

## Problem Solving and Engineering

Good engineers are not the ones who know lots of formulas, but those who can approach any problem in a consistent manner and effectively apply existing laws of math and sciences as well as community rules and regulations to create solutions adoptable to the real life environment.

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### ***Explorer's Guide***

#### **Before You Start**

Your young friend Jack has never sent or received any postal correspondence. However, he decided to mail a postcard to his grandparents. You are the one who can help. Jack wants to do everything by himself. Please write what you will recommend Jack to do so that his grandparents will enjoy his postcard. Think of different situations that could occur in real life and cause delays in this project (e.g., no stamps, bad card selection, incomplete address, etc.)

#### **Learning by Doing**

1. In groups of 2-3 select an everyday problem, such as: boil an egg, change a tire, vacuum a carpet, plant a tree, record a TV show, feed a dog, etc.
2. In a sequence of brief instructions, guide someone who had no experience with the problem you've selected to effectively solve it. Pay attention to "what if" situations.
3. Apply your engineering problem solving skills. In other words, be precise in your instructions and make sure that will work in the world where many things can go wrong.

#### **How Does It Work**

Every problem solving process should consist of these essential steps:

1. Identify what is the final report or product.
2. List all known information that can influence your solution.
3. Designate laws of math and science and other rules applicable to your problem.
4. Identify what additional data is necessary to provide a valid solution.
5. Solve the problem and verify your answer, if possible.
6. Present your solution (final product or report).
7. Identify conditions when your solution may not be applicable.

As an example, let's solve the following problem: "boil three eggs for a potato salad that your mother is about to prepare".

1. Final product – three boiled eggs.
2. There are three raw eggs that need to be ready to be incorporated in a potato salad.
3. The egg itself does not "boil". However, an egg can be called "boiled" if placed in boiling water (100 °C under normal atmospheric pressure) for at least 5 min. It is better to have the entire egg be surrounded with the water. Rapid cooling of a "boiled" egg helps cleaning it afterwards. Boiling water as well as freshly "boiled" eggs are very hot and should not be touched.
4. Locate three raw eggs without visual signs of a "bad" egg. It is unclear whether the eggs should be boiled only, boiled and cleaned, or boiled, cleaned and cut for the potato salad (ask mother). Need to identify some sort of a pot that can contain three eggs completely surrounded with water and some space left above for water to expand and splash when boiling (check around the kitchen). A large pot may be suitable, but will result in the waste of energy and time. Need to identify the source of heat (solve stove operation problem) and the

source of cold water (solve kitchen sink operation problem). Based on previous experience, define proper stove temperature setting, justify presence or absence of the lid, identify the routine to transfer the pot from stove to the sink. Locate a trash container for shells (if needs cleaning), locate a knife and a cutting board (if needs cutting).

5. Fill the pot with proper amount of water, place it on the stove and turn the stove on. When water is boiling, use a spoon to place the three eggs into the water and mark the time. After 5 minutes, turn the stove off and transfer the pot with eggs under cold water (proceed with extreme caution). When the eggs are cooled you can check their status by spinning one of them on a flat surface (raw or undercook eggs do not spin well). Clean and cut the three eggs if needed.
6. Tell you mother that the eggs are ready.
7. In case there are lesser than three good eggs, no operational stove, no cold water, no suitable pot or the house is located at a very high altitude (low atmospheric pressure), the task cannot be completed following your solution. In these situations, an alternative solution should be considered.

### **Additional Challenge**

Try to optimize any routine that you do every day using the engineering problem solving skills.

### **Vocabulary**

- **Engineering** is the discipline of acquiring and applying scientific and technical knowledge to the design, analysis, and/or construction of works for practical purposes.
- **Problem solving** is a form of thinking process when various fundamental skills are integrated to accomplish an existing task.

### **Interesting to Know**

Although an engineer is someone who is trained or professionally engaged in a branch of engineering, in the United States, a person who operates an engine (e.g., railroad locomotive) can also be called an engineer following the origins of this profession.

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