F. Airfoils: High-Lift Conditions

Content Area: **Science**
Course(s): **CAD Architect**
Time Period: **Marking Period 1**
Length: **1**
Status: **Published**

Assessment

"Do Now" Activities

"Exit Ticket" Activities

Practice Problem Worksheets

Quizzes

Standards

SCI.9-12.HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
SCI.9-12.HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
SCI.9-12.HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
SCI.9-12.HS-PS2-1	Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
SCI.9-12.HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

Enduring Understandings

Students will come to understand:

1. While the stalling angle of attack of a given airfoil is constant for varying lift demands, the stall speed increases as the demand for lift increases (regardless of the reason for the extra demand in lift, either a result of increased gross weight or angle of bank).
2. An airfoil can be modified, via the extension or application of a high-lift device, to increase the available lift coefficient, thus reduce the airspeed required for a given lift demand (such as at high gross weights or during maneuvering flight).
3. A variety of high-lift and/or high-drag devices may be installed on an aircraft wing and operate

separately or in combination to facilitate safe flight at different airspeeds for different applications.

Essential Questions

The following questions will guide student inquiry:

- How can aircraft wings be designed to safely accommodate a wide range of flight conditions?
- Why do lift demands increase during maneuvering flight?
- What aircraft design factors affect aircraft performance during high lift conditions?

Knowledge and Skills

Unit Content:

The lift coefficient of an airfoil must be increased by increasing the section's angle of attack as an aircraft's velocity decreases. Since it is advantageous for an aircraft to take off and land at the slowest possible speed (due to the reduction in runway length requirements, increased brake and tire life, reduced stress on landing gear components, etc.), aircraft fly at very high angles of attack during critical times of flight close to the ground: namely take-off and landing. This unit explores the host of practical and theoretical considerations that accompany flight at high-lift conditions. Many of these considerations explain what happens during everyday take-off and landing procedures.

- Effect of Weight on Stall Speeds
- Effect of Maneuvering Flight on Stall Speeds (3 days)
- The Purpose of High Lift Devices
- High Lift Devices (flaps, slots, and slots) (3 days)
- The Use of High Lift Devices during Flight (2 days)
- High drag devices (spoilers, dive brakes)
- Effect of induced flow over wings due to propwash

Science, Technology, Engineering, Mathematics, and/or Aerospace Skill(s):

- Specific Aircraft Configurations for Take off and Landing- interpreting aircraft flight manual instructions.
- The affect of drastically different design requirements: Airliner vs. Jet Fighter wings

Resources

Textbook(s):

Hurt, H. H. (1965). *Aerodynamics for Naval aviators*. Washington, DC: Federal Aviation Administration.

Cessna Aircraft Company. (1977). *Pilots operating handbook: Cessna 172*. Wichita, KS: Cessna Aircraft Company.

Federal Aviation Administration. (2013). *The pilots handbook of aeronautical knowledge*. Washington, DC: Author.

Lab Equipment:

Pasco Low Speed Wind Tunnel

Balsa tools to create airfoil sections

Foam cutter and foam cutting tools to create airfoil sections

Balsa gliders

Video Camera/digital camera

Computer Software:

Microsoft Excel

Foilsim

NASA Site