UNIVERSITY of NOTRE DAME
School of Architecture

DESIGN VI/ ARCH 41121 (& AME 47431)

BUCCELLATO STUDIO SPRING 2015
Environmental Stewardship through Interdisciplinary Research and Design

PROJECT 1A:
CONTEXT, CLIMATE, AND ARCHITECTURAL FORM

ISSUED: JANUARY 14, 2015

The purpose of this exercise is to study and analyze specific ways that climate and context – or, more specifically, the simultaneous consideration of locality, function, resources, program, and culture – influence architectural form.

Each pair of students (ARCH and ME) will select one* of the following traditional architectural prototypes in order to: 1) study, 2) analyze, and 3) describe how external forces, like climate and local resources, and internal forces, like function, building program, cultural traditions, etc. have (had) a profound influence on building form and disposition, including building location, orientation, massing, construction materials, methods, and detailing.

As you will discover in your forthcoming research, thermal analysis, and graphic analysis, these archetypes (among many) remain influential models of bio-climatic design and important examples of the relationship between architectural form and building performance.

1. Yemeni Tower House
2. Traditional Japanese House (*shoin sukiya*)
3. Native American Pueblo (or similar accretive dwelling type)
4. Iranian Atrium House
5. Baghdad Courtyard House
6. Spanish Colonial Plaza Type (or mission complex)
7. *Siheyuan* or Chinese Quadrangle

(4–7: regional variation of courtyard house)

8. New Orleans Shotgun House
9. Inuit igloo & Traditional African or Turkish mud dwelling (in comparison)
10. Underground village type (China or Africa)
11. Croft Cottage (Ireland or Scotland)

* Another, similar prototype may be selected for study, with approval in advance from Professor Buccellato

Deliverables:
ARCH: The research and graphic analysis of the prototype(s) studied should include a thorough description of the *specific* and normative architectural "responses" that are demonstrated by the architecture either to amplify or mitigate the effects of the prevailing external and internal forces/ influences, like climate and context (as expanded above), and influence the performance of the building. These "responses" may include, but are not limited to the following:

- Building location
- Orientation
- Organization
- Materials
- Protective devices (wind, sun)
- Passive methods (heating, cooling, ventilation, and lighting)

ME: This research and graphic analysis must be accompanied by an analysis of the thermal performance of the prototype to generate an estimate of the interior air temperature in the prototype for at *least* two conditions (though more conditions could be analyzed). Note that:

- The structure (size, orientation, etc.) must be defined through discussion with your ARCH collaborator. Reasonable estimates that are properly rationalized should be used rather than detailed structural information.
- It is your responsibility to define the thermal system and the boundary conditions. These must be explained and justified in the deliverable document. The two cases could be two extreme conditions (winter/summer) or one extreme and one 'normal' condition, or a transient analysis.

Your successful completion and presentation of Project 1 requires the following (at minimum):

Documentation and Analysis Drawings:

Single Sheet (18 x 24) monochrome line drawing **on vellum or Mylar**

- *Analysis* to include the following graphic components (minimum) **:
  - Building Plan(s)
  - Building Section
  - Building Elevation
- *Diagrams* to illustrate climate/ context forces on form, essential thermal/energy parameters, and estimations of the thermal/energy performance of the prototype
  Additional possible drawings:
  - Axonometric
  - Perspective
- *Bibliography*

** Please refer to plate one of the case studies in Precedents in Architecture: Analytic Diagrams, Formative Ideas, and *Partis* (Roger H. Clark and Michael Pause) as a guide for the **layout** of your analysis drawing; in other words, as a guide for the orientation, organization, and clarity of your sheet (not necessarily content).

Technical Memo (five page maximum, follow required format)
Detailed description of thermal analysis approach, assumptions, results, and discussion.

Prototype Selection, by Teams: BEFORE Friday, January 16 at 1:15 pm

DEADLINE -PROJECT 1 (PRESENTATION DRAWING): Friday, January 23 at 2:00 pm
PROJECT 1 PIN-UP: Friday, January 23; 2:00-3:30 pm
DEADLINE FOR PROJECT 1 TECHNICAL MEMO: Monday, January 26 at 2:00 pm

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THERMAL ANALYSIS TIPS

- In general, this thermal model should be at the *engineering scale*, which means that it can be solved with pen and paper or a simple code (*e.g.*, Matlab) rather than requiring more complex numerical schemes. Thus, it is highly recommended that the approach be to use a lumped capacitance type approximation and energy balance as well as effects such as 1-D conduction. The limitations of these approximations must be pointed out (*e.g.*, if the body fails a Biot number analysis), but that does not mean that more complex approaches are required. Similarly, a steady state approximation may also be used, but also should be noted if not explained.

- It is highly recommended that the students take a progressive analysis approach starting with the simplest analysis and adding subsequent complexity in order to refine the answer. For example, an initial analysis may simply *assume* reasonable values for all heat transfer coefficients, and subsequent iterations might improve on these estimates by using a correlation to arrive at the heat transfer coefficients. Another example may be a model that initially uses black body assumptions for the radiation analysis and then the subsequent model assumes gray bodies. One of the advantages of taking this approach to analysis is that it inherently helps dissect the relative roles of different heat transfer modes on overall thermal performance.

- The deliverables should be directed toward different audiences corresponding to your different 'bosses'. The pin-up drawing analysis should give a high level explanation of what were the primary driving forces on the thermal performance (wind conditions, sunlight, etc.) and focus more on the results and their interpretation. It should be organized in a way to effectively communicate the thermal performance of the prototype to your *non-engineering* boss – the overall project director. The technical memo should include the details not included in the pin-up drawing, such as the governing equations, important assumptions, estimates for various parameters (convection coefficients, radiation properties, conductivity, etc.), and interpretation of the results. It should be organized in a way to effectively communicate the thermal performance of the prototype to your *engineering* boss – your immediate supervisor who can effectively assess the quality of the work.

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