Your Science Expo Planning Guide - 2017
-for Engineering projects-

Adapted from Science Buddies: http://www.sciencebuddies.org/science-fair-projects/engineering-design-process-guide.shtml

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Step 1: Define the problem you would like to solve

Problems are things in your world that bug you and that need to be fixed! You need to think about:

- **What** is the problem?
- **Who** has the problem?
- **Why** is it important to solve the problem?

Once you have thought about these questions, you are ready to write your problem statement, "**Who** needs **what** because **why**". Fill in the blanks: _____ needs _____ because _____.

Your problem can be real or pretend. For example, in the STEAM lab we work on solutions to this pretend problem: *The little toy animal needs a parachute because it needs to drift down slowly from a height.*

Step 2: Do some background research

For the background research you can:

1. Read a book about your problem to learn more about it.
2. Look at examples of different solutions to your problem or similar problems.
3. Talk to someone you know that is an engineer and get information from them about your problem.

Step 3: Figure out what your success criteria and constraints are

Now that you understand your problem a little better, you are ready to think about how to make a successful solution.

Your success criteria are the things that have to happen in order for your project to be successful.

- *For example, for our "parachute for the little toy animal" project: The success criteria is that the parachute will take at least 3 seconds to drift down and not dump the little animal out of the bucket when it lands.*

The constraints are the things you have to do, materials you have to use, etc.

- *For example, for our "parachute for the little toy animal" project: The constraints are that you can only use a certain amount and type of material (for example, one long string, one cup, and one piece of tissue paper).*

Step 4: Brainstorm lots of solutions and choose the best one

When you brainstorm lots of solutions you:

- Think of as many solutions to the problem as you can.
- Write them down or draw pictures of them.
- Do not judge whether the ideas are good or bad.
- Simply let your brain go crazy generating lots of ideas!

After you have a list of a few ideas for solutions:

- Decide which one solution you think is best to solve your problem and why you think it is the best.

For example, in the "parachute for the little toy animal" problem, you might brainstorm these ideas: 1) a large square parachute, 2) a small circle parachute, 3) a double parachute, etc. Then, based on the materials you can use you might choose a large square parachute as the best solution because you thought it would catch more air as it came down and that the air would slow the parachute down.

Step 5: Design your solution

- Make a list of all the materials you have to work with.
- Think about how these materials can fit together.
- Draw and label a picture of the solution you have chosen.
- This will be your "blueprint" or model that you can look at once you start building your solution.

Step 6: Figure out how to test your solution

- Decide how to test our solution.
- Decide if you need to test different things about your solution.

Some tests might be simple. For example, for the parachute for the little toy animal problem, you simply need to put the animal in the parachute and drop it.

Other solutions might have different things you can test and compare. See "Example 2" in the summary table at the end if you'd like to see a more complicated example.

Step 7: Build your solution and test it!

- Gather all of your supplies.
- Build your solution, or put together your different testing groups if you are going to compare things.
- Test it to see if it works like you thought it would!

Remember, if you are using any tools or sharp objects while you are building, make sure an adult is there to help you.

Step 8: Re-design, re-build, and re-test

Engineers never give up! If your solution didn't work the way you wanted it to, or if it fell apart and completely failed, then you get to think about what went wrong and how to fix it.

- Change your design.
- Fix whatever broke or didn't work.
- Build your solution again.
- Test it again.
- Keep doing this until your project has met all if it's success criteria and constraints.

You can also collect data or information from all of your tests. *For example, for the parachute for the little toy animal problem, your testing data table might look like this*:

Test number	Parachute characteristic	Time it took to fall	Other notes
First test	Large square tissue paper (5 cm wide and 5 cm long)	2 seconds	The string came off - I added more tape
Second test	I made the tissue paper bigger (10 cm wide and 10 cm long)	1 second	The string came off - I used a different tape
Third test	I added 5 more pieces of string to the edge of the tissue paper and attached them to the bucket.	5 seconds - SUCCESS!	The string stayed on
Fourth test	I added 10 more pieces of string to the edge of the tissue paper and attached them to the bucket.	10 seconds - SUCCESS!	I used the stronger tape

Even if your solution worked great after the first test, still try to improve on it!

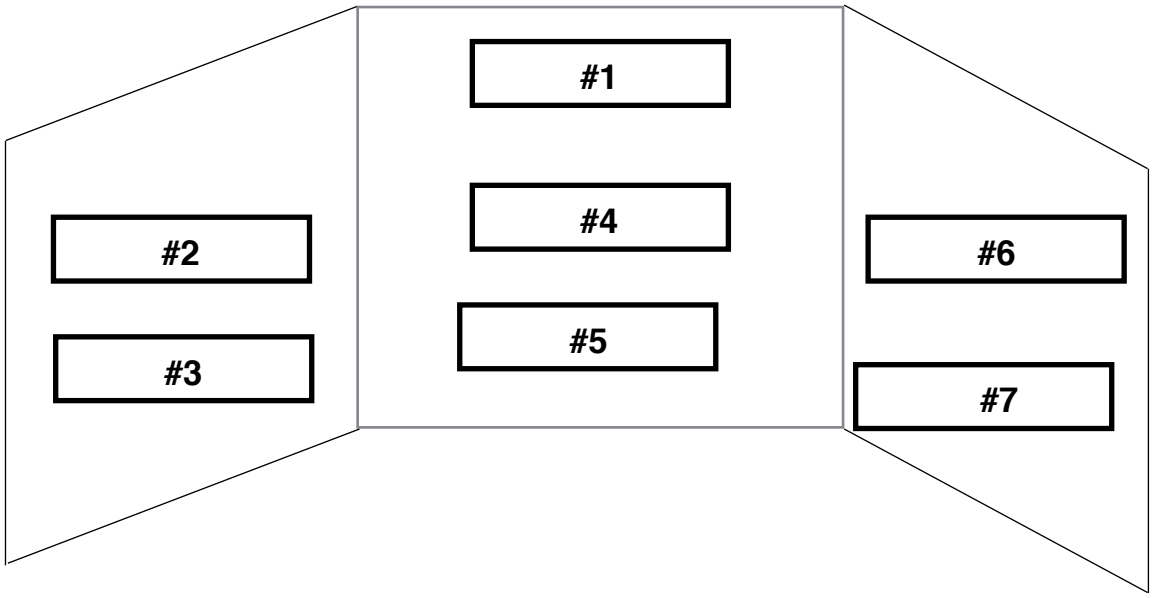
Step 9: Summarize your results

Ask yourself, what worked? What didn't work? What was surprising about your solution? If you did this again, what would you do differently? Write a brief summary of your results.

For example, a brief summary of the parachute project might look like this:
The parachute did not work very well with the smaller tissue paper. The larger paper caught more air and caused the parachute to fall slower. I also had to add more string so that the parachute would make an upside down bowl and that air could get caught under all of it. If I could do this again I would try thicker paper because the thin tissue paper tore very easily.

Step 10: Create your display board

A display board is a great way to share what you learned with other engineers! Below is a basic guide for how to put the different pieces of your engineering design project on the display board.



- #1: Title of your project
- #2: Problem statement
- #3: Success criteria and constraints
- #4: Brief summary of the ideas you brainstormed and why you picked the solution that you picked
- #5: Your solution: a detailed and labeled drawing of your solution
- #6: Pictures and any testing data
- #7: Summary of key findings
- **Put your name, teacher, and room number on the back

Things to remember for your display board:

- Keep it neat.
- Parents, let your kids write it themselves. Let them be creative and use their own words!
- Use a computer if you want, but hand-written is just as great!

Engineering project summary and examples

Step #	Section	Description	Example 1 (pretend problem)	Example 2* (real-world problem)
1	**Define the problem**	A statement about what problem you want to solve, who you are solving it for, and why it needs to be solved.	The little toy animal needs a parachute because it needs to drift down slowly from a height.	I need to keep my lunch cold until lunchtime so that it will be yummy.
2	**Do some background research**	Do a little research on your problem to help you figure out how to solve it.	• Read book about different types of parachutes. • Read a book about how air can be a force that can slow things down.	• Ask friends at school how they keep their lunches cold. • Read about which materials might be the best insulators.
3	**Figure out what your success criteria and constraints are**	The things that have to happen, or the things you have to use or do, in order for your project to be successful.	• The parachute will take at least 5 seconds to drift down and not dump the little animal out of the bucket. • The only materials available are one long string, one cup, tissue paper, and tape.	• My lunch will be 40 degrees F or colder by the time I eat it. • My solution has to be reusable • I have to use whatever I can find at home.
4	**Brainstorm lots of solutions and choose the best one**	Try to think of many possible solutions to your problem and choose the one you think is best.	• A larger square parachute, small circle parachute, double parachute, triple parachute, parachute with wings off to the side. • I chose the larger square parachute with tissue paper idea because I thought it would catch more air as it came down and that the air would slow the parachute down.	• Wrap each item in aluminum foil, line the lunchbox with bubble wrap, make sure it stays out of the sun, bring it into the classroom, put it in the school fridge, freeze everything the night before, put bags of ice in it. • I chose to wrap each item in aluminum foil because through my research I learned that foil radiates heat away from objects and is a great insulator.
5	**Design your solution**	• Think about and decide the best way to build your solution • Draw and label and picture of your solution. • Figure out how to test your solution.	I will create a single layer parachute using a square piece of tissue paper and 5 pieces of string.	I will fold the foil over the food or crumble it around the food.

6	**Figure out how to test your solution**	Think about the best way to test your solution.	• I will put the animal in the parachute and drop it.	• I will create 4 different groups, A, B, C, and D. • I will wrap them in different amounts of foil or crumble the foil around the food.
7	**Build your solution and test it**	• Gather all of your supplies. • Build your solution! • Test it to see if it works like you thought it would.	• Gather the cup, string, and tissue paper. • Build the parachute. • Put the little animal in it. • Test it to see if it works like you thought it would.	Label lunch boxes as Group A, Group B, Group C, or Group D. • Do nothing to “Group A” • Wrap the food in “Group B” in one piece of foil. • Wrap the food in “Group C” in two pieces of foil. • For “Group D” fill all the empty spaces in the lunchbox with crumpled foil. • Measure the temperature of each one in the morning and at lunchtime.
8	**Re-design, re-build, and re-test**	• Change your design • Fix whatever broke or didn’t work • Build your solution again • Test it again • Keep doing this until your project has met all if it’s success criteria and constraints.	Try different sizes of tissue paper and add more string	I will roll the ends of the foil instead of folding it over.
9	**Summarize your results**	A brief summary describing what worked, what didn’t work, what was surprising about your solution, and if you did this again, what would you do differently.	The parachute did not work very well with the smaller tissue paper. The larger paper caught more air and caused the parachute to fall slower. I also had to add more string so that the parachute would make an upside down bowl and that air could get caught under all of it. If I could do this again I would try thicker paper because the thin tissue paper tore very easily.	Wrapping each item with foil maintained the internal temperature at 40 degrees F. Wrapping each item with two or three pieces of foil also maintained the temperature but this won’t be necessary in the future since one piece of foil was sufficient to maintain a cool temperature. Filling the spaces with aluminum foil did not maintain the temperature below 40 degrees perhaps because the food products were free to absorb heat since they were not protected by the foil.
10	**Create your display board**	Create your display board	Ask Mrs. Rattan if you would like to see example.	Ask Mrs. Rattan if you’d like to see an example.

Example 2 adapted from: https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_design/cub_design_lesson01_activity2.xml