OBJECTIVE:

Cantilevering is a form of spanning which refers to the act of projecting or extending beyond a support or boundary. This project will both literally cantilever and intellectually extend from the essential concepts of structure, to examine the relationship between strength, stiffness and form. Through a rigorous testing process, you are to develop a structural system to support a given design load. The project’s goal is to construct the most beautiful, effective, stable, and ductile system that meets the performance criteria—it is not simply to build the strongest structure. Each submission will be load-tested to failure to examine failure mechanisms and ductility as well as to determine the quantity of undesired excess capacity.

ORGANIZATION:

This project is divided into four components:

a. Proposed support system (25%) In Lab, April 26th
b. Load testing and final review (75%) In Lab, May 10th

PROPOSED SUPPORT SYSTEM: due at the end of Lab, April 26th

Trusses may be considered ‘vector-active’ assemblies. Bona fide ‘trusses’ or ‘vector-active’ assemblies maintain their ‘vector-only’ or ‘axially-loaded’ status based on the following set of assumptions, which ensure all individual truss members act either in tension or compression:

- Individual members of a truss are straight. (In other words, bowing, curving, folding, and camber is not allowed for any single segment.)
- Each member of a truss must be pin-connected.
- External loads acting on a truss only occur at member joints.
- Centerlines of members and loads align with center of joint (often referred to as the node or panel point, or in some cases the work point).

In full-scale built projects, the realities of construction and economics often transgress one or more of these rules. For example, a continuous member for top or bottom chords is not unusual. Such an assembly is, technically speaking, not a ‘pure truss’; however, it is possible to use the above noted simplifying assumptions to arrive at a sufficiently accurate analysis.

For this support system, each of you is to propose a structure with defined hierarchies of support and bracing. Each project must define primary, secondary and tertiary tectonic levels. For example, how is the lateral system defined? What role do diaphragms play in bracing a structure’s lateral system from buckling? What braces each diaphragm? How is diaphragm rigidity achieved? The response to these questions will help you understand the complexity inherent in many structural systems. You should consider un-braced length and slenderness, both locally and globally as to what role it plays in structural performance.
For the last fifteen minutes of Lab, April 26th, pin up your proposal for the following:

- A vertical cantilever structure that at a minimum defines the spatial intervals shown to the right and meets the following requirements:
  
  o Construct a stable structural model at 1/8” = 1'-0” scale.
  
  o Base or ‘Ground’ is made of 1” thick nominal plywood (glued together two pieces of ½ plywood is okay)
  
  o Structure or armature is constructed using:
    
    ▪ Plastic drinking straws
    ▪ Glue or epoxy
    ▪ String
    ▪ Foam core or cardboard (may only be used for horizontal diaphragms -- also okay to use straws to make diaphragms)
    ▪ Straws/strings must have continuity through the diaphragms.
  
  o Wood screws may be used to connect the armature to the ‘ground’.
  
  o Structure is to be designed to support a 12½ pound load acting horizontally at a height of 252'-0” above the base. The direction of the applied horizontal load will be decided by your lab instructor. (ie. if your structure is directional, we may decide to load in the weak direction)
PROPOSED SUPPORT SYSTEM: during Lab, April 26th
This lab session is intended to provide a work session with individual project feedback prior to final production and ultimate testing the models. The primary concern will be to understand the structural logic and hierarchies and to ensure that there are no instabilities in the system (as this would subvert any potential to support load). You should be ready to discuss how you are designing for the specific 12½ pound load and are not providing too much or too little strength to achieve this performance. Preliminary testing prior to May 10th is highly recommended. We will pin up our ideas on the wall for a discussion during the last fifteen minutes of class.

Due May 10th:

Final Structural Model: Your final model to be tested should be ready for testing at the beginning of class.

Analytical Component: Calculate the approximate internal force for your two most heavily loaded members one for tension and one for compression. You may use the method of sections, method of joints, the graphical method, or an approximate method based upon the moment diagram for your structure. This last method may be the most time efficient. We’ll discuss calculations further in lab, specifically touching on rapid strategies for these computations.

LOAD-TESTING AND FINAL REVIEW: during Lab, May 10th
For our final lab we will celebrate by load-testing your structure and determine if there is sufficient strength and stiffness in your structure to support the prescribed design load. We plan to test each structure to failure in order to verify its ultimate strength. Each project will be evaluated based on the following criteria and requirements:

- Structure must be stable! (ie. it must have diagonal bracing members)
- **STRENGTH CRITERIA** Structure should support a 12½ -pound force applied horizontally at a height of 252'-0" it should begin to fail in a ductile manner once this forced is exceeded.
- An upper diaphragm must be constructed so as to provide a connection point to attach a rope for loading.
- **STIFFNESS CRITERIA** The upper-most diaphragm should not deflect more than 96'-0" while supporting the design load.
- Evaluation of supporting performance will be based on a standard deviation from the design load. (ie. too strong is just as incorrect as too weak!)
- Repairs may be made in lab and models retested--if time permits
- Submit your analytical calculation (one 8.5" x 11" page max)