Technology

Fin Factors

GRADES 9-12
Two Class Lesson Plan

STEP 1 LEARN (First class session: 20-25 minutes)

Objectives

- Students will identify the purpose of fins and the factors that contribute to their effectiveness.
- Students will discover the different fin shapes and parts of a fin.
- Students will build and launch an Estes model rocket to see how fins affect a rocket in flight.
- Students will determine if the rocket's fin design should be changed.

Materials

1. Generic E2X®, Alpha III® or UP Aerospace™ SpaceLoft ™ Rocket Lab Pack™ (12 pack) - 2 or more
2. Rocket Engine Lab Pack™ (24 pack) - 1 or more
3. Electron Beam® Launch Controller - 1 or more
4. Porta-Pad® II Launch Pad - 1 or more
5. Paper, pencil, white or carpenter's wood glue or plastic cement, scissors, modeling knife, ruler and masking tape for each student
6. Visuals/Overheads: Common Fin Shapes, Parts of a Fin, What is Drag?
7. Design Considerations for Fins Worksheet for each student

Time

Two class sessions

Background

The primary purpose of fins on a rocket is to serve as the rocket's control system. Fins give directional stability and help the rocket fly straight. Fins can either be passive or active meaning they can move or not, to affect the rocket's stability. Model rocket fins may be made of plastic, balsa wood or stiff card-

NATIONAL STANDARD

Standard 11
Students will develop the abilities to apply the design process.

Benchmark M
Students should learn to identify the design problem to solve and decide whether or not to address it.

Benchmark N
Students should learn how to identify criteria and constraints and determine how these will affect the design process.

board. Fins should be attached in a symmetrical form of three, four or possibly more. Model rocket fins are usually fixed; while some actual rockets have fins that have movable components that allow for the in-flight control of the rocket's guidance.

The four most common shapes of fins are rectangular, elliptical, straight-tapered and swept-tapered (See visual/overhead Common Fin Shapes). The four parts of a fin are leading edge, trailing edge, root edge and tip (See Parts of a Fin).

The effect of drag is one of the major concerns when designing fins. Drag is the frictional force or resistance between the surface of a moving object and air. The visual/overhead What is Drag? shows the effects of drag on a hand placed into wind. The amount of drag is directly proportional to the amount of surface area that comes into contact with the leading edge of the rocket as it cuts through air. Because the palm of the hand has a greater surface area coming in contact with the moving air, it produces greater drag than the edge of the hand.

KEY WORDS

aerodynamic
directional stability
elliptical
fins
guidance system
leading
rectangular
root
straight-tapered
swept-tapered
symmetrical
trailing

The shape of a fin is one factor that determines the amount of drag produced. Fin characteristics such as the total surface area, total span and sweep angle all help to determine the amount of drag produced by a rocket's fins. When viewing the fin from the fin's tip, the sectional shape is a factor in determining the amount of drag produced by a rocket's fin.

To help students understand fins, compare a model rocket to a tree. A tree has a trunk, a model rocket has a body tube. A tree has roots, a model rocket has fins. The roots of a tree anchor the tree and give it stability to help it stand up straight. The fins of a model rocket give it guidance and stability so it flies straight.

Activity

1. Discuss with students why rockets have fins. Ask them if they know of any control systems on other types of transportation.
2. Use the What is Drag? visual/overhead to explain drag to the class.
3. Show the class the most common fin shapes and the parts of a fin using the visuals/overheads – Common Fin Shapes and Parts of a Fin.
4. Students will identify which fin shape will create the least amount of drag and make the rocket more aerodynamic.
5. Students will complete Design Considerations for Fins and label the parts of a fin on one of their sketches.

STEP 2 BUILD (First class session: 35 - 40 minutes)

Activity

1. Students will make and launch an Estes model rocket to see how the fins affect the rocket's flight.
2. Build the Alpha III®, Generic E2X® or UP Aerospace™ SpaceLoft™ together with students, using step-by-step procedures. E2X® rocket kits contain parts that are colored and easy to assemble. Glue the parts together as per the instructions, apply the self-stick decals, attach the recovery system and you are ready to launch.

STEP 3 LAUNCH (Second class session)

Activity

1. Assign and post launch jobs for students. Launch jobs are in the *Estes Educator Guide for Teachers & Youth Group Leaders.*
2. Prepare rockets for launching in your classroom before going outside to launch. Follow the Engine Preparation steps located in the rocket instructions.
2. Launch rockets outside at a soccer field, football field, baseball field, green grass area or blacktop area.

Wrap Up - Touch Down & Recovery

1. Discuss with students the fin shape of their rocket and if it was effective in reducing drag. If the rocket launched in a straight position and went higher than expected, the fin shape was probably correct for the rocket and the fin was glued straight on the body tube.
2. Students will make sketches of their rocket with a fin shape they think will produce less drag and a fin shape that will create more drag for the rocket and explain under each sketch why they chose each fin's shape.

Extensions

1. Students can make an Estes rocket that has a different fin shape and compare it to their first rocket. They will predict which rocket will fly the highest and straightest when launched one after the other. Use the Estes Altitrak™ to track the altitudes of both rockets.
2. Students can learn more about the center of pressure (CP) and how it affects a rocket design. This is what the fins adjust through the process of lift, a sideways steering force created by the fins.

Evaluation/Assessment

- The students' participation and discussion about rocket fins.
- Students will complete the Design Considerations for Fins Worksheet.
- Students will assemble and launch an Estes model rocket.
- Students will sketch their rocket with fin shapes to create more and less drag for the rocket.

References

- *Estes Educator™ - Guide for Teachers and Youth Group Leaders*
- Estes Educator™ Website - www.esteseducator.com
- Estes Educator™ - *Industrial Technology and Model Rockets Curriculum*