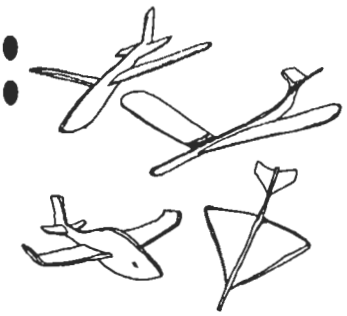
Aerospace Technology: Research and Development of a Metric Glider



Introduction

The ***design process*** is used by industry to design and build new products, including aircraft. Engineers begin the design process by identifying the design and performance ***specifications***. The design process itself can take hours to years depending on the complexity of the project. In this activity, you will design a "metric glider" using the same design process used by industry.

Designers start with drawings on paper. They refine their designs based on research, testing, previous experience, and present technology. ***Models*** and ***mock-ups*** are then used to do extensive testing in wind tunnels and testing stations. Next, a ***prototype*** is built and tested. Finally, after the prototype design has proven successful, production can begin.

Job Description

You are going to develop an original prototype for a metric glider according to given specifications. You will use the design process, creating thumbnail sketches, rough sketches, and design drawings done "full size". ***Thumbnail sketches*** are small drawings used to help develop your ideas. For this activity you will use thumbnail sketches to define what your glider will look like. ***Rough sketches*** are more detailed and will show your glider from two views or "profiles".

Drawings are used to describe shape and size. Since this glider activity requires the use of metric measurements, your design drawings will be done on metric graph paper.

Once your drawings are completed, you will create a mock-up to check your design and dimensions. Next you will build a balsa wood prototype, which will be tested to determine if your design meets the "design criteria".

This activity will provide you with an opportunity to experiment with the technology associated with flight, and allow you to experience the ***research and development*** process used by industry to develop new products. If your school offers a Technology Student Association program, the Aerospace Technology "metric glider" competition is one of the TSA competitive events you may want to enter.

Materials and Supplies

To complete this activity, you will need the following materials:

- drawing paper
- metric grid graph paper
- carbon paper
- card stock for mock-ups
- tracing paper
- pencils
- metric ruler or scale
- X-Acto knife with #11 blade
- cutting board or surface
- balsa wood blanks (1 each)
  - 3mm x 75mm x 230mm (fuselage)
  - 1.5mm x 75mm x 300 mm (wing)
  - 1.5mm x 40mm x 70mm (stabilizer)
- white or CA glue
- t-head pins
- modeling clay

Getting Started

1. Read carefully the current requirements for the TSA Aerospace Technology competitive event.

2. Do some basic research on the principles of flight. You should know and understand the following terms and conditions that affect the flight of a model glider: ***lift, drag, gravity,*** and ***thrust.***

3. Examine ***Bernoulli's Principle***. How does the shape of an ***airfoil*** affect the amount of lift generated by a wing?

4. Research the term ***angle of attack***. How does the angle of setting of a wing affect the lift or stall generated by an airfoil?

5. Do some reading or research on weight and the ***center of gravity***. How do these affect the design of a glider?

6. Find out what the term ***dihedral*** means; what does this concept accomplish in the placement of a wing on an aircraft? What does it contribute to?

7. Do some research and find out what is meant by ***pitch, roll,*** and ***yaw.*** What controls these movements on an aircraft?

8. Do some reading and research and find out what is meant by the following aircraft terms:

angle of incidence	rudder
wing span	elevator
chord	stabilizer
length	aileron
fuselage	

Determining the Design Specifications

1. Carefully read the design specifications in your *TSA Resource Guide*. Determine the size requirements for each of the following glider parts: fuselage, wing, and stabilizer. What materials are specified?

2. What is the performance specification? What is it you want your glider to do, and how is it supposed to perform?

3. What restrictions are included in the design specifications. In other words, what can you do and not do?

Creating Thumbnail and Rough Sketches

1. Begin the design process by creating several thumbnail sketches of possible design solutions. What will your glider look like?

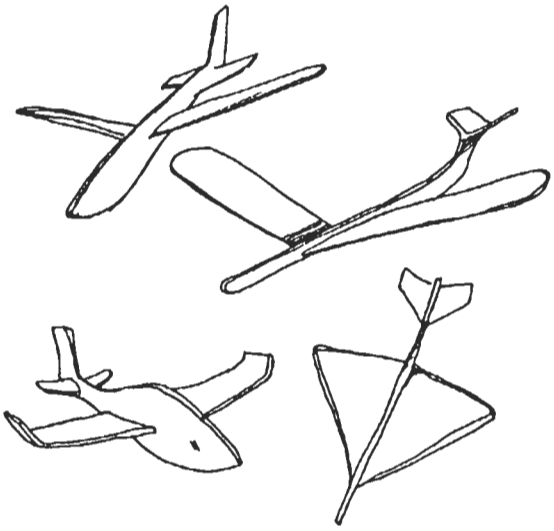


Figure 1 - Thumbnail Sketches

2. After you have created your thumbnail sketches, study them carefully. How do they compare to the design specifications? What about lift and drag? Do you have an airfoil? Have you taken into consideration what you have learned about the principles of flight?

3. Select the design you think will best meet the design specifications. Begin a rough sketch of your selected design. Note that the rough sketch is done as a two-view ***orthographic*** drawing. (See Figure 2.)

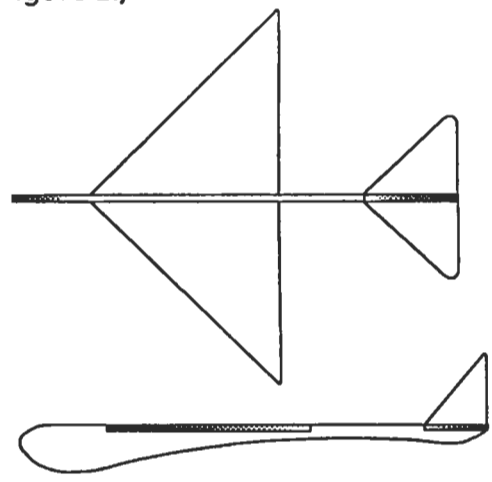


Figure 2 - Rough Sketch

Beginning Your Drawing

1. Select a sheet of metric graph paper. The grids should be 5mm in size. Measure and sketch a rectangle 75mm x 230mm for the fuselage blank.

2. Plot points for your fuselage shape within the limits of the 75mm x 230mm blank; then darken in the object lines. (See Figure 3.)

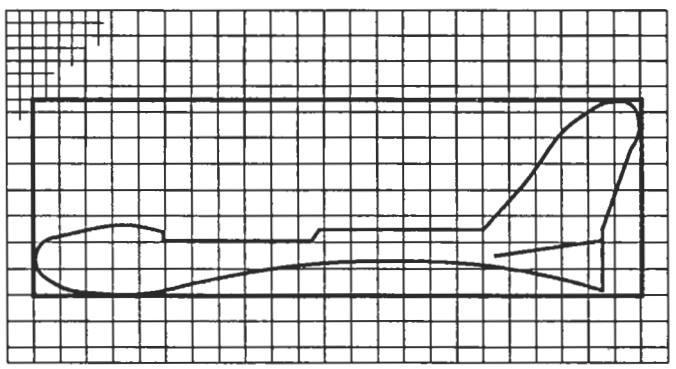


Figure 3 - Fuselage Shape

3. Repeat the process for each part of your glider. For the wing, determine if you will build a single wing or two wing parts. If you are using a design with two wing parts, draw a box 75mm x 150mm for one wing part. (Draw a box 75mm x 300mm if you are using a single wing part.)

4. Sketch in the shape of one wing section (right or left) inside the limits of the wing blank size. (See Figure 4.)

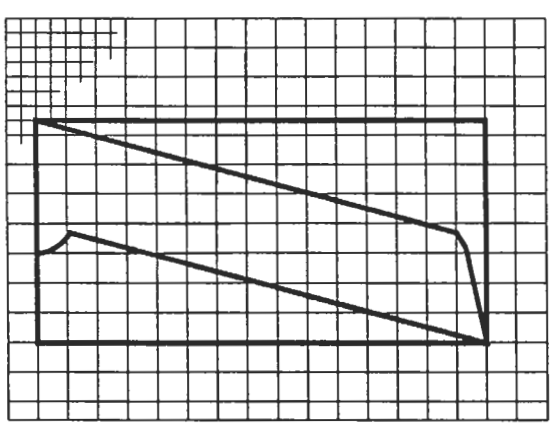


Figure 4 - Wing Section

5. Repeat the process for your horizontal stabilizer. (See Figure 5.)

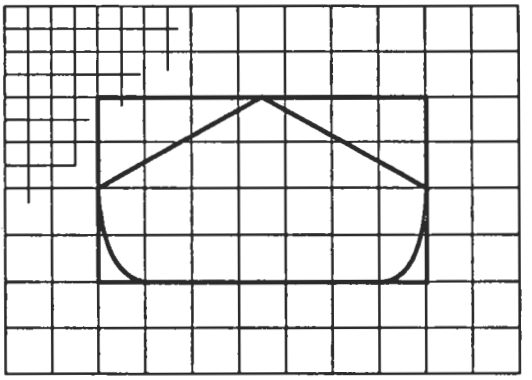


Figure 5 - Horizontal Stabilizer

6. Add basic overall dimensions with extension lines and dimensions as shown in Figure 6.

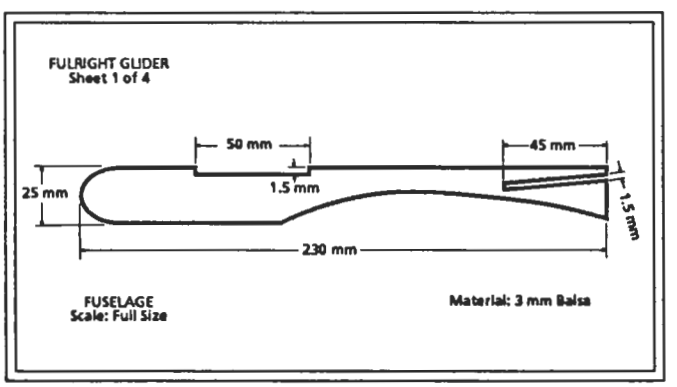


Figure 6 - Drawing with Basic Dimensions

Constructing Your Mock-Up

1. Place your graph paper drawing over the sheet of card stock with carbon paper underneath and tracing paper over the top. Carefully trace the design, transferring it to the card stock underneath. (See Figure 7.)

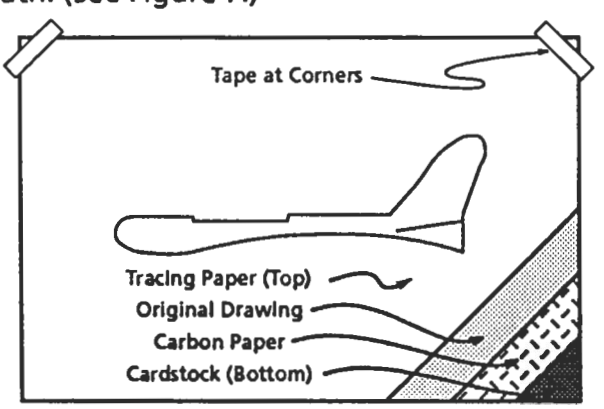


Figure 7 - Carbon and Tracing Paper Drawing

2. Cut out the card stock ***template*** you have created. Carefully check each template against your original drawing to insure accuracy.

Building Your Prototype

1. Transfer your design to your balsa wood blanks by taping the templates to the balsa wood; then cut out using your X-Acto knife.

2. Carefully cut out each part; then check it against the original drawing for accuracy.

3. Carefully sand your parts before you attempt to glue them together. It is much easier to sand the parts before assembly.

4. Use white glue or CA glue to assemble your parts.

5. Use pins to hold parts together; allow glue to dry thoroughly before removing pins.

Preparing for Your Test Flight

1. Determine the center of gravity of your prototype. This will usually be on the fuselage, under the center line of the main wing.

2. Balance your glider at the center of gravity on your X-acto knife.

3. Add weight to the nose until the plane balances. A nose-heavy plane will dive; a tail-heavy plane will stall. Balance is extremely important!

4. Hand launch your glider outside or in a designated place. Do not throw gliders in the classroom, as someone could get injured!

5. Launch your glider with a slow, dart-like motion. Do not throw hard at first.

6. Try to obtain an even glide toward the ground. Make adjustments to wing warps or balance until you achieve a satisfactory flight.

Ecology

Be conscious of the environment. Don't leave broken or damaged gliders and/or parts in your flying area. Clean up after yourself!

Safety

Be careful when using an X-Acto knife, as the blade is extremely sharp. Always cut away from your hands and fingers. Use a cutting board or cutting surface; do not cut on the drawing table or desk top! Store knives in a block, or use the blade cover when putting your knife away.

Read the label on your glue bottle. Avoid contact with skin and eyes.

Vocabulary

thumbnail	fuselage	thrust
rough	stabilizer	dihedral
model	lift	roll
mock-up	drag	pitch
prototype	gravity	yaw

On Your Own

1. Obtain a copy of *Aerospace Technology: The Metric Glider* by Steven A. Bachmeyer, PITSCO, 1991. Read the text thoroughly; it is a good source for information on the metric glider project.

2. Use this publication to learn about assembly drawings. Try completing an isometric assembly drawing of your glider. If you are going to enter your glider in the TSA competition, this drawing could be included in the required folio.

3. Visit the library and check out the magazine section for *Model Airplane News, Model Aviation,* or *RC Modeler.* They often have articles on model gliders.

4. Visit the local hobby shop. Buy a simple model balsa wood glider, and experiment with the method of obtaining a good flight pattern.

Office of Vocational, Adult, Career, and Community Education
Technology Education
Dade County Public Schools
Miami, Florida

TEACHER GUIDE
AEROSPACE TECHNOLOGY:
RESEARCH AND DEVELOPMENT OF A METRIC GLIDER

Objectives: Upon completion of this assignment, students will be able to:

- Research the fundamentals of flight and define lift, drag, thrust, and gravity.
- Research the basic elements of flight and define pitch, roll, and yaw.
- Demonstrate the design process by completing thumbnail, rough, and design drawings based on specific performance requirements.
- Create a mock-up and prototype of a glider design and test the design to achieve desired results.

Helpful Hints:

1. Prepare ahead of time; have all the materials and supplies available before you start this assignment.

2. PITSCO has available a Flight Pak that contains all the materials and supplies needed for this activity, including 25 copies of the Metric Glider Book, in a single package. The balsa blanks are cut to proper size. Metric graph paper is also included. For more information call PITSCO at 1-800-835-0686. Ask about item #21842.

3. Obtain a copy of the *TSA Curricular Resources Guide*; it contains the latest competitive event specifications. Reproduce copies of this information for each of your students.

4. White glue is acceptable for building gliders; however, it takes a day to set up. While it is recommend that white glue be used for middle school students, CA glue may be used for senior high students. It sets up quicker; however, there are some safety concerns with this product. **Read all labels.**

5. Check your library for resource materials. This is a good assignment to introduce the concept of doing some research. Students should have some knowledge of lift, drag, thrust, balance, center of gravity, and Bernoulli's principle. Schedule a library session on how to do research.

LANGUAGE ARTS APPLICATION
AEROSPACE TECHNOLOGY:
RESEARCH AND DEVELOPMENT OF A METRIC GLIDER

_____
Student Name

In all types of jobs you will find that you need the ability to communicate your ideas effectively. Writing skills are necessary in all occupations. Here are a few examples of how writing skills are related to this activity.

Before starting to design or build your model, you must first do some research on the principles of flight. Go to the library and check out books or magazines that explain how conditions such as lift, drag, gravity, and thrust affect the flight of the model glider. Examine Bernoulli's principles and how the shape of an airfoil affects the amount of lift generated by a wing. Learn as much as you can about the principles of flight; this will help you in the designing of your model. After you have completed and tested your design, a technical report should be written.

The TSA Aerospace Technology Competition requires that a technical report based on the glider design be submitted. Be sure to explain the basic principles of flight, and how you applied these principles to your glider. Included in the technical report must be assembly instructions for the glider and a description of the launch techniques that should be employed to ensure a successful flight. Drawings and diagrams may be used to supplement the report.

Use the area provided to write a rough draft of your technical report. You may then type your report or use a computer with word processing software. Limit your report to four pages, excluding drawings and diagrams.

MATH APPLICATION
AEROSPACE TECHNOLOGY:
RESEARCH AND DEVELOPMENT OF A METRIC GLIDER

_____
Student Name

In all types of jobs and occupations you will need the ability to apply mathematics effectively. The following exercise will help prepare you for the challenging world of aerospace technology.

The metric system of weights and measures is used throughout the world. While the United States stilll uses the english system of pounds and inches, many american industries in an effort to compete internationally, are using the metric system in there research and design departments.

Metric measurements are based on the decimal system. This makes measuring with a metric scale relatively easy because there are no fractions. A metric scale is marked off by millimeters and centimeters. The short lines on the scale represents millimeters. The longer lines are the centimeter marks (10 millimeters = 1 centimeters).

When measuring a distance with a metric scale, always place the zero at the starting point and read the measurement at the end point.

Try these: Measure the lines and record your answers

Measure to the nearest centimeter.

1. _____ _____
2. _____ _____
3. _____ _____
4. _____ _____
5. _____ _____

Measure to the nearest millimeter.

6. _____ _____
7. _____ _____
8. _____ _____
9. _____ _____
10. _____ _____

QUIZ
AEROSPACE TECHNOLOGY:
RESEARCH AND DEVELOPMENT OF A METRIC GLIDER

_____
Student Name

True or False

_____ 1. A thumbnail sketch is a very detailed drawing that explains both the size and shape of the object.

_____ 2. Models are often used to check dimensions.

_____ 3. A prototype is often the first working example of a design.

_____ 4. Models and mock ups are often used for testing purposes.

_____ 5. There are ten millimeters in one centimeter.

_____ 6. A dihedral is a tool used to build balsa gliders.

_____ 7. A drawing often contains dimensions which give information about size.

_____ 8. An orthographic drawing shows an object in more than one view.

_____ 9. A rough drawing is often done full size, and often in more than one view.

_____ 10. Four forces acting on an aircraft in flight are lift, drag, thrust, and gravity.