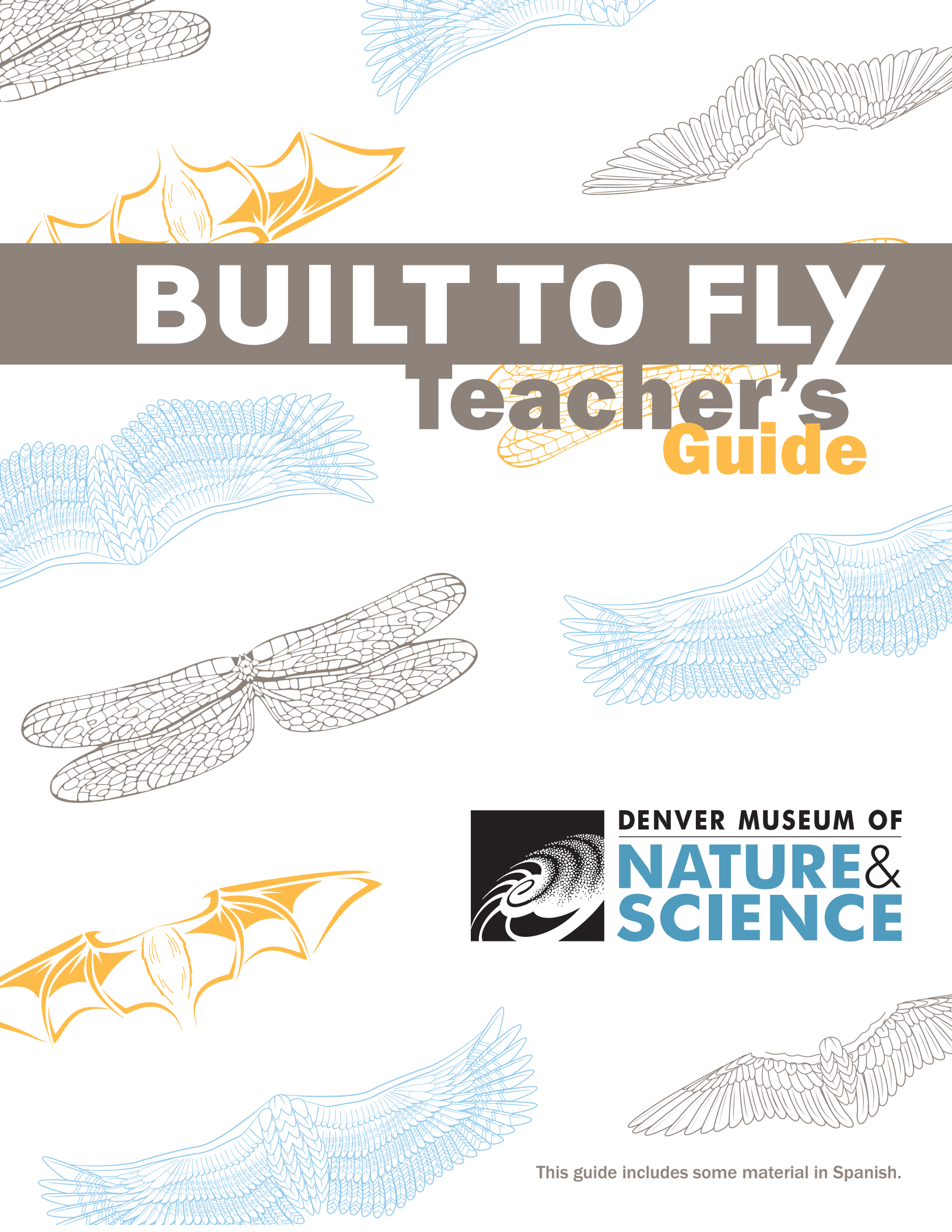


BUILT TO FLY

Teacher's Guide

DENVER MUSEUM OF NATURE & SCIENCE

This guide includes some material in Spanish.

BUILT TO FLY

Teacher's Guide

Grades 2–5

Objective

Design, build, and test a flying animal.

Key Concepts

- Animals have physical and behavioral adaptations, including specialized structures that help them fly.
- Birds, bats, and insects use a wide variety of structures and techniques to move through the air.

Colorado Academic Standards

- SC09-GR.2-S-GLE2: Each plant or animal has different structures or behaviors that serve different functions.
- SC09-GR.5-S.2-GLE.1: All organisms have structures and systems with separate functions.
- SC09-GR.4-S.2-GLE.3: There is interaction and interdependence between and among living and nonliving components of ecosystems.
- SC09-GR.2-S.1-GLE.1: Changes in speed or direction of motion are caused by forces such as pushes and pulls.
- NGSS Practice 1: Asking Questions and Defining Problems.
- 21st Century Skills: Critical Thinking and Reasoning; Collaboration; Self Direction; and Invention.

Provided in Museum Box

1 TEACHER BOX containing:

1 Teacher's Guide *

1 USB drive with preloaded videos *

1 iPad with preloaded videos *

1 iPad charging cord *

1 iPad charger *

1 measuring tape *

2 RESOURCE BOXES containing:

A - 3 specimens (1 bird wing, 1 bat, 1 dragonfly) *

B - 18 stencils (for Design Challenge 2) *

6 laminated Challenge sheets (1 per team) *

8 dry erase markers (1 per team) *

(3) CLASSROOM BOXES
(each box contains a custom number of items for each class):

6 Trial Tracker sheets (1 per team)

Printed foam bodies (1 hawk, bat, dragonfly, and swallow per team)

Paper wing and tail sheets

4 small binder clip boxes *

Design sheets

Small binder clips *

Blank foam bodies

* *Items to be returned to the Museum*

NOTE: This guide contains some material in Spanish.

Classroom Materials

Projector
(optional to view videos from iPad or USB)

Scissors
(1 per student)

Chart paper or whiteboard

Pens or pencils
(1 per student)

Clipboards (optional for Trial Tracker)

Tape

KEY VOCABULARY	DEFINITION
Lift	An upward force acting on an object.
Drag	A force that opposes or slows an object's movement.
Gravity	A force that pulls objects to Earth.
Thrust	A force that moves objects through the air.
Weight	The force of gravity moving in a downward direction.
Fly	To move through the air propelled by thrust, such as that created by flapping wings.
Glide	To use air currents and gravity to move over short distances without flapping wings or generating thrust.

VOCABULARIO IMPORTANTE	DEFINICIÓN
Sustentación	Fuerza ascendente que actúa sobre un objeto.
Resistencia	Fuerza que se opone o reduce el movimiento de un objeto.
Gravedad	Fuerza que hala los objetos hacia la Tierra.
Empuje	Fuerza que mueve los objetos en el aire.
Peso	La fuerza de la gravedad moviéndose en dirección descendente.
Volar	Moverse a través del aire con el impulso de un empuje, como el creado por el batido de alas.
Planear	Usar las corrientes de aire y la gravedad para el moverse en distancias cortas, sin batir las alas o generar empuje.

I. Classroom Set-Up: 10 minutes	Materials	Tips and Adaptations
A Place tape on the floor to designate a flight-testing area. B Review and sort materials into six sets (one for each team). C Review the videos using the iPad provided or classroom technology.	**For Each Team** - 4 printed foam bodies (1 hawk, bat, swallow, and dragonfly) - 4 printed wings - 2 printed tails - 3 small binder clips - 1 Trial Tracker sheet - 1 Challenge sheet - 1 dry erase marker - Measuring tape (shared by entire class) **Class Materials** - Clipboards - Scissors (1 per student) - Pencil or pen (1 per team)	Students will stand behind tape to test their animals. Remove fragile items that may be easily knocked over in the area.

II. Activate Prior Knowledge: 10 minutes	Materials	Tips and Adaptations
A Ask students what they know about animal flight (birds, bats, insects). B Introduce the vocabulary. C Encourage students to pay attention to animal flight while watching video. D Show video clips.	iPad or USB drive and classroom projector	Write on paper, pair share, or discuss as a class.
E Ask students to share something they learned from the video. 1. Dragonflies hover, glide, and fly backwards. 2. Wings help butterflies escape predators and find mates. 3. Swan feathers overlap to help swans soar. 4. Hummingbirds can hover and their wings beat very quickly (80 times per second). F Share the specimens with students.		Write on paper, pair share, or discuss as a class.

II. Activate Prior Knowledge: (continued from previous page)	Materials	Tips and Adaptations
G Ask students what they notice about the specimens that might impact flight. 1. Dragonflies are among the earliest fliers. They hover by flapping their wings rapidly. 2. Birds that fly have hollow, but strong bone structures. Some flightless birds, such as ostriches and penguins, have solid bones. Feathers complete a bird's wing shape. 3. Bats are the only true flying mammal. The membrane stretched across their arm and finger bones creates a surface for air to move across in flight. **Prompting Questions:** 1. Why might dragonflies have evolved to fly in many directions? *Potential answers: To escape predators, to more easily catch prey* 2. What parts of a bird's wing can you identify? *Potential answers: feathers (both small and large), bones* 3. What bones do you think make up the structure of the bat's wings? *Potential answers: arm bones, phalanges (fingers).*	**Specimens** - bird wing - bat - dragonfly	Pass specimens around to students for a quick view and/or use your overhead projector to enlarge them. Display specimens during trial phases for student reference.

III. Design, Test, Record: 25 minutes	Materials	Tips and Adaptations
A **Class Structure** Divide students into six teams.		
B **Behavioral Expectations and Safety** Explain the flight test expectations. 1. Animals can only be tested in the testing area. 2. Students should stand behind the tape to test animals. 3. Only one team can test an animal at a time.		

III. Design, Test, Record: (continued from previous page)	Materials	Tips and Adaptations
C 1. Remind students of teamwork expectations (each student builds an animal for each trial). 2. Students should share the tape measure to measure distance. 3. Review laminated Challenge sheet. 4. Review the Trial Tracker sheet. 5. Instruct students to begin the challenge. 6. Once the majority of students have conducted 12 trials, ask them to make a final animal for the gliding contest.	**For Each Team** - 4 printed foam bodies (1 hawk, bat, swallow, and dragonfly) - 4 printed wings - 2 printed tails - 3 small binder clips - 1 Trial Tracker sheet - 1 Challenge sheet - 1 dry erase marker - Clipboard (optional) - Pencil or pen - Scissors (1 per student) Measuring tape (shared by entire class)	**Suggested Team Roles** - Animal designer (builds the animal) - Data collector (records trial data) - Observers (observe trials and make recommendations for next animal) Encourage students to rotate roles. **Note:** The binder clips should be placed on the heads of each animal. The bat and dragonfly fly best with the clip **on the top** of the head. Birds fly best with the clip **at the front** (beak area).
IV. Gliding Contest: 5 minutes	**Materials**	**Tips and Adaptations**
A Each team takes turns launching their animals. 1. One team member measures the distance from the start tape to where the animal lands. 2. Teacher or student records the distance on chart paper or whiteboard.	- Measuring tape - 6 final team animals - Chart paper or whiteboard - Dry erase marker	Remind students to stand behind the tape. Encourage students to watch all animals and pay attention to different designs.
V. Closure: 5 minutes	**Materials**	**Tips and Adaptations**
A Ask students what they learned from the challenge. 1. Amount of weight in the front (clip) impacted gliding. 2. The size of the body and wings were important. 3. The tail made the animal glide better. 4. The angle of the wings changed how the animal glided.		**Fly:** To move through the air propelled by thrust, such as that created by flapping wings. **Glide:** To use air currents and gravity to move over short distances without flapping wings or generating thrust.

VI. Extension Activity Design Challenge 2: 25-45 minutes	Materials	Tips and Adaptations
A Materials for students to make their own animal are provided.	- Animal bodies - Pencils or pens - Stencils - Scissors - Binder clips - Design sheets	Decorate the animals. Name the animals and write about them. Hang the animals in the classroom. Send animals home with students.
B Distribute one animal body to each student, using only the materials in your Classroom box.		
C Instruct students to complete the design challenge. 1. Use the stencils to trace wings and a tail, or create your own designs. 2. Cut out the wings and tail. 3. Construct the animal. 4. Test the animal and adjust for optimal flight.		

BUILT TO FLY
Challenge

DENVER MUSEUM OF NATURE & SCIENCE

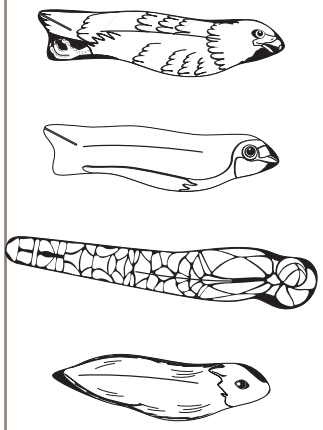
Your team challenge is to design, build, and test a flying animal that will glide across the room **6 feet or more**. Work together and take turns changing your animal for each trial.

1. Choose one animal body.
2. Cut out all the wings and tails.
3. Choose one set of wings and one tail.
4. Bend the wings to your desired angle.
5. Attach a clip to the animal's head.
6. Test the animal in the testing area one team at a time.
7. Measure how many feet your animal glided.
8. Write the number on the Trial Tracker.
9. Repeat steps 3–8 to make a better design. Take turns!
10. Make your best gliding animal for the gliding contest.

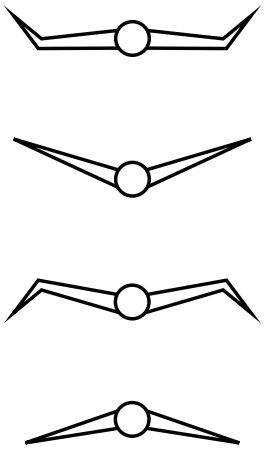
If you finish early, you can ...

1. Build and test another animal using a different body, wing, or tail.
2. Draw a picture of your animal.

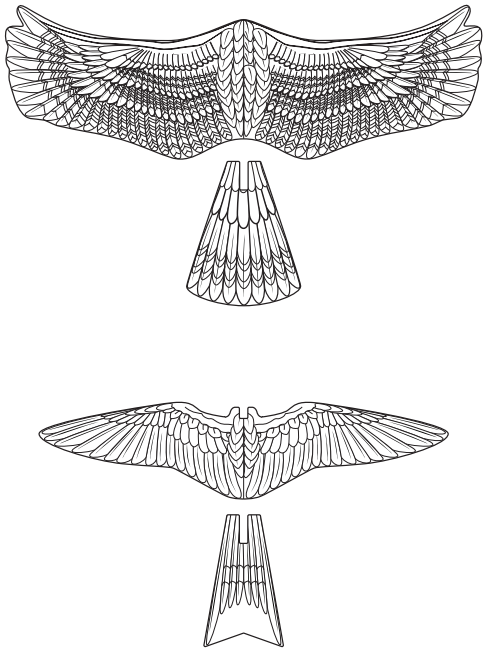
BODIES

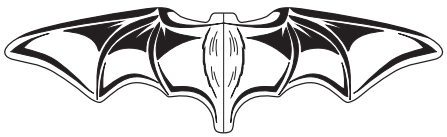


ANGLES



WINGS & TAILS





CREADOS PARA VOLAR

Reto

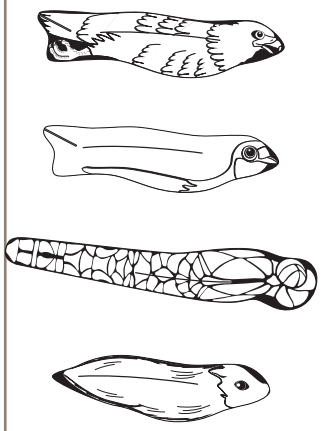
El reto de su equipo es el de diseñar, construir y probar un animal volador que planee por el salón **6 pies o más**. Trabajen en equipo y tomen turnos cambiando su animal para cada prueba.

1. Escojan un cuerpo de animal.
2. Recorten todas las alas y colas.
3. Escojan un juego de alas y una cola.
4. Doblen las alas a su ángulo deseado.
5. Sujeten un clip a la cabeza del animal.
6. Prueben el animal en el área de prueba, un equipo a la vez.
7. Midan cuántos pies planeó su animal.
8. Escriban el número en el seguimiento de pruebas.
9. Repitan los pasos del 3 al 8 para hacer un mejor diseño. ¡Tomen turnos!
10. Creen el mejor animal planeador para el concurso de planeadores.

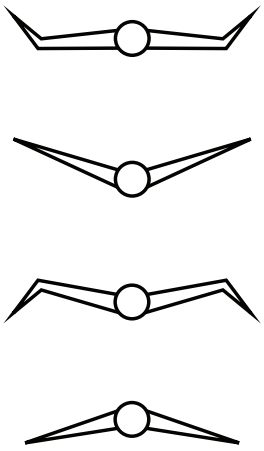
Si terminan pronto, pueden:

1. Construir y probar otro animal usando un cuerpo, alas o cola diferentes.
2. Dibujar a su animal.

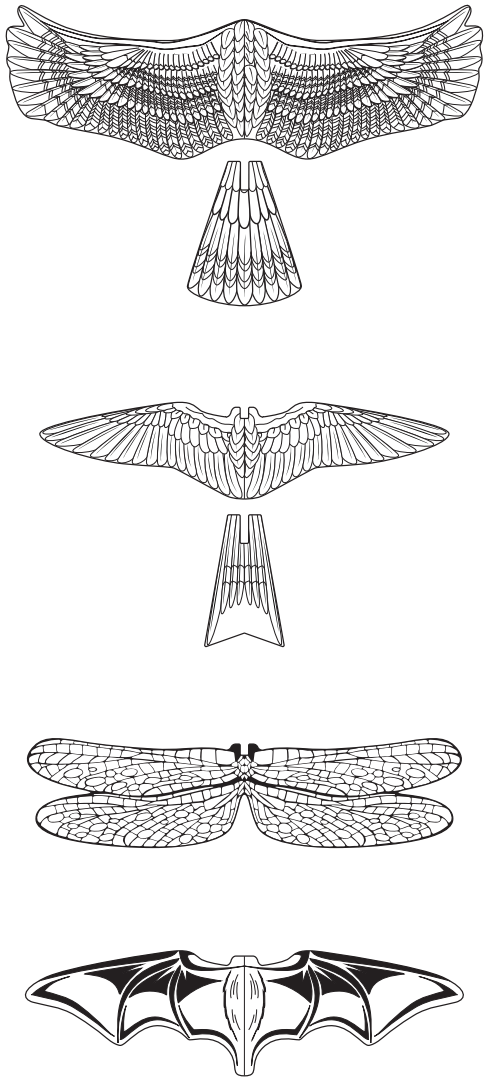
CUERPOS



ÁNGULOS



ALAS Y COLAS



BUILT TO FLY
Trial Tracker

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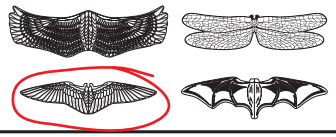
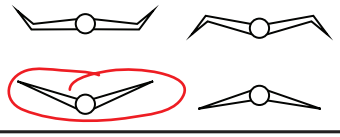
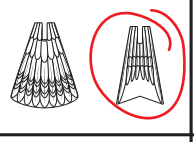
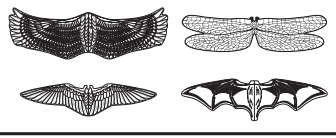
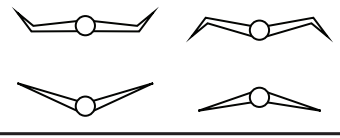
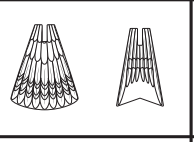
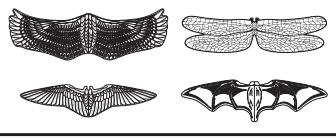
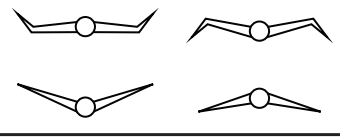
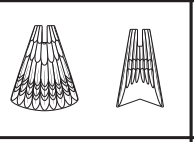
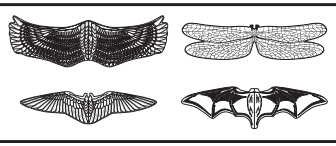
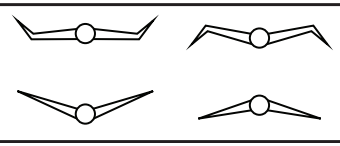
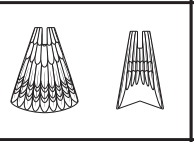
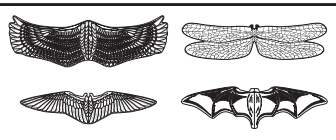
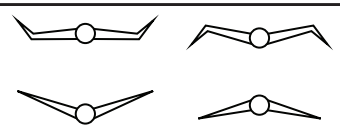
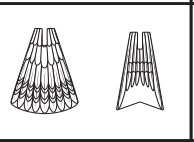
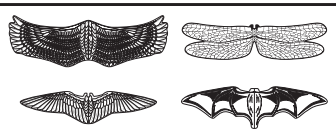
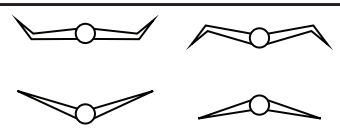
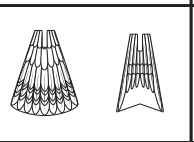
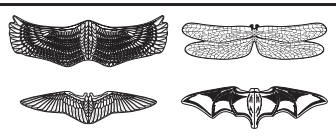
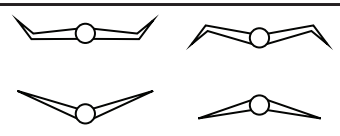
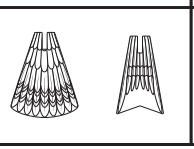
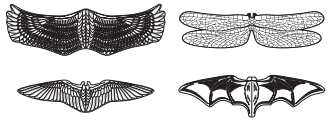
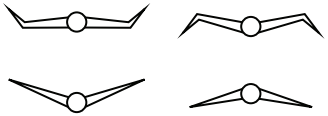
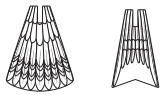
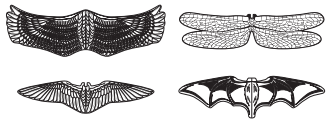
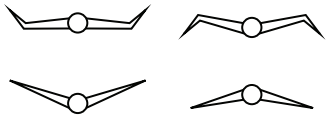
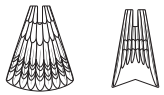
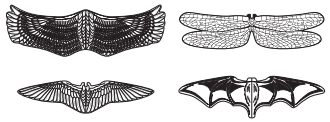
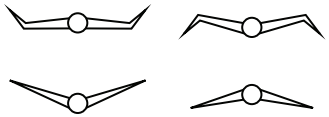
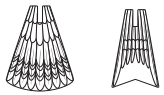
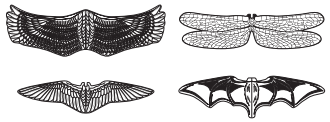
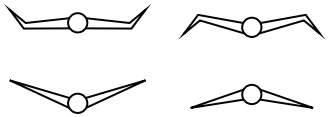
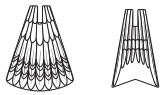
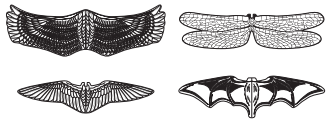
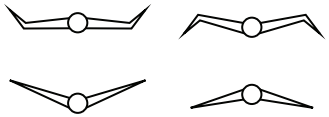
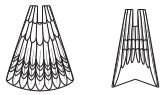
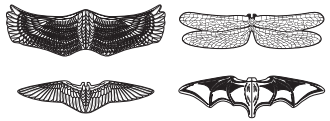
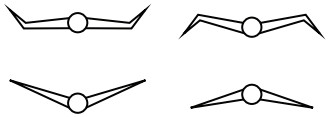
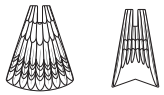
Group Member Names _____

For each trial, circle your choice for wings, tail, angle, and clip size. Write your observations below.

Circle your body type:

Hawk Swallow Dragonfly Bat

Trial #	Wing Type	Wing Angle	Tail Type	Clip Size	Observations (measure and describe)
sample					4 feet Flew in circles
1					___ feet
2					___ feet
3					___ feet
4					___ feet
5					___ feet
6					___ feet

Trial #	Wing Type	Wing Angle	Tail Type	Clip Size	Results (measure and describe)
7					____ feet
8					____ feet
9					____ feet
10					____ feet
11					____ feet
12					____ feet

Reflection: How will you assemble the best glider for the contest?

CREADOS PARA VOLAR
Seguimiento de pruebas

DENVER MUSEUM OF NATURE & SCIENCE

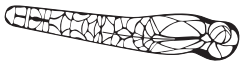
Nombre de los miembros del grupo _____

Para cada prueba, encerrar en un círculo su opción de alas, cola, ángulo y tamaño de clip. Escriba sus observaciones abajo.

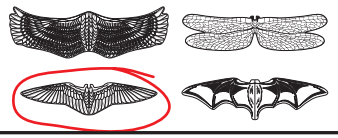
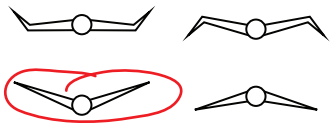
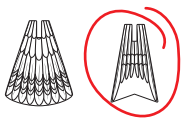
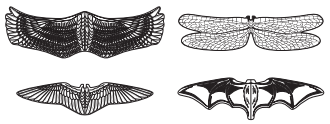
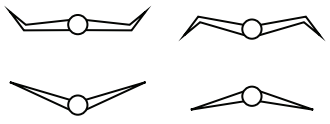
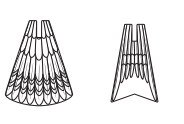
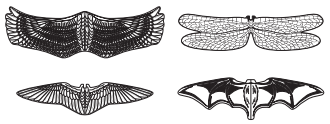
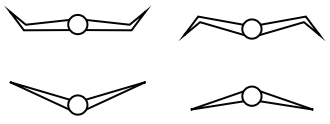
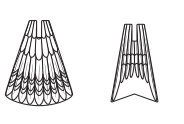
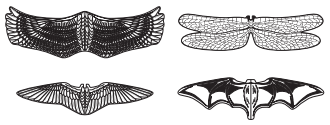
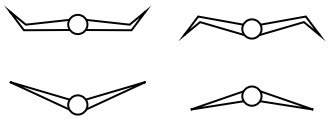
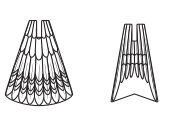
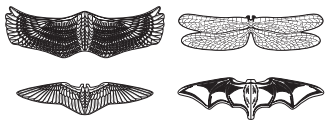
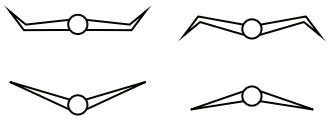
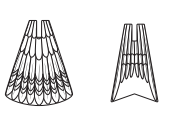
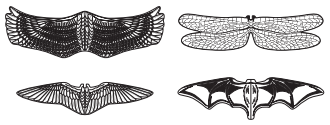
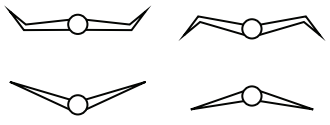
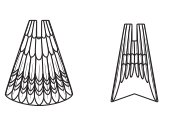
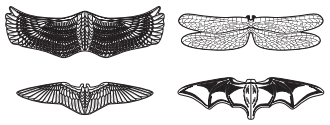
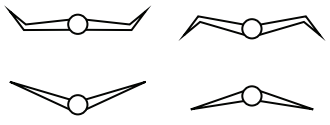
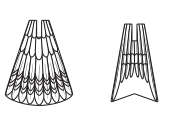
Encerrar en un círculo su tipo de cuerpo:

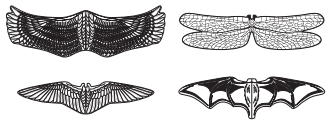
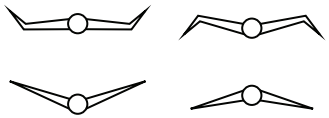
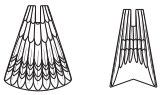
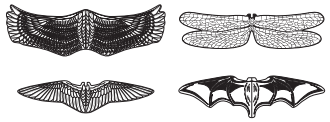
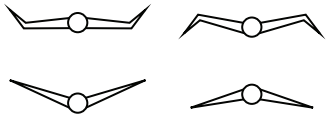
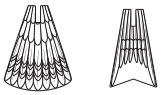
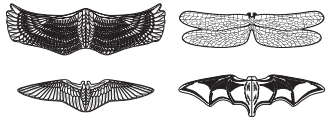
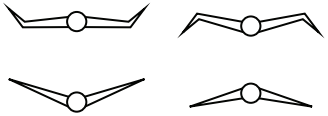
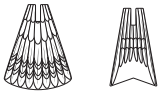
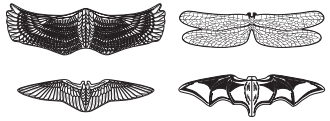
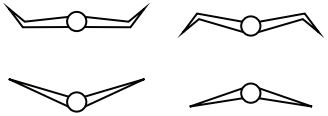
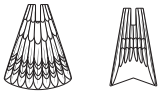
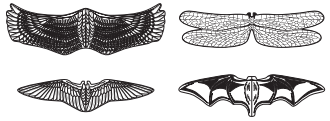
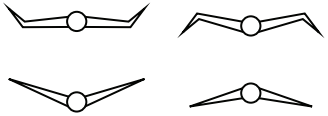
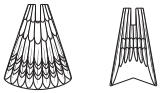
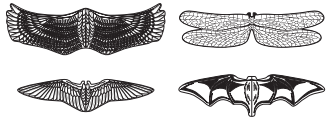
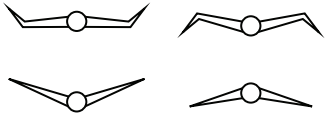
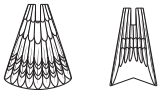

Halcón


Golondrina


Libélula


Murciélago

Prueba #	Tipo de ala	Ángulo del ala	Tipo de cola	Tamaño del clip	Observaciones (medir y describir)
ejemplo					4 pies Voló en círculos
1					___ pies
2					___ pies
3					___ pies
4					___ pies
5					___ pies
6					___ pies

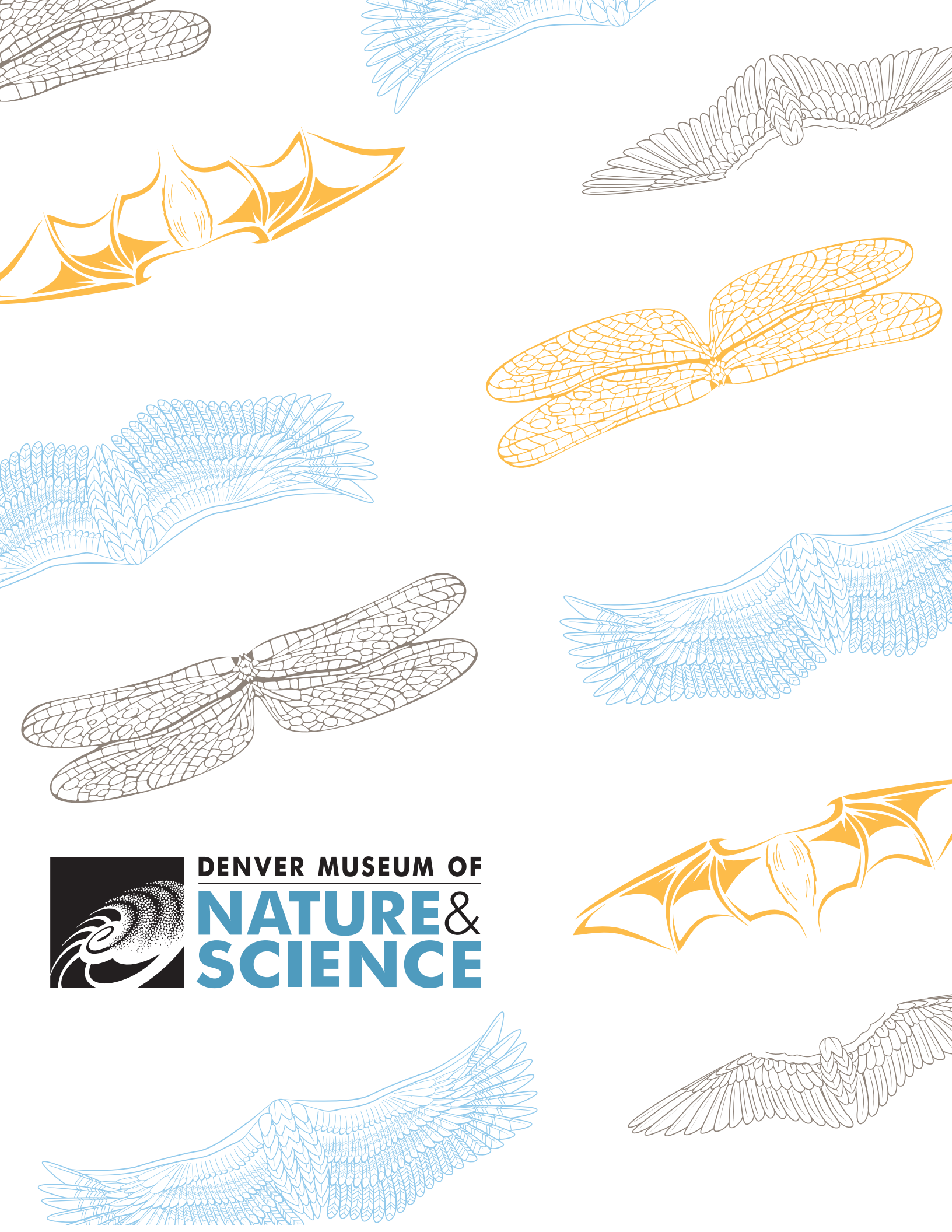
Prueba #	Tipo de ala	Ángulo del ala	Tipo de cola	Tamaño del clip	Observaciones (medir y describir)
7					____ pies
8					____ pies
9					____ pies
10					____ pies
11					____ pies
12					____ pies

Reflexión: ¿Cómo vas a armar el mejor planeador para el concurso?

_____

_____

_____



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