not white

diversity in beginning design education

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Section-Plane Construction from Cube Design:

Three Dimensional Modeling of Sections through a Cube Designed with Solids and Voids as a Tool for Understanding the Importance of Sections in Design

abstract

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The boundaries of a square can hold many two dimensional areas of space whether defined by the geometries of the square itself or by external forces. The boundaries of a cube therefore can hold many three dimensional volumes of space. To explore the possible variations within the volumes of space the designer must think, visualize and draw in sections cut through the space.

For the beginning architecture design student this understanding of three dimensional space is one, if not *the* most important design concept they must begin to explore. To consciously "think in section" is crucial for a successful designer.

This exercise begins with the design of a 3 inch wooden cube (from Jonathan B. Friedman's Volume exercise in Creation in Space) containing solids and voids using one inch cubes and 3 inch by ¼ inch rods. From this exercise the student transforms the cube into a 3-dimensional exploration of sectional planes. A series of nine sections are cut through the cube and drawn at 2:1 scale. These nine sections are cut three horizontally, three vertically and three verticals perpendicular to the previous verticals. Section cuts are chosen to communicate the most information as possible about the original cube design. This project enables students to mentally imagine planar sections or walls cutting through the solid masses of their earlier cube designed of solid pieces. They must think inside the space of the solids.

All nine sections are then constructed into a 3-dimensional planar model with the same relationships as the original cube. Each student designs in study model using chipboard to explore the diverse methods of joining the intersecting planes and methods of support for the "floating planes" which result from the solids surrounded by space. Each student designs their own method of joinery for the many intersecting planes. The diversity of approaches varies depending on the students experience in model-making such as airplane modeling as a child, construction, shop work and background experience in areas such as sewing and sculpture. This joinery becomes very important depending on the material chosen for the final model. Various materials and connections are explored with a partial full-scale materials study model experimenting with numerous connection types, some being able to be disassembled and others permanent. Students using no permanent connections or joinery are able to disassemble the planes and correct mistakes before the model is completed.

Models have been constructed a diverse range of materials such as various papers both homemade and store bought, soft and hard woods, metals such as copper, aluminum cans, Plexiglas, foam board, Bristol board, stained glass, plastics, craft mesh, hog wire and even sculpting clay. A challenge is created as the student tries wrapping their mind around the puzzle of connections and joinery.. The lack visible means of connection allows the pure reading of the intersecting planes. This project is a challenge in both design assembly and model craftsmanship. A two-point perspective is then drawn of the final model reinforcing graphic skills learned earlier which drawing only the cube.

The dialog between the intersecting sectional planes creates even more volumes of space bridging between the masses of the original cube. This project enables students to explore the possibilities of designing architectural space with the section plane model as the genesis for creating space.

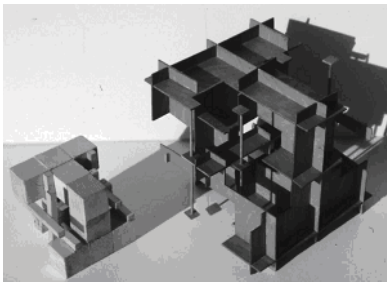


Figure 1 - Wood 3 inch cube with wood section-plane model.

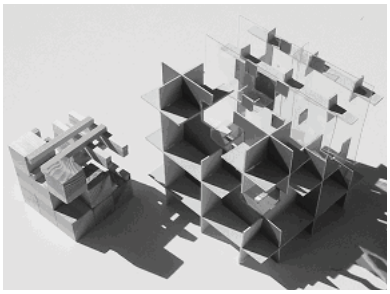


Figure 2 - Wood 3 inch cube with colored board model.

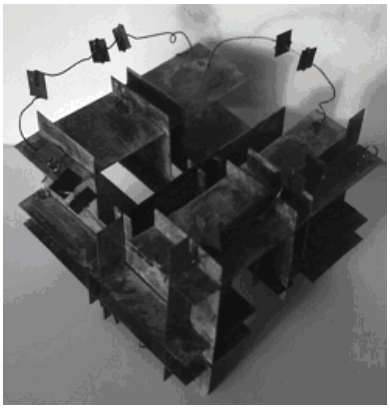


Figure 3 - Welded copper model with brushed patina finish.

The first design studio for the beginning architectural design student introduces a varied design vocabulary, an understanding of space, systems of order, and graphic communication skills used in the field of design. As part of the design process, students are introduced to creative and critical thinking skills. It is important that beginning design students are given the opportunity for the development of perceptual understanding and the visualization of ideas. We must give them the chance to analyze opportunities, develop and evaluate alternatives, and conceptualize form into three dimensions. Our challenge is to establish a diverse environment and a yearning for inquisitiveness, imagination and discovery.

For the beginning design student, the understanding of three dimensional space is one, if not *the* most important design concepts they must begin to explore. To consciously "think and explore spatially" is crucial for a successful architectural designer. This design studio exercise challenges the student to enter and "move through" a design of *their* making in order to read the spaces that already exist and explore the potential for further spatial development. To "*think in section*" is the goal. Sections convey the underlying conceptual strategies and ideas that are most clearly evident in a successful design. This project also addresses the issues of creating structure, materiality and connections.

Geometries within architecture can be very seductive with their endless possibilities. The geometries of the square include right-angles, axial symmetry, proportional ratios, curves, circles and triangles among others. The edges of a square can contain many two dimensional areas of space whether defined by the geometries of the square itself or by external forces. The edges of a cube therefore, can hold many three dimensional volumes of space. These geometries of the square and cube engage the student in dealing with the relations, properties and measurements of the solids, surfaces, lines, points, planes and angles that are all a part of architectural space. To explore the possible variations within the volumes of space, the designer must think, visualize and draw in sections cut through space.

This first semester first year design project begins with an exercise designing a cube, initially derived from Jonathan B. Friedman's Volume exercise in *Creation in Space* (Dubuque, Kendall/Hunt, 1989). The students design a 3 inch cube which is implied by balancing the use of the wood solids and spatial voids. This dialog between the solids and voids creates volume. The model is composed of 12 one inch wood cubes and 12 wood rods, 3 inch by ¼ inch long. The students manufacture the cubes in the model lab from standard scrap lumber which they have planed and cut to size. This is typically the first introduction and use of tools and equipment in our model lab.

For this project, Section-Plane Construction, the student transforms the wood cube of solid and void spaces into a series of three-dimensional sectional *planes,* cut through the cube. The nine total sections are cut as three horizontal slices and six vertical slices, three which are cut perpendicular to the first three verticals. The locations of the cuts are chosen to communicate the most information possible about the original cube. Typically, cuts are taken at the center of each cube or rod, allowing for the planes to intersect at center points. Section cuts are never taken through joints, but always through solids. Students draw these sections at 2:1 scale with pencil on trace paper, pocheing what is cut through as solid. These poched planes become the basis for the three dimensional models which now become six inch *implied* cubes. These sections are seen as a series of planes, showing where the cut was taken, much like showing the slice or "kerf" of a saw blade through wood solids. As a result, the "slice" becomes the material plane through space, that was previously occupied by a solid volume. (See Figure 1.)

It is through the act of "making" that the meaning of these sections begins to coalesce into understanding. These nine sections are constructed into a 3-dimensional planar model maintaining the same relationships and proportions as the sections through the original cube. The use of different colors or patterns for each section poched in the drawing, and then continued with color or pattern in the study model helps the student differentiate which pieces belong to which sectional cut when model construction begins.

The first study model constructed is usually the intersecting planes of one solid

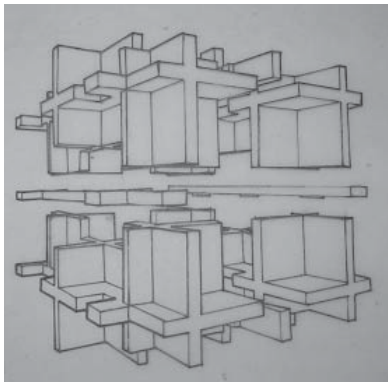
small cube. Next, one total vertical plane intersecting the horizontals and other verticals is explored, before the whole. Finally, as all the larger pieces come together, the *puzzle* of supporting the small "floating" planes becomes a challenge. These "floating" planes are the result of section cuts through solid rod pieces which may not be contiguous to other pieces and therefore have no means of support. Cutting a section through the same piece, in a different direction, can often solve this problem. The explorations of structure, both in stability and support, and the exploration of materiality, dealing with connections, become by products of the exercise. (See Figure 2.)

This project is a challenge both in design assembly and model craftsmanship. The adeptness and proficiency of various skills such as measuring, cutting, assembly, joining and finishing are explored and developed. The models must be built to convey the beauty of the design but also have structural stability. Having no top or bottom, the models must be capable of being handled and displayed in various positions.

Investigations into a diverse assortment of construction materials are explored with several small study models. Final models have been constructed of wood, various metals (copper, brass, aluminum) as well as wire, Plexiglas, foam board, Bristol board, handmade papers, stained glass and even sculpting clay. Several projects have combinations of materials and colors for the different planes. The choice of materials, finishes, color variations, opaqueness or transparency within the design, can create a sense of order and new relationships throughout the model. A challenge is created as each student puzzles and explores the intersections, methods of joinery and connections for these planes. (See Figure 3.)

The problem solving of joinery depends on the materials chosen for the model. The level of sophistication and diversity which occurs often relates to the student's previous experience in *building things*. Construction or carpentry experience, model making as a child, shop courses and background experience in areas such as sewing and sculpture have an effect on the materials choice, joinery and craftsmanship. Solutions such as stitching in textured materials, to welding and riveting in metal have been used as well as the typical glued or pressure fitting connections. Many use no glue and are able to disassemble and reassemble the planes, allowing for changes or corrections to be made. Often the lack of a visible means of connection allows for a purer reading of the intersecting and bypassing planes.

Once the final model is completed, drawing is another communication skill explored. First the student completes freehand sketches, and then constructs a two-point perspective drawing. The use scale, line weights, line quality and color are graphic skills developed. The students are challenged to create the same sense of depth of space with two dimensional skills that they were able to achieve with three dimensions. (See Figures 4 and 5.)



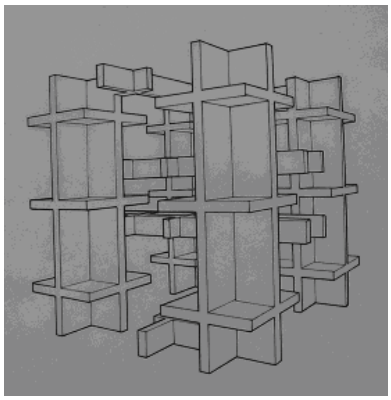


Figure 4 and 5 - Perspective Drawings of Section-Plane Models.

Photographs are taken in daylight to cast shadows and enhance the shaded areas, revealing the play of light and dark. Models constructed of a transparent medium are able to capture the wonderful play of light *through* the various planes and shadows that are cast. (See Figure 6 and 7.)

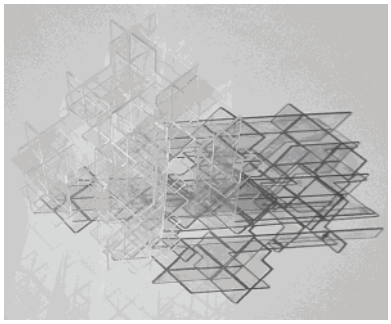


Figure 6 - Transparent Plexiglas model with shadows cast on sur-

The dialog between the intersecting planes creates even more volumes of space bridging between the masses of the original cube. This enables students to explore the possibilities of designing space, with the section plane model as the genesis for creating space. While creating space, that limitless area in which all things exist and move, students learn to define the boundaries of that space.

This exercise gives the beginning design student a strong sense of accomplishment and pride in their work. Verbal presentations and critiques of the models, drawings and design development sketches are vital for the conclusion of this project. Self confidence is the key to challenging students to the endless inventive opportunities ahead of them.

This first semester design project has many further reiterations and possible avenues to explore. Often, students want to continue development, by adapting a human scale and creating a true architectural design, but as with many projects and works of art, they may never be *finished*, they just stop in interesting places. To deepen the mystery of what the student thinks they know, or all of us for that matter, is the role, challenge and joy for the

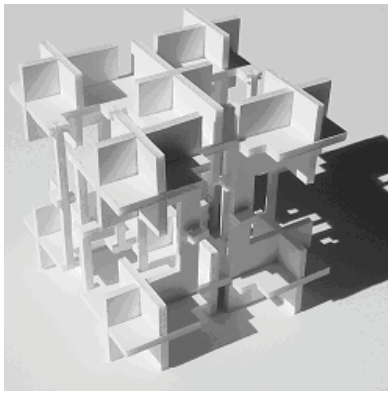


Figure 7 - Section-Plane model of foam core board.

true educator.