



Texas Alliance for Minorities in Engineering

## 2016 STATE STEM COMPETITION: ENGINEERING DESIGN CHALLENGE

# WRAP IT UP

**Boeing's** newest plane, the 787 Dreamliner, is very fuel efficient because it is made of lightweight composite materials. Carbon fiber is one such composite material. Thin, thin carbon fibers are encased within plastic to create a material that is lightweight, but strong. The fiber is then wrapped around a shape to create a skin. For the 787, Boeing engineers designed and built a machine that wrapped carbon fiber around the fuselage evenly, quickly, and in multiple directions.

**Project Overview:** You have 60 minutes to design and build a human-powered wrapping machine for an airplane fuselage. Each team will be given a fuselage (cardboard tube) that must be wrapped in the fiber (yarn). The fuselage and fiber may not be modified. The wrapping machine must be self-supported, and the wrapping mechanism will be operated by a team-member for 20 seconds. During this time, the fuselage should be covered in a single layer of fiber. To earn maximum performance points, your machine must function for 20 seconds, wrap all of the fuselage with an even layer of fiber with no gaps and no overlapping strands. Teams will be asked to come up with a creative name for the wrapping machine, present the design concept for the wrapping mechanism, explain which orientation they chose for wrapping the fuselage (vertical/horizontal/at an angle) and why, and explain how their wrapping machine would need to change if a fuselage of a different shape had to be covered. Teams will also earn points for creativity and teamwork.

**Awards:** Five teams will win awards for performance and three teams will be recognized for teamwork, design and creativity.

### SUPPLY LIST – CHECK IMMEDIATELY!

You have five minutes to replace any missing items.

Fuselage (Cardboard Tube with masking tape attached) - <b>May be decorated, but cannot be cut or otherwise altered</b>				
RAW MATERIALS, MAY BE ALTERED				
1 cardboard tube	1 sheet cardboard	1 strip masking tape	1 Ziploc bag	1 sheet chipboard
2 paper clips	2 rubber bands	2 dowels	2 straws	2 cups
1 bundle of yarn				
OTHER RESOURCES, MAY <b>NOT</b> BE ALTERED OR USED				
1 pair of scissors	1 pencil	1 set of instructions	1 team number sign	

### DESIGN BRIEF

- Introduce yourself to your team. Decide who will take on the different roles. Each team member must have an assigned role and all roles must be assigned. If your team has less than five members, some team members will serve in more than one role. (Engineering Team Members, page 3)
- Draw your design on the team documentation form. (Design Drawing, page 4)
- Review the scoring rubric and determine how you can meet the requirements and maximize points. (Scoring, page 2)
- Test as you build to make sure the wrapping machine works as planned. (Answer all questions, page 5)
- Be creative and have fun with this project!

### RULES AND GUIDELINES

#### MATERIALS:

- Only the materials provided (and listed in this document) may be used in building the wrapping mechanism.

## REQUIREMENTS:

- The fuselage must be supported in the wrapping machine and cannot be held by team members while it is being wrapped.
- The wrapping machine may be fastened to the table.
- The fiber may be attached to the fuselage at the start of the testing process.
- Team members may not touch the fiber once testing begins.
- At judging:
  - A team member must operate the wrapping mechanism as appropriate.
  - A team member must describe the mechanism that powers the wrapping machine and the part of the machine that will be moved to wrap the fuselage. Only this part of the machine may be touched by a team member during judging.
  - No part of the fuselage may fall/touch the table during judging. Judging ends at 20 seconds or when the mechanism stops working.

## SCORING:

Points are awarded for:

- Length of the fuselage covered – Try to cover the entire length of the fuselage.
- Even coverage – Make sure that the fiber is in a single, even layer throughout.
- Consistent coverage – Reduce the number of gaps between coils.
- Creativity, teamwork, presentation and documentation

## TIME:

- Teams will have 60 minutes to design, build and test the machine.
- After 60 minutes, time will be called and construction will be halted.
- Immediately after time is called, the Structural Engineer will have 1 minute to set the wrapping machine up for judging.
- The Test Engineer on the team will show the judges the wrapping mechanism and identify which part will be moved during testing. No other part of the wrapping machine, the fuselage, or fiber may be touched by team members.
- Teams will have 20 seconds to wrap the fuselage and 1 minute to deliver their presentation to the judges.
- Team members may watch the judging runs from a distance, as specified by the judges.

## SCORING

Judges will score the design, performance and creativity of the wrapping machine as follows:

Design	MAX: 20
Team has a name	0 or 5
The fuselage is self-supported	0 or 5
There is a mechanism that drives the wrapping process	0 or 5
Creativity of wrapping machine	1 to 5
Presentation	MAX: 25
Team has a creative name for their machine	1 to 5
Team can explain design concept for wrapping machine	1 to 5
Team can explain the design considerations for fuselage orientation in the wrapping machine	1 to 5
Team can explain how mechanism would change for differently shaped fuselage	1 to 5
Teamwork	1 to 5
Performance	
Wrapping mechanism worked for 20 seconds	0 or 10
Length of fuselage wrapped	In inches
Number of single-layer fiber coils on fuselage	Count



**NOTE: The completeness of documentation will be used to break any ties.**

## PROJECT DOCUMENTATION

Team Number: \_\_\_\_\_ Team Name: \_\_\_\_\_

Wrapping Machine Name: \_\_\_\_\_

## ENGINEERING TEAM MEMBERS

- **SYSTEM ENGINEER** will verify that the wrapping machine has a name, team members have specific roles, and documentation is complete. She/he will work with the rest of the team to answer the design-related questions.
- **DESIGN ENGINEER** will lead the overall design and is responsible for including the design drawing(s) in the documentation. She/he will lead the team in developing a strategy to maximize points earned.
- **STRUCTURAL ENGINEER** will verify that the fuselage is self-supported, and that the mechanism works without any team member holding/supporting any part, including the fiber.
- **PRODUCTION ENGINEER** will lead the building phase of the competition. She/he will ensure that all the materials and tools provided are considered by the team when building the wrapping machine.
- **TEST ENGINEER** will be responsible for engaging the fiber for wrapping and working the wrapping mechanism at judging.

ROLE	FIRST NAME	LAST NAME	CHAPTER
SYSTEM ENGINEER			
DESIGN ENGINEER			
STRUCTURAL ENGINEER			
PRODUCTION ENGINEER			
TEST ENGINEER			

DESIGN DRAWING(S) AND NOTES

1

2

3

4

5

6

7

8

8 inch ruler

**SYSTEM**

What factors were considered when determining how the fuselage would be placed in the machine? Why did you select the approach that you used?

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**DESIGN**

What was your team's approach to designing the machine? Did it work or were there any revisions?

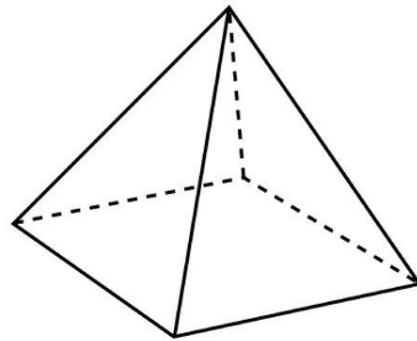
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**ADAPABILITY**

How would you change the design to wrap a pyramid?



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## SCORING SHEET

Team number: \_\_\_\_\_ Team name: \_\_\_\_\_

Wrapping mechanism name: \_\_\_\_\_

METRIC		Judges: Please circle your selection				
<b>DESIGN</b>						
Team has a name		Yes		No		
Fuselage is self-supported		Yes		No		
Machine has a power mechanism		Yes		No		
Machine is creatively built and decorated		1	2	3	4	5
<b>PRESENTATION</b>						
Wrapping machine has a creative name		1	2	3	4	5
Team can explain design concept for wrapping mechanism		1	2	3	4	5
Team can explain fuselage placement/orientation		1	2	3	4	5
Team can explain what changes would need to be made if fuselage was shaped differently, like a pyramid		1	2	3	4	5
Team demonstrates creativity, is enthusiastic and has good overall presentation skills		1	2	3	4	5
<b>PERFORMANCE</b>						
Machine works for 20 seconds		Place ruler on the fuselage. Mark the extreme ends of the wrap and record the two readings here.			Number of <b>single-layer coils of fiber</b> (count). Coils that overlap/cross over another coil in the taped area should not counted.	
		Reading on left extreme	Reading on left extreme			
Yes	No					

## VERIFICATION

\_\_\_\_\_  
Judge's name – please print

\_\_\_\_\_  
Judge's name – please print