ASEN 5151
HIGH-SPEED AERODYNAMICS
Spring 2006

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TIME: T, Th, 09:30-10:45
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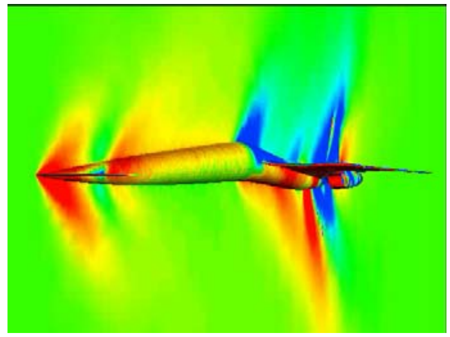

Lockheed Martin/UCB QSP Concept

Recent events might seem to indicate a downturn of interest in high-speed flight (e.g., the retirement of the SR-71 and the Concorde). We must remember, however, that these aircraft were conceived in the 1950s and first flown in the 1960s. Regardless of how elegant these aircraft were—and they were beautiful, their inefficiencies and special requirements finally caught up with them and made them too expensive to continue fly.

Interest in high-speed flight, remains alive and well. This is evidenced by the DARPA (Defense Advanced Research Projects Agency) Quiet Supersonic Platform (QSP) program. This program was started in 2000 and our AES research team was one of the original recipients of a QSP contract. The original goal of the QSP program was to design aircraft with reduced sonic boom. Specifically, bow shock of an aircraft cruising at M = 2.4 must generate an overpressure not to exceed 0.3 psf. This is somewhat peculiar, because it does not put any requirements on the tail shock that is present for a typical aircraft flying supersonically at high altitude. Nevertheless, addressing the bow shock might lead to strategies that will lower the overall sonic boom.

One of the distinguishing features of the AES sonic boom research is that it relies on the classical linear theory for sonic boom minimization. This classical theory is coupled with the most modern multidisciplinary optimization methods for a unique strategy to address the sonic boom problem. One of the things that was obvious from the beginning of the research program was that there is a general lack of understanding in the aeronautics community of the linear aerodynamic and sonic boom theories that were the basis of the high-speed designs from almost 50 years ago. Although we had Professor A. Richard Seebass, one of the few remaining aerodynamicists versed in the classical linear theory, leading the AES team, he died about two weeks after we were notified of our research contract award. While at Cornell and NASA during the 1960s, Professor Seebass and his colleague Professor Alfred George developed what remains the state of the art in sonic boom theory. There was an immediate need to revisit the classical methods of high-speed aerodynamics, thus the reason that I am now teaching this course.

The primary goal of this course is to introduce the basics of classical high-speed aerodynamics. Chapters 8-12 of the text will serve as the foundation for more advanced applications that include the application of the method of characteristics for supersonic nozzle design, Taylor-Maccoll flow for conical shocks, sonic boom theory, then conclude with a couple of applications for hypersonic flow. First, we consider special shapes called *waveriders*. Then we will look at the thin shock-layer flows that Prof. Michel Lesoinne and I, along with Lockheed Martin and NASA researchers, have recently applied to the problem of a hypersonic *ballute*.

PREREQUISITES BY TOPIC

Students should be familiar with basic fluid dynamics and incompressible/compressible aerodynamics (e.g., ASEN 3111), and vector calculus. There will be assignments requiring programming and numerical methods. Students must be able to employ computing environments such as MATLAB or Mathematica.

TEXT: Bertin, J. J., *Aerodynamics for Engineers, 4th Ed.*, Prentice Hall (2002)

TOPICAL OUTLINE

1. Dynamics of a Compressible Flow Field
    a. Isentropic Flow
    b. Method of Characteristics
    c. Shock Waves
2. Compressible Subsonic and Supersonic Flows
    a. Small Disturbance Theories
    b. Supersonic Wings
    c. Area Rule
    d. Slender Body Theory
    e. Sonic Boom
3. Hypersonics
    a. Waverider Aerodynamics
    b. Thin Shock-Layer Flows

ASSIGNMENTS AND GRADING

Homework assignments will be given periodically. Projects will be assigned that might require up to two weeks of effort. Several papers from the literature will be distributed and students will be expected to lead discussions of these papers.

Grades will be assigned according to:

Homework & Projects	50%
Exams (2)	40%
Quizzes and Class Participation	10%

Collaboration is permitted on homework. This means you may discuss the means and methods for solving problems and even compare answers, but you are not free to copy someone's assignment. The work that you turn in must be your own—copying is not allowed for any individual assignments. **Collaboration is not permitted for quizzes or exams.**

Notes

1. To subscribe to the class email list, send and email to listproc@lists.colorado.edu. In the body of the email type the following:

    subscribe   asen5519_arg   Firstname Lastname   your_email_address

2. *Projects are due before the start of class on the due date.* If you have a late submission, you must state your reason for tardiness to your classmates. They will then vote, by show of hands, to determine if the instructor shall accept your work. If the nay votes are the majority, the assignment will be assigned a grade of zero. If you must miss class for an excused absence, you may submit early. Late assignments are not accepted. Of course assignments can always be submitted early.

    Collaboration on quizzes or exams, using another student's work as your own, or allowing another student to use your work as their own is academic misconduct and is not tolerated.

3. Read the statement of the University's Student Honor Code at http://www.colorado.edu/academics/honorcode/.

4. Please read the University policy for religious obligations at http://www.colorado.edu/policies/fac_relig.html.

5. Students with disabilities who qualify for academic accommodations must provide a letter from Disability Services (DS) and discuss specific needs with the professor, preferably during the first two weeks of class. DS determines accommodations based on documented disabilities (303)-492-8671, Willard 322, www.colorado.edu/sacs/disabilityservices)
6. Please read the University's policies on classroom behavior and associated procedures at http://www.colorado.edu/policies/classbehavior.html .