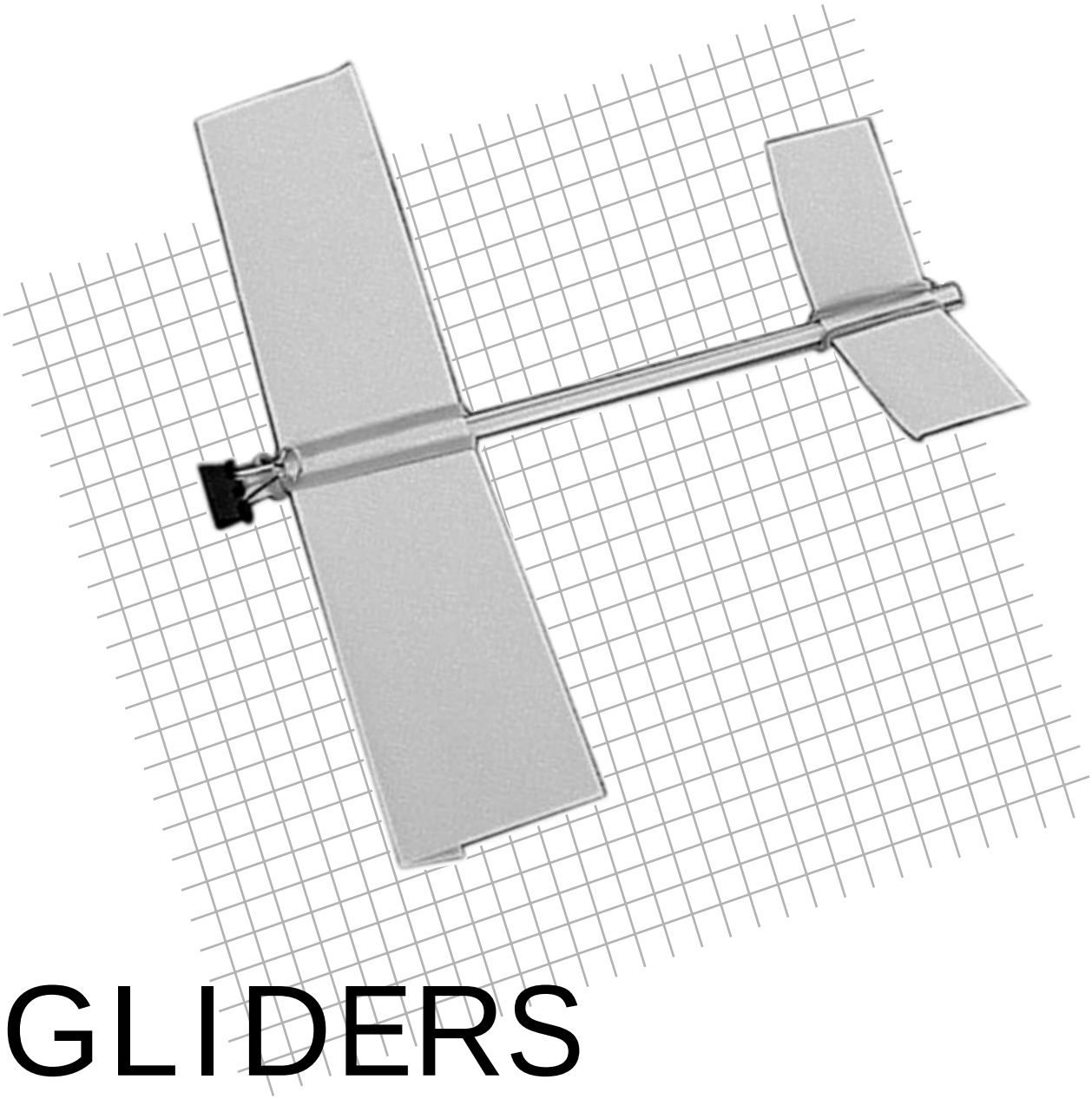

GLIDERS

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DESIGN IT! ENGINEERING IN AFTER SCHOOL PROGRAMS

Education Development Center, Inc.

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Activity 1: The Simplest Glider

You've probably made fold-up paper airplanes before. This is a slightly different challenge. Now you are going to make gliders that look more like regular airplanes (and birds) with no folds in the wings.

THE CHALLENGE

Make a glider that flies for 10 feet (or more) in a straight line.

Design limitation: You may not fold or bend the cards!

Part A

What Materials Do I Have?

- index cards (3 x 5 inches)
- index cards (5 x 8 inches)
- binder clips (as many as you like)
- paper clips (as many as you like)
- masking tape (12 inches)
- *Data Sheet—Activity 1*

What Do I Do?

1. Attach index cards together in any way that you choose to make a glider. Remember: You cannot fold the cards!
2. Test the glider by throwing it. Be careful not to aim near other people.
3. If necessary, make changes to your design to make the glider a better flier.
4. If your glider flies 10 feet in a straight line, make a drawing of your design in Part A of *Data Sheet—Activity 1*. Write down how far it flies (in a straight line) and be sure to show the direction of flight on your diagram.

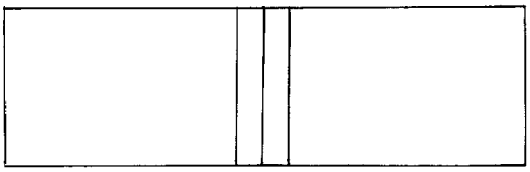
Part B

What Materials Do I Have?

- 2 index cards (3 x 5 inches)
- 1 binder clip
- 6 paper clips
- masking tape (6 inches)
- *Data Sheet—Activity 1*

What Do I Do?

1. Tape the two index cards together along their short sides to make a long narrow wing.



2. Try flying it just like that. What happens?

3. Add weight (binder clip or paper clips) somewhere on the wing and see if you can make it glide.

4. When your glider flies well, make a diagram of it in Part B on the data sheet. Record where you put the weight and how far the glider flew. Show the direction of flight, too.

What to Think About

- Where is the best place to put the weight to make the glider fly straight and far?
- What is the best way to launch your glider?
- Can you put the same weight on the same wing, but make it fly in a different way?

Data Sheet—Activity 1

Team Members: _____

_____

_____

Draw a diagram of your gliders for Part A and Part B of this challenge.

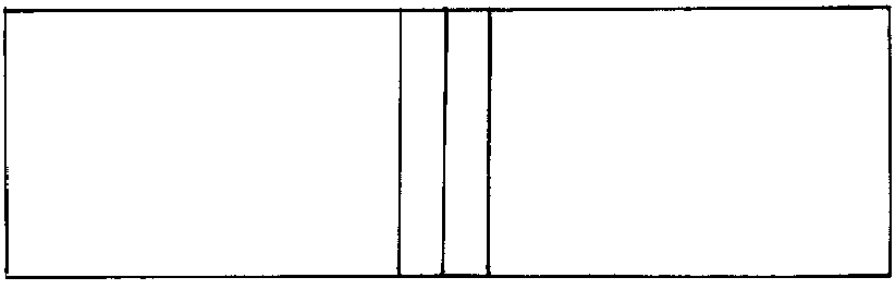
With each diagram, also do the following:

- Draw an arrow to show in which direction the glider was thrown.
- Mark where you placed the weights. (Use a large B for binder clips or a P for paper clips.)
- Write the farthest distance the glider flew in a straight line.

PART A

This glider flew _____ feet.

PART B



This glider flew _____ feet.

Challenge Sheet

Use this chart to record what you discover about what works and what doesn't when you try to make a simple glider.

What Works?	What Doesn't?

Activity 1: The Simplest Glider

Preparing Ahead

Before you begin working with the children, experiment with your own gliders. Try attaching together different combinations of cards and placing binder clips or paper clips in various positions on the wings. Launch your gliders with the weight at the front, at the back, or at the side to see if the position of the weight makes any difference.

You will probably be amazed that the best flier you can make with these materials is almost the simplest design possible—just two 3 x 5 cards taped together as in Figure 1.1, with a single binder clip at the front-center. Make such a glider yourself and play with it until you get used to the best way to launch it. Make any minor adjustments to the binder clip that might help the glider fly better.

Make enough copies of the Challenge Sheet, including *Data Sheet—Activity 1*, for each team.

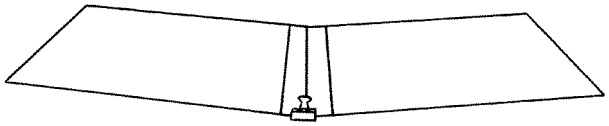


Figure 1.1
The simplest glider—two cards and a binder clip.

The Challenge

Make a glider that flies for 10 feet (or more) in a straight line.

Design limitation: You may not fold or bend the cards!

Introducing the Activity

Tell the children that in this project they will design and make a series of gliders with just a few simple materials. (Show the index cards and clips.)

Ask if anyone has made fold-up paper airplanes before, and then stress that the challenge of this project is to make straight-winged gliders—so the design limitation is that they may not fold or bend the cards at all.

Materials

FOR EACH TEAM

- 4 index cards (3 x 5 inches)
- 4 index cards (5 x 8 inches)
- 2 binder clips (3/4 inch)
- 6 paper clips
- masking tape (18 inches)
- *Data Sheet—Activity 1*

Hold up a large index card *without any weights on it*. Ask if they think it can fly. Drop the card from as high as you can reach. Ask the children to describe what it does. Ask:

- What is the card doing as it fall?
- Is it "flying"?
- What exactly does it mean to "fly"? What does it look like?

After that conversation has run its course, hand out the Challenge Sheet, *Data Sheet—Activity 1*, and the materials. Explain the challenge to the children and let them begin making gliders.

Leading the Activity

Part A—Initial Exploration

Give the children the materials and let them experiment. You may or may not choose to limit the number of cards and clips they can use. It is recommended, however, that you limit their use of tape to 12 inches per team. Remind them to make a diagram of any successful glider that they make in Part A on the data sheet.

After 10 or 15 minutes, or if the children are obviously becoming frustrated that their gliders will not fly, pull out a two-card glider that you made earlier and launch it across the room among the teams. Do not specifically tell them what you did, but don't try and stop them from copying your design, either. Fly your glider several times until everyone sees that there *is* a way to meet the challenge. Let them work for a few more minutes and then break for a Discussion Circle.

Troubleshooting

Call all the children together to share their gliders with the whole group. Let each team demonstrate its glider to the group, one at a time. Each time a glider is flown, ask the group the same question:

What did you notice?

Typically, children's responses to this question are short on detail. "It bombed." "It went farther than Elisha's." Follow up these responses with probing questions, such as:

- How straight did it fly?
- Why did you choose that shape? Did you try other shapes?
- Why did you put the clips in those places? Did you try other places?
- Did it stay stable/even/balanced?
- How did you launch it?
- What words describe how it looked while in flight?
- Is there a best place for the weight?

By the end of this show-and-tell, it will probably be obvious to the children that their complicated designs aren't going to fly, and that your simple design does. If necessary to make the point, take a turn yourself and demonstrate your glider to the whole group. Ask them the same questions about this simple glider as you asked about theirs. Then, point out Part B of the challenge on the Challenge Sheet.

PART B—FURTHER EXPLORATION

Collect all the old materials and hand out just the two cards, one binder clip, some paper clips, and 6 inches of tape to each team. Tell them you want them to make a glider just like yours and to discover the best way to make it fly.

As they get back to work, walk among them and ask them to describe to you what makes their gliders work well. See if they can make it fly in any of the ways shown in Figure 1.2, and remind them to record their results in Part B of the data sheet. Ask them also to make a few entries on their *What Works?* charts (p. 14). See below for some examples of the kinds of statements they might be able to make about this kind of glider design.

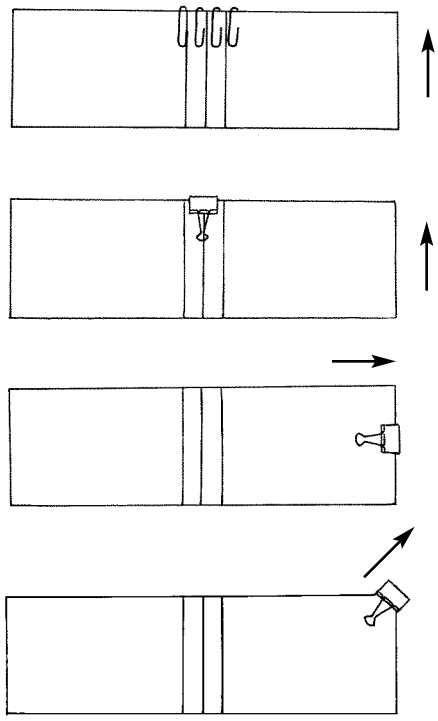


Figure 1.2
Different ways to place the clips that work. Arrows show direction of flight.

LEADING THE DISCUSSION

When the children have had ample time to test their gliders, gather them again into a Discussion Circle. Make a large version of the *What Works?* chart on chart paper or a chalkboard. As you discuss the various gliders, make a list of "findings" about what does or does not work for this kind of glider. Once again, ask each team to launch their new glider in front of the whole class. After each glider flies (or does not), ask the children to describe its motion. Look for words like those listed below:

Verbs	**Adjectives**
Dive-bombs	Straight
Falls	Twisty
Flips	Wobbly
Flutters	
Glides	
Swoops	
Tumbles	
Twists	
Graceful	

Look also for statements for the *What Works?* chart. Remember, you are looking only for practical tips that would help someone else make a better glider. You are not looking for *explanations* but descriptions. Typical statements might be like those in Table 1.3.

What Works	What Doesn't
Putting weight at the front*	Putting weight at the back or side
Even and balanced wings	Unbalanced wings
Launching gently	Throwing hard
Using one binder clip	Using too much weight
Launching slightly upward	Launching steeply

Table 1.3

**Front* means the leading edge in the direction the glider is being thrown.

Each time someone offers such a suggestion, write it on the chart and then ask the group if this was also other people's experience. If everyone agrees, underline or circle the entry. If there is debate, put a question mark by the item and suggest that more testing is needed.

At the end of the session, you might say something like the following: "We have learned something very interesting here. If you put the right amount of weight in the right place on a flat card, it flies!! Who would have guessed it? But there is still a problem! It will not fly in a straight line most of the time and it won't go very far. Next time we will try to solve these problems."

Activity 1: The Simplest Glider

Rationale

Surprisingly, the simplest glider flies beautifully when the weight is fixed to the wing in just the right position. Because there is no folding of the paper and because the weight comes in simple units (binder clips or paper clips), there are only two factors to adjust—the amount of weight and the position of the weight.

By not folding the cards, it is much easier to see what effect changing the position and size of the weight has on the performance of the glider. This is a good example of cause-and-effect analysis—something that is central to the design process.

Introducing the Activity

When you drop the index-card wing (without weights) in front of the children, the point is to establish that it will not fly as constructed and to draw out their ideas about what *will* make it fly. Most probably, no one will be surprised it didn't fly. Most people expect a plane to have a body, tail, wings, and so on. The children will have all kinds of ideas about how to make a plane fly (many of which involve folding the paper). Add the children's ideas to a new or existing *What Works?* chart. Keep this in sight for the rest of the project. It is good to come back to the list over and over again to ask the children if they have changed their minds on any of the important ideas. It is helpful if *they* can see from this list how their thinking changes over time.

Leading the Activity

We begin by letting the children make a glider with any design they like—with the limitation that they may not bend or fold the cards. Also, they are given only a set amount of materials. It is highly unlikely that any of their initial designs will fly at all, let alone 10 feet and in a straight line. But this initial period of exploration is still very useful. First, it is fun for the children, and second, it provides a basis for their understanding of what will and what will not work in the design of paper gliders.

If someone does make a plane that flies well during this initial exploration period, you might choose to use their design as the basis for further exploration along the lines laid out for the standard model given here. Most likely this will not happen, but some useful conclusions often emerge. For instance, children often guess quickly that adding weight to a glider is important, but they tend to put the weight all over the place at first, often at the back or the

middle of the wings. So although they have not yet "succeeded" in their own terms, they have often incorporated elements into their first designs that will serve them well as they continue.

A single binder clip of the type recommended for this activity is an excellent match for a simple wing made of two 3 x 5 inch index cards (or one 5 x 8 inch card). If the children have reached their frustration point with their own designs and have begun to doubt that the challenge can be achieved, launch your glider into their midst to prove that it can. Drop your glider from a height of 6 or 7 feet with the clip side leading. With luck, it will glide straight and fast among the children. Hopefully they will all notice this (do it several times if necessary) and, perhaps, they will all immediately want to copy your design. If so, that's fine, but fairly soon you should break for the first Discussion Circle so they will have a chance to share what they first tried before moving on to your design.

Unless they have had a lot of experience with design engineering projects, children's experimentation tends to be random at first. They don't usually think systematically about causes and effects. Even when they occasionally achieve success, they may not realize what it was about their design that made it happen. This is very common among children of this age; they are much more focused on "making it work" than on understanding how it works. It is suggested that you test the gliders in a whole group setting so you can draw the children's attention to what happens with each glider and what factors may have caused the good or bad outcomes.

Leading the Discussion

Formal discussions about design projects should be separate from the handling of the materials. Children often find it hard to switch from touching to talking, so it is important to make the transition very obvious. We suggest that the materials be left where they are while the children gather in a Discussion Circle.

Discussions should be short, at first, centering more on setting up the habits and routines of discussion rather than getting to the whole truth of the matter. Eventually both can happen, but it might take a while, so try to observe the following guidelines from the beginning of your work with *Design It!* projects:

- Keep the early discussion short (5–10 minutes).
- Insist that only one person talk at a time.
- Insist on taking turns. Work out your own way to keep it fair, but make the system clear and consistent (hand raising, etc.).
- Reflect. Repeat back to the speakers the essence of what they said so they will know that they were heard and whether they were understood.
- Separate construction problems from design “findings.”

During the Discussion Circle toward the end of the day, repeatedly ask the question: “What did you notice about how this plane flies, and about what

makes it fly better?" Many children will be more expressive with their hands than with words at first. This is fine, but throughout this project, try to get the children to agree on which words best describe what they observe. Typical questions might be:

- How did the card fly with no weight? *Look for words like* wobbled, fluttered, nose-dive, unpredictable, went backwards.
- What happened when you added weight? How would you describe its flight now?
- Where did you place the weight? *Have children refer to their* data sheets *to say exactly where they placed the weights.*
- Is there a "best position" for the weight?
- Can tiny adjustments of the position of the weight make any difference? *Notice the effect of swinging the handles of the binder clip forward or backward.*
- What is the best launching technique? *Ask the children what they noticed about how they launched their gliders. Probably they will have noticed that gently launching the glider from as high as they can reach is better than throwing it as hard as they can.*

ASSESSMENT

Over the weeks that you work with this project, look out to see if there is a gradual increase in the following behaviors among your children. In general, do they:

- think through their designs and deal with problems in a skillful manner?
- work cooperatively (i.e., share their work and listen to each other's ideas and suggestions)?
- describe to you and to each other how they did whatever they did and why it worked?
- focus on what they actually see happening rather than what they think should happen?

Specific skills that this project hopes to emphasize and practice are:

- taking turns and sharing the hands-on work,
- asking each other for help before asking you,
- listening when their peers share ideas,
- responding constructively to ideas from peers or adults,
- making deliberate changes to their designs in order to improve how it works,
- making changes to only one factor at a time, and
- keeping accurate and clear data and records where appropriate.

It is unlikely that you will observe dramatic changes in these behaviors in the short term, but if you are thinking about them from the beginning, you can encourage them when appropriate and be aware of changes (if any occur) as the project progresses.