Objective: To develop an understanding of the thermal performance and embodied energy factors involved in selecting a wall assembly.

Introduction
Using the personal studio space developed in Project #1, you are asked to make preliminary selections for a typical opaque wall element and a typical glazing element (window) for the studio. Opaque walls are usually (but not always) more or less custom assembled from several components selected by the architect. Windows (or, more generically, fenestration) are usually manufactured objects chosen by the architect. Both opaque and transparent envelope elements must meet design intent/criteria and comply with building codes (often with an energy emphasis).

Christian Norberg-Schulz (Intentions in Architecture) developed an interesting take on envelope design intentions (as barrier, connector, filter, or switch). Recent developments suggest that “transformer” also be added to that list. These possible intents should be considered as you proceed through this project.

Your Assignment

1. (8 Points) Select, describe, and discuss your selection of an opaque wall assembly that you believe would be most appropriate for this studio. The wall may be conventional or unconventional as best suits your values and design inclinations.
   a. (4 points) Provide an annotated wall section (at an appropriate scale) that clearly shows all the components (finishes, structure, insulation, etc.) of your wall and how they are arranged. Annotate this section (hard line or neat freehand) to clearly and specifically identify all the components and their dimensions (6” glass fiber batt insulation … not just “insulation”).
   b. (3 points) Provide an analysis (in the form of a table) that describes your intent (including as per Schulz, see above) for the wall as a whole relative to each of the following forces: wind, rain (liquid water), humidity (water vapor), heat, and solar radiation. Note which component of your wall is most responsible for addressing each of these intents.
   c. (1 point) Discuss how you think your wall assembly will fare relative to minimum energy efficiency requirements and why. Provide a specific performance benchmark: meets, exceeds by 50%, etc. This question is intended to capture your “gut” feeling and should not be researched.

2. (3 points) ‘R-value’ stands for thermal resistance and is a key factor in envelope heat flow. All the R-values in an assembly contribute to heat flow resistance. Assemble R-
value data for each component of the wall assembly presented in Part 1. Clearly indicate the source of all values and note any assumptions (such as material type, density, thickness, etc.). R-values for many components can be found in manufacturers’ literature; for other (generic) materials data will be found in handbooks (such as MEEB). Be sure to include the thermal resistances provided by air films and spaces.

3. (1 point) Another property (U-factor) is used to describe the overall thermal resistance. \[ U = \frac{1}{\sum R} \] (alternatively expressed as \[ 1 / R_{\text{total}} \]). Calculate the U-factor for your wall.

4. (4 point) Embodied energy is the non-renewable energy consumed in the acquisition of raw materials, including processing, manufacturing, transportation and construction. Designers must take this into account when considering the “greenness” of their design. Using the Embodied Energy Coefficient spreadsheet (on Blackboard), calculate the approximate embodied energy for a one square foot section of your wall assembly. Comment on your result.

\[ \text{Volume}_{\text{component}} \left( \text{ft}^3 \right) \times \text{EEC}_{\text{material}} \left( \text{embodied energy coefficient, Btu/ft}^3 \right) = \text{estimated EE}_{\text{component}} \left( \text{Btu} \right) \]

*accurate EE values must take into account local conditions, therefore this calculation is an estimate

5. (3 points) Describe your thermal design intent for a typical window in your studio (reference the Schulz taxonomy). Note the seasonal context (heating season, cooling season, year-round). Select a window product (see the web or manufacturers’ catalogs) that you believe best meets this intent. Clearly describe this product and the source of your information. Discuss how the window product meets your intents.

6. (1 points) List the U-factor, SHGC (solar heat gain coefficient), and VT (visible transmittance) values for your selected window product. Identify data source(s).

Some resources if you have trouble getting started:

Allen and Iano, *Fundamentals of Building Construction*
Brown and Dekay, *Sun, Wind & Light*
Ching, *Building Construction Illustrated*
Means, *Building Construction Cost Data*
Moore, *Environmental Control Systems*
Thallon, *Graphic Guide to Frame Construction*
Stein et al., *Mechanical and Electrical Equipment for Buildings*

[www.realgoods.com](http://www.realgoods.com) (for wood and other renewable building materials)