Using the Engineering Design Method

The Engineering Design Method will help you develop successful devices and machines. A little planning will save you time and frustration, especially when working on more complicated projects. To help you get started with the Engineering Design Method, take a blank design sheet (like the one at the end of this document) and fill in the title of your project. Giving your project a title helps you focus on your objective and prevents you from designing a really cool machine that does not ultimately accomplish your goals.

Steps in the Engineering Design Method

- Identify design objective
- Define goals and identify constraints
- Research
- Brainstorm potential solutions
- Analyze viability of solutions
- Choose appropriate solution
- Build
- Test and evaluate
- Revise and repeat

The first step in the Engineering Design Method requires that you state your objective. Suppose you are building an Aquarium Monitor. Your primary objective might be to test the quality of the water, but when you go to choose a sensor, you begin to wonder what is meant by "water quality." Are you trying to keep the water at a certain temperature so that your fish do not get too hot or too cold? Being cold-blooded creatures, fish have trouble regulating body temperature. What about checking whether the fish tank needs cleaning? A Turbidity Sensor could be used to determine how clear the water is. Some species of fish require fresh water, while others require salt water (like the ocean). You could use a Salinity Sensor or a Conductivity Probe to test the salt concentration of your fish tank.

The second step in the Engineering Design Method asks you to identify your goals and the factors that might limit your ability to achieve those goals. For example, should you continuously monitor the tank or just take readings every hour? Should you build a mobile robot or a device that attaches permanently to the tank? How will you protect the electrical components from getting wet? Do you have a single tank or multiple tanks? Are the sides of the tank the same height?

It is often helpful when developing an initial design to draw a process map. A process map is a work-flow diagram used to outline a sequence of tasks that must be performed in order to achieve an objective (see Figure 1). There are three main symbols used when drawing a process map. Circles or ovals represent starting and ending points. Rectangles are used to define tasks. Diamonds are used to indicate decision points. Good decision points have only two possible outcomes: yes/no, true/false, on/off, etc. Symbols are connected by input/output arrows indicating the direction of flow. All tasks (rectangles) should have only one input and one output (arrows), while decisions (diamonds) will have two outputs. It is often helpful when starting a new process map to list tasks and decisions on post-it notes so they can be rearranged or new tasks inserted.

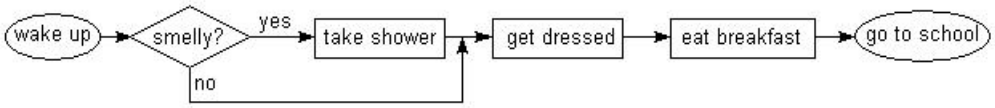

Figure 1

The next step in the Engineering Design Method is to research tasks have been accomplished by other machines. Have you ever built a machine to use a sensor, lower an arm, or display results on a computer screen? Looking back at the way you built or programmed other machines will help you with designing this project. Engineers often rework or adapt previous tasks to implement a new idea. Brainstorm several possible ideas. Make simple sketches to help you visualize your design. Figure 2 shows a typical process map. Show your ideas to your peers or teachers to get their feedback. Often talking things over with another person will help you see additional ways you can accomplish your objective. Are your designs realistic?

Figure 2

Finally, choose your best solution and build it. There are several things to consider when choosing your final design. Do you have enough materials to build it? Must you make substitutions? Is your design structurally robust (sturdy)? Will critical pieces fall off when during operation? How quickly does it execute a task? How much power does it consume? How easy is it to operate? Is it pleasing to look at? Your design does not have to be perfect to start building. Most engineering firms build a prototype when starting a new project. A *prototype* is a draft version of the final product. When you have your machine built, start developing a program to operate it. This stage of the project will require several iterations to test and revise your program and your structural design. Don't be afraid to make modifications if the program or machine is not doing what you expect.

Engineering Design Sheet

Project Code Name:	**Team Members:**
Design Objective	
Design Requirements and Constraints	
Process Map (Work Flow Diagram)	
Ideas & Sketches	
Test Log (Include what did not work and how you changed it)	
Final Design (Include screenshot of Logger Pro Digital Out dialog box and pictures, as necessary)	