Wood Cantilevers

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To know one material intimately is to gain an understanding of its potential and its limits; this experience defines a framework for understanding all materials. An architect requires a knowledge of materials that is both logical and intuitive in order to effectively exploit and appropriate the materials in the process of design innovation. These are timeless abilities~sensibilities that are fundamental to understanding all materials, traditional and emerging.

The presented project is conceived for third-year undergraduate architecture students and is delivered through a required structures course. This laboratory project challenges students to explore the nature and potential of wood structures through the design, construction and development of a six-foot cantilever with a back span of eighteen inches. The cantilever condition is derived from the generative conditions of natural wood, as found in tree branches and trunks. The project conditions and objectives mandate resistance in contrast with the natural condition, which resolves force through dissipation. Students' designs are to resolve one linear concentrated load imposed in accordance with specific physical conditions and material constraints within a sound conceptual framework. The students are encouraged to consider structural design to be a dialectic negotiation between the realms of force, form, material and connection.

This project is executed by teams of three students and is delivered in two iterations. Each iteration consists of a design component and a construction component. The design component requires students to formulate a structural hypothesis through conceptualizing, modeling, diagramming and drawing. The construction component requires students to negotiate the material and fabrication processes required to realize the design intention. The class collectively investigates wood structure in three distinct systems: glu-lamination, stressed skin, and light framing. Each team investigates one system for the duration of the project and is charged with establishing a strategy for resolving the load conditions of the project comprehensively from the essence to the detail. Each design must exploit and render legible the opportunities and constraints inherent to its respective wood system. The projects are evaluated through destructive testing in a group forum where the principles of structural behavior, design concepts and structural performance are reviewed and discussed through a chalkboard. The concurrent testing and review of the three systems encourages the development of attributes specific to each team's interpretation of their respective system.

The realm of structures is a wonderland fertile with qualitative as well as quantitative architectural value. Computational analysis is essential to developing an informed conceptual understating of structures, but most architecture students find it formulaic and abstruse. To be effective, computation must draw upon an experience based understanding and knowledge of the physical nature of forces and materials. The wood cantilevers project is administered concurrently with lectures on the physiology and nature of wood as a material, wood structural systems, and with computational exercises related to the sizing of wood beams, columns and connections. The course elevates the traditional role of the laboratory project, from being an exercise in verification to being the central learning vehicle.

a priori **BEHAVIOR** iterative

an **OSCILLATION** between the **RATIONAL** and the **EMPIRICAL:** **design** as **hypothesis | making + destructive testing** as **sensorial experience**

empowering **STUDENTS** with **CREATIVITY** in the **TECHNICAL REALM: EXPLORATION** of **structural behavior** through **structural design**

doing something **ONCE** is for **EVALUATION** **LEARNING** requires an **OPPORTUNITY TO IMPROVE** to **know one** material is to **know many**

A POSTERIORI design **LEARNING**

WOOD CANTILEVERS

This laboratory project challenges students to explore the nature and potential of wood structures through the design, construction and development of a six foot cantilever with a back-span of eighteen inches. The cantilever condition is derived from the generative conditions of natural wood; tree branch and trunk. The project conditions and objectives mandate resistance in contrast with the natural condition which resolves force through dissipation. Students' designs are to resolve one linear concentrated load imposed in accordance with specific physical conditions and material constraints within a sound conceptual framework. The students are encouraged to consider structural design to be a dialectic negotiation between the realms of FORCE, FORM, MATERIAL and CONNECTION.

The class collectively investigates wood structure in three distinct systems: GLU-LAMINATION, STRESSED SKIN, and LIGHT FRAMING. Each team investigates one system for the duration of the project and is charged with establishing a strategy for resolving the load conditions of the project comprehensively from the essence to the detail. Each design must exploit and render legible the opportunities and constraints inherent to its respective wood system.

This project is executed by teams of three students and is delivered in two iterations. Each iteration consists of a design component and a construction component. The design component requires students to formulate a STRUCTURAL HYPOTHESIS through conceptualizing, modeling, diagramming and drawing. The construction component requires students to negotiate the material and fabrication processes required to realize the design intention. The projects are evaluated through DESTRUCTIVE TESTING in a group forum where the principles of STRUCTURAL BEHAVIOR, DESIGN CONCEPTS and STRUCTURAL PERFORMANCE are reviewed and discussed via CHALKBOARD. The concurrent testing and review of the three systems encourages the development of attributes specific to each team's interpretation of their respective system.

The WOOD CANTILEVERS exercise is administered concurrently with lectures on the physiology and nature of wood as a material, wood structural systems, and with computational exercises related to the sizing of wood beams, columns and connections. The course elevates the traditional role of the laboratory project, from being an exercise in verification to being the central learning vehicle.

GLU LAMINATION

Glu-lamination fundamentally involves the configuration of small pieces of high quality wood such that their composite nature and potential is greater than that of its constituent components or of a solid sawn section of a comparable size. The process of laminating these small pieces with adhesives affords the designer and craftsperson certain opportunities; curvature and cross-sectional transformation is fertile with technical and aesthetic potential. Challenges lie in the flexible limits of the material and the continuity of grain relative to the concentrations of tensile stresses.

STRESSED SKIN

Stressed skin structures utilize plywood surfaces to embody and resolve membrane stresses. Stressed skins cover the spectrum of monocoque and semi-monocoque systems. They are conducive to uniform loads yet the project conditions mandate a concentrated load. The principal challenge lies in translating the concentrated load into a uniform load, raising issues related to the structural role of the frame (often necessary for fabrication) and the integrity of continuous surface to surface edge connections. Most well made projects fail due to shear generated by concentrated loads.

LIGHT FRAMING

Light framing can be interpreted to be the use of a few highly customized pieces formed for specific forces and connections as one can find in the design of wooden aircraft; requiring students to utilize a wide variety of wood working tools and processes. Light framing can also be interpreted to be the configuration of many standardized pieces into a custom structural form as it occurs in the building industry; the economy of standardized components is offset by the challenge of developing connectors that can adapt to the diverse geometries and conditions of the project.