



Engineering Design

Engineering is about solving challenges by building something new or repurposing something that is already in existence. Youth love engineering activities because they are hands-on and they can use their imagination. In order to translate the activity into a learning opportunity which can be applied anywhere, including the school day, please select on process, either the Solution Fluency Model or the Inquiry Model to ensure youth understand the process of learning, rather than simply jumping into a task because it is fun and exciting. Be sure they follow the process you select and you can see evidence of each of the steps BEFORE they have the supplies and are randomly trying to meet the challenge without being intentional in their solution finding process.

Transforming Activities Into Learning Opportunities

We believe engaging young people in any task is more than ½ the battle. If they find a task fun, relative, and challenging, we can count on engaging young people. Lee Watanabe-Crockett talks about visiting a classroom and the children were engaged in an engineering project. The challenge was to build the tallest possible tower using only straws and tape, which would be free standing and hold a tennis ball on top. He describes the energy and joy in the room, but when he asked the teacher, “What are they learning?” there was no answer.

Hands-on, minds-on activities can be transformed into learning opportunities by adding a process which can be utilized not only in the current circumstance, but in other situations as well. Watanabe-Crockett suggests the utilization of the Solution Fluency Model which has six steps: define, describe, dream, design, deliver, debrief. In his book, *Literacy Is Not Enough: 21st Century Fluencies for The Digital Age*, he describes the Solution Fluency Model which you can see in the table below. A second format, The Inquiry Model, follows a similar pattern: ask, imagine, plan and organize, build and test, review and revise. This Model will also be further explored in this document.

Both these models require critical thinking, collaboration, communication, and creative problem solving. Adding the words, “Use the Solution Fluency Model” or “Use the Inquiry Model” in front of an Engineering Design Challenge (or most any other assignment) transforms the activity into a learning opportunity. Youth will have the opportunity to practice and learn both process and content.



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Solution Fluency Model

Solution Fluency Model

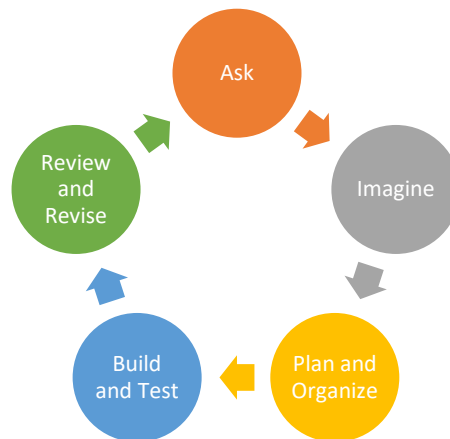
Define	Discover	Dream	Design	Deliver	Debrief
What is the SITNA—what are we supposed to do?	What do we need to know and learn so we can find a fundamental solution to the SITNA?	What do we want the fundamental solution to look like?	What are the steps we will take to make that happen?	Just “Do It” and then debrief against the criteria you established	How will we know we were successful—determined BEFORE delivery?

Step 1, while the first, is also one of the most important steps to ensure the problem which is the focus is the actual problem you are trying to solve. Too many times the failure to define the challenge correctly and in enough detail can lead to false starts and not following the advice of “measure twice and cut once”. **Step 2**, discover, encourages people to determine what they need to know in order to solve the problem. This is about asking questions and wondering and being curious about what they know, what they need to know. **Step 3**, dream, is about imagining what a perfect solution would look like in action—not only look like but sound like and feel like as well. The more detailed the “dream”, the better handle the person or team has on the problem to be solved. **Step 4**, design, is about planning and laying out a road map so not only the team knows what steps they are taking and what the end solution will be, but as an advisor or mentor, you can understand what the team is trying to accomplish. **Step 6**, debrief, has two parts. **Part A**, determining the criteria for success, happens **PRIOR** to Step 5, which is deliver. Criteria for Success are the means by which the team will measure their success, it defines the outcomes and results they will be looking to accomplish. Preparing those criteria in advance of “deliver” is critical, and then once **Step 5**, deliver, is accomplished, moving to **Step 6** to debrief and determine next steps is essential.



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The Inquiry Model consists of five (5) steps. The graphic below depicts those steps.



Step 1, Ask requires the learner to answer each of these questions:

What is the challenge or SITNA (Situation in Need of Attention) we are trying to solve?

What do we believe are the criteria for success in this challenge?

When asked, “What do we already know about ...”, what is our response?

What do we have to work with—supplies and materials?

Is there any real-world application for our solution?



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Marble Roller

The Engineering Design Challenge for December will take two days. It is an iterative project and once the original marble roller is created, youth will add to the design a new challenge. This will require them to revise their plan. Each addition will require youth to go back to the Inquiry Design model and figure out how to incorporate this new addition into the existing model. It is not about starting over, it is about adding to it.

Challenge: Using the Inquiry Design process, create a marble roller which will follow each of the 5 challenges.

December 19	December 27
Create a marble roller which will take a marble from the start of the marble run to end in a cup	Add a tunnel to the original marble roller

Possible Criteria for Success: materials they select, timing for each of the challenges—time from start to finish, incline needed to have marble go up and down the hill, marble does not go off course

What you will need:

Invite youth to bring any recyclable items from home (water or soda bottle lids, plastic containers like for yogurt, other items they think they may need to meet the challenge. Save these items if they are unused to add to your maker space supplies.

- Paper plates—heavier ones are better, multiple sizes
- Card stock
- Glue
- Painter's tape
- Marbles
- Crayons, colored pencils
- Straws
- Scissors (may not be altered)
- Craft sticks
- LEGOS
- Wooden blocks
- Any supply youth bring or request which you can easily accommodate—add to your Maker Space supplies

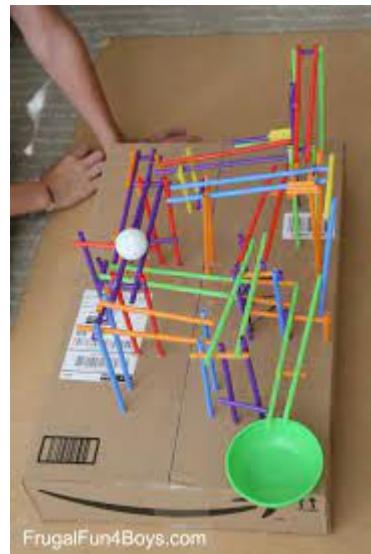


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What you will do:

1. Assemble the teams. Review the Inquiry model which they are to apply in the planning and execution of this challenge.
2. Explain their task is to use the materials they select to create a way to cushion the balloon's fall so it will not pop. Place additional Criteria for Success you select here or have the children self-select the Criteria for Success.
3. Have teams complete an index card with the Criteria for Success.
4. Explain the winning teams will be the teams that can create a solution to meet the Criteria for Success of the challenge.

Below, you will find pictures of Marble Rollers which have been built by youth.





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Debriefing

When the challenge is finished it is important to debrief the engineering process with the youth. The debriefing process begins with a quick review of what was done. Since this is a group project have the group review.

The second step is to reflect on what has been learned. Here are some questions which may help youth reflect.

1. What question did we answer or problem did we solve?
2. How did our work meet the criteria for success?
3. Did the criteria place constraints on materials, time or cost?
4. In what ways did our drawing guide our work?
5. How could it have been more helpful?
6. What data did we collect?
7. In what ways was it the data needed?
8. What other data could we have collected?
9. What did we learn from the data we collected?
10. When we look at our solution compared to the solution of others, which do we think more successfully met the criteria for success and meet any constraints on the solution?

Step three is to determine how the information gained in this Design Challenge can be used during the next one.