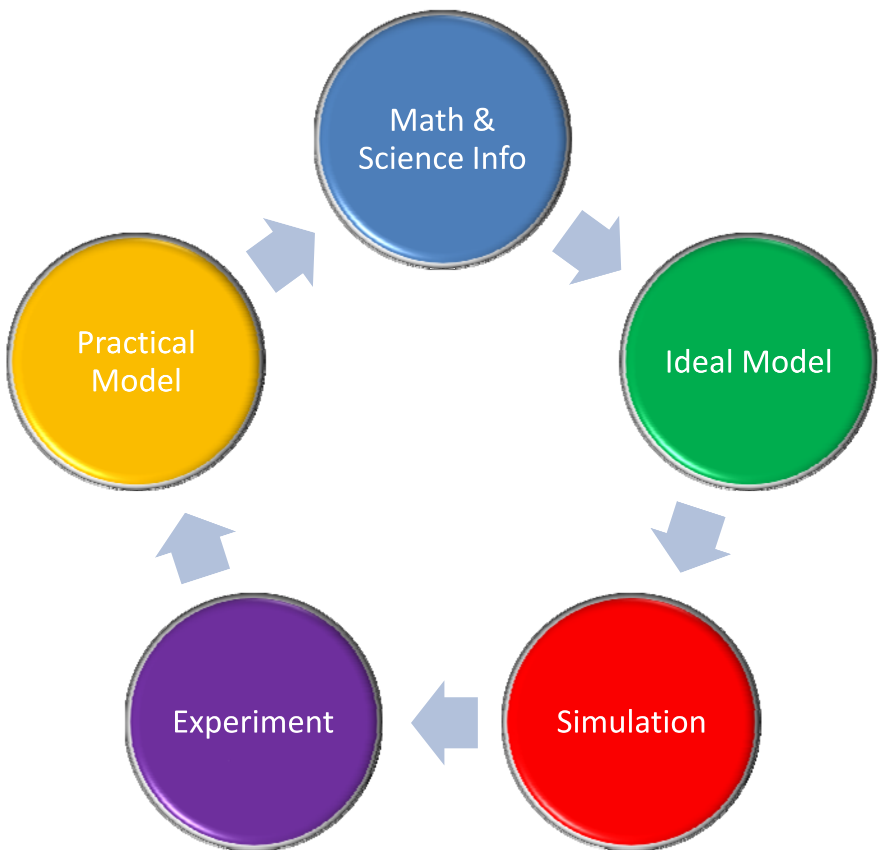
Design Problem: What Light Bulbs to Use?

In this activity, we will go through a basic engineering design cycle to address the use of LED Light Bulbs in the home.

ENGINEERING DESIGN PROCESS

1. Collect relevant basic knowledge from math, physics, chemistry, etc.
2. Develop an ideal model and use the model to predict system behavior (paper and pencil analysis)
3. Apply simulation tools to predict system behavior based on the ideal model incorporating the characteristics of real components.
4. Build and test a prototype system (e.g. experiment with an actual circuit)
5. Develop a practical model and establish its limits of applicability

SIMPLIFIED CYCLE DIAGRAM



STATEMENT OF PROBLEM

Consider the following two questions:

1. Should LED light bulbs available from sources like Home Depot, Lowes, Amazon, etc. be purchased instead of incandescent or CFL bulbs for new applications?
2. Should bulbs presently in use (CFL or incandescent) be replaced by LED light bulbs?

Note that the conditions for the second question are more stringent since it is assumed that the bulbs presently being used have significant lifetime remaining. This question will not follow exactly the same decision cycle for producing a product of some kind as briefly described on the previous page. Rather, we will look at the life cycle of bulbs to see if the overall costs and other advantages of LED bulbs make them an attractive choice for use in the home. We will not consider commercial use directly, but will include issues relevant to commercial use to see if they also may impact residential application.

ISSUES TO CONSIDER

We will not provide a complete list of issues, but some of the more obvious examples should stimulate discussion.

1. Initial cost – this is the usual driver for selecting light bulbs. One goes to the store and finds the cheapest option available and buys it. To judge one bulb against another, it is necessary to have some information that demonstrates equivalency. For light bulbs, the key characteristic is light output. How is this specified?
2. Installation cost – this is typically not a consideration for residential application because we usually change bulbs ourselves rather than hiring someone to do it. However, this can be an issue for the elderly or infirm. For commercial application, this is very significant, because it is necessary to account for the cost of employee time.
3. Operating cost – for the same light output, the three types of bulbs (incandescent, CFL, and LED) use different levels of power. How do we use this information to determine the annual cost of operation?
4. Control – will dimming or other types of controls be used?
5. Quality of light – will the light properly illuminate the intended area with the best color and pattern? Does the light need to turn on and off quickly to be of use?
6. Visual appeal – do the fixtures in which the bulbs are to be used require some particular shape of bulb to look right?
7. Safety and temperature – are some choices of bulbs too fragile or too sensitive to temperature changes to be useful for the desired application?
8. Disposal – are there environmental issues with some bulbs that make it complicated and/or expensive to dispose of them?

Our task is to collect information, develop a model of bulb use, apply the model to see what it tells us, assess the model to see if it needs some improvement especially in ease of use, revise the model to make it practical and useful and then, finally, to apply the model to decide which bulbs to use.