The variable we are testing is (circle one)
LENGTH or WIDTH or NUMBER OF BLADES

We will measure our variable in (circle one): INCHES NUMBER OF BLADES

Test (in inches or number of blades)		**Voltage (in Volts)**	**Ranking of Success**
#1			_____place
#2			_____place
#3			_____place

Write a ***claim*****!** This claim is like a rule about how your variable affects the output.

_____

_____

_____

_____

Support your claim with **evidence**! Write how you know your rule is correct. (Use data from the table!)

_____

_____

_____

_____

The variable I am testing is _____.

Variable	Voltage	Ranking of Success
		_____place
		_____place
		_____place

Write a ***claim*** to support what you discovered about the variable you tested.

_____

_____

_____

_____

Provide ***evidence*** from your experiment to ***support your claim***. (Use your data table to help you find evidence of your claim)

_____

_____

_____

_____

Name: _____

Results Sheet

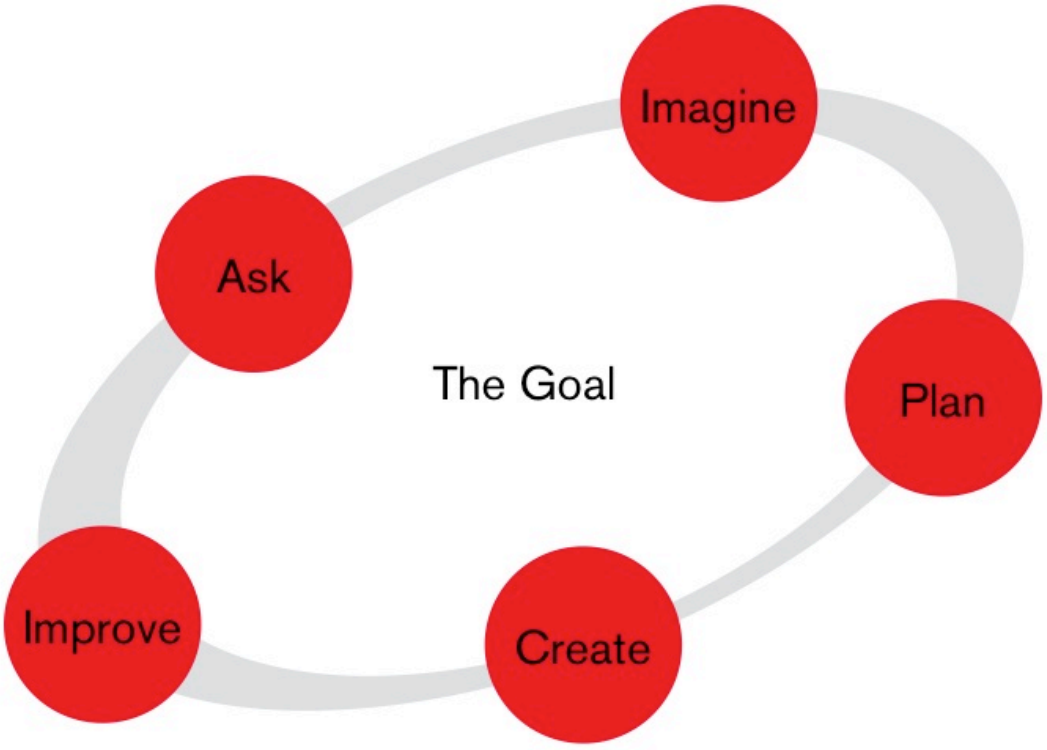
As other teams present, record their claims and any other notes that you have (e.g., evidence to support those claims) in the right column.

Variable	**Claims and Notes**
The **number** of blades	
The **angle** of the blades	
The **length** of the blades	
The **width** of the blades	
The **shape** of the blades (group 1)	
The **shape** of the blades (group 2)	
The **orientation** of the blades	

The Engineering Design Process

We have already been working in the "Ask" step ask we tested variables (like length, width, number of blades, angle, and shape) that affect voltage during our science investigations.

We'll begin today in the "Imagine" step, and we will continue through the "Plan," "Create," and "Improve" steps! (EiE, 2009).



Engineering Notebook Pages

~ Imagine ~

Imagine Part 1: My Imagined Designs: Sketch one or two (individually):

My Idea #1	My Idea #2

Imagine Part 2: Each team member should share her/his ideas. Talk about how you can use different ideas from different team members in your design. Use this space to sketch:

~ Design #1 Plan ~

The team must come up with one idea to test (Design #1) for the Plan step.

Plan Part 1: Make a labeled drawing of your plan for Design #1.

Plan Part 2: Record your plan for each variable for Design #1:

Variable	Our design decision
The number of blades	
The angle of the blades	
The shape of the blades	
The length of the blades	
The widest width of the blades	

~ Create (and Test) Design #1 ~

Create: Build Design #1! Make sure each member of the team helps with building Design #1.

Test: Test your design at the turbine station. Record your average voltage here:

Average Voltage for Design #2	Volts

~ Improve (Design #2) ~

Engineers *always* try to improve their designs when they are going through the engineering design process.

Improve Part 1 - Imagining Design #2: Brainstorm some ways that you could try to make your design better. Make sure you have good reasons for your improvement ideas!

Improve Part 2 - Planning Design #2: Make a detailed plan for Design #2.

Make a labeled drawing of your plan for Design #2.

Record your plan for each variable for Design #2:

Variable	Our design decision
The number of blades	
The angle of the blades	
The shape of the blades	
The length of the blades	
The widest width of the blades	

Improve Part 3 – Creating Design #2: Build Design #2! Make sure each member of the team helps with building Design #2.

Improve Part 4 – Testing Design #2: Test your design at the turbine station. Record your average voltage here:

Average Voltage for Design #1	Volts

~ Reflection Questions ~

1. Were you able to improve your wind turbine design? How do you know?

2. If we had more time, how would you improve by making Design #3?

3. How did you use your knowledge of wind turbine variables when you planned your designs?

Key Questions & Associated Rubric for Assessing Student Learning in the Structure-Function Wind Turbine Blade Investigation & Design

Key Questions:

1. Were students'/groups claims about a structure-function relationship supported by the experimental data they collected?
2. Did students/teams apply structure-function experimental results (from both classes) when designing their first set of wind turbine blades?
3. Did students/teams apply experimental results (see #2) *and* first design test results when designing their second set of wind turbine blades?
4. Could students articulate the way in which the wind turbines transformed mechanical energy to electrical energy (and heat energy)?

Rubric:

Criterion	2	1	0
Quality of **Claim** about Structure-Function Relationship with Supporting Evidence-Based Reasoning	Student can articulate a claim with accuracy and clarity, and can draw upon appropriate evidence to support the claim.	Student can articulate an accurate claim, but has trouble connecting this claim to the evidence.	Student seems to be confused by what the claim is, or the claim is unrelated to the experiment or entirely inaccurate.
Application of Structure-Function Relationships from Experiments to **First Design**	First design contains two or more features that are direct applications from experimental results, including results acquired by other groups.	First design contains only one feature that is a direct application from experimental results.	The first design does not appear to have any features that are supported by experimental findings.
Application of Structure-Function Relationships from Experiments to **Second Design**	Second design contains two or more features that are direct applications from experimental results, including results acquired by other groups.	First design contains only one feature that is a direct application from experimental results.	The second design does not appear to have any features that are supported by experimental findings.
Consideration of First Design Test Results in **Second Design**	Second design directly responds to test results from this team and others' first designs; students can articulate what, specifically, they want to change based on how their first design performed.	Second design may respond to the team's own first design test results, but does not reference others' test results – or – the second design changes are only generally related to first design test performance.	The second design has no relationship to the test results for the first design results for this or any other team.
Articulation of **Energy Transformation** in the Wind Turbine	Student can articulate the way in which the wind turbine transforms mechanical energy into electrical energy. Student also mentions that some of the mechanical energy in the wind turbine and windmill is converted into heat energy due to the moving parts in the turbine.	Student can articulate the way in which the wind turbine transforms mechanical energy into electrical energy. Student does not, however, mention how some of the mechanical energy is converted into heat energy due to the moving parts in the turbine.	Student is not able to articulate how energy is transformed by a wind turbine; input and/or intended output energies are poorly understood.