

Architecture 4.411
Building Technology Laboratory
Spring 2004

Assignment 1 Solar Heating and Building Thermal Dynamics

February 4 and 5, 2004

The first phase of our first lab consists of two parts:

1. Mr. Potato Head. Please do the following:
 - Please measure the temperature of a baked (well, microwaved) potato as it cools to room temperature. Take internal temperatures at two locations, one at the center and one about halfway between the surface and the center. Measure room temperature as well. All temperature readings will be with thermocouples. Be sure to prop up your potatoes with toothpicks to minimize conduction losses to the table.
 - Estimate the thermal time constant by estimating the thermal resistance and heat capacitance, and taking the product. Use provided tables that have thermal property data for a number of materials (but not spuds). You will learn about time constants in lecture next week.
 - With the data, estimate the thermal time constant using three procedures, to be discussed in lab next week.
2. Solar building. Please design and construct a passive-solar building, call it an elf house, according to the following specifications:
 - Volume, as measured from external dimensions, between one and two cubic feet (about 28300-56600 cm³).
 - Interior volume of at least 0.2 ft³ (5660 cm³). Interior volume is air space and does not include thermal mass.
 - Windproof. Should not blow off roof. Make it heavy or provide a means of tethering it.
 - Waterproof. Should not dissolve if wet.
 - Sun proof. Walls should not curl up under strong sun. Glazing should not fog up.
 - Windows of any size, material, or orientation you desire.
 - Any type and amount of insulation material and thermal mass, subject to above size restrictions.

- Measurable. Provide a means to mount a temperature logger within your dwelling that will keep the logger dry in the event your house leaks and also keep it out of direct sun.
- Indoor temperature suitable for humans. Aim for 20 °C around the clock, sunny or cloudy. Performance will be evaluated on the basis of deviation of measured temperatures from the target.

While you are free to construct your house entirely on the basis of your design and modeling skills and your physical intuition, please consider making use of provided software to guide you in choices about windows and insulation. We will use several versions of this software throughout the lab to compare prediction with performance. The elf house should be ready next week to be placed on the roof for an initial, one-week test period. Please come to lab next week prepared to finish the construction during the first half of our session. We'll then activate and insert the temperature loggers and place the houses on the roof . We'll also work with the data from the potatoes and continue to work with the software.