviation and including the FAR requirements associated with performance. They also include details on propellers, a topic that has become much more important with the widespread emphasis on drones.

Timothy Takahashi, *Aircraft Performance and Sizing, Volume I, Fundamentals of Aircraft Performance*, Momentum Press, 2016. This book covers a lot of the practical aspects of operating an airplane that are extremely useful. Tim primarily covers commercial transports. There is also a *Volume II, Applied Aerodynamic Design*. The second volume could be considered an aircraft design book, but also covers field performance and stability and control issues.

So far I haven't seen good text material for the emerging electric and electric-hybrid airplane propulsion systems. Check the latest edition of Brandt, he said he was including it.

Another good source of aerodynamic reference material is the web site by Brenda Kulfan, http://www.brendakulfan.com. Many of her reports and papers are collected here, and most can be downloaded. Her work is also notable for insight and the superior figures and illustrations.

Note: I was hoping to make this a one-page summary. I ran over!