Interweaving Culture and Form: Weaving as an Analogy for Architecture

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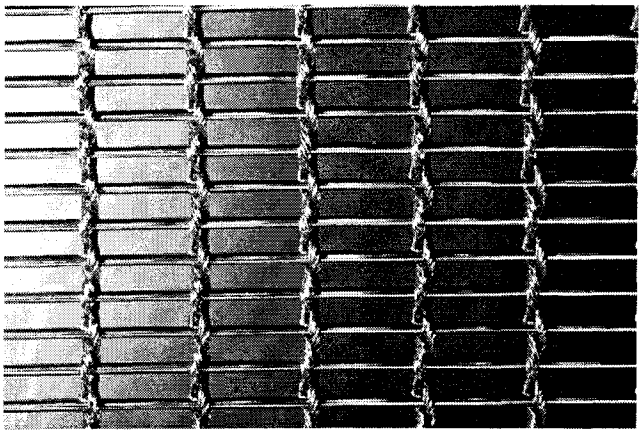

Fig. 1. Woven Metal Fabric, National Library of France, Dominique Perrault

PREMISE

As professionals become increasingly specialized, architects must continue to operate as generalists. Although more specialized today, their breadth of required knowledge is still widespread and expanding. As digital communications shrink the global village, architects must become increasingly culturally literate on a worldwide scale. An architect's knowledge ranges in scale from the macro of global environmental issues to the micro of soil geology. It spreads across disciplines from the subjective realm of aesthetics to the objective sciences. While an expert in none, an architect must draw from such diverse disciplines of anthropology, art, business, construction, ecology, engineering, geology, history, law, physics, psychology, sociology, and so on. But how does an architect retain and process all this information? To architects these are not separate fields existing on their own. Rather, I propose, each is a thread in a complex matrix of information from which they must glean and weave together the strands relevant to each project.

Weaving, as a practiced craft, has been a common cross-cultural phenomenon for thousands of years. While patterns and techniques differ between cultures, the basic craft of weaving can be found in most. Because the concept of weaving is so accessible, it is often used as an analogy to describe various systems in our world. It describes fabrics of different races, religions, beliefs and values all co-existing. It is used as an analogy for the natural world to explain the delicate web of climates, plants, animals and organisms that depend on each other. In terms of sociology we read about the urban fabric with its interweaving of people, neighborhoods, homes, work places and institutions. It is an apt analogy for how systems overlap and work together to create a harmonious living environment, as well as the possible destruction caused by the breaking of a single element or strand in the fabric. The fact that we exist as individual members of a cohesive team also applies directly to the building industry. A look at the range of trades composing any building design team will clearly demonstrate this. Architects, as generalists, have traditionally occupied the role of supervisor for a building project. They are responsible for coordinating and 'interweaving' the interests of the related consultants, owners, occupants and contractors to produce a meaningful work of architecture.

By investigating the similarities between weaving and architecture we begin to see overlapping concepts. Architects and weavers both recognize the need to look beyond surface appearances in the process of designing. In the same way architects realize that quality design is more than skin deep, weavers understand the quality of a textile is dependent on the structure of the weave and not just the visual appearance of its fibers. As Anni Albers, a weaver from the Bauhaus, revealingly states:

> *"Surface quality of material, that is matière, being mainly a quality of appearance, is an aesthetic quality and therefore a medium of the artist; while quality of inner structure is, above all, a matter of function and therefore the concern of the scientist and engineer. Sometimes material surface together with material structure are the main components of a work; in textile works for instance, specifically in weavings or, on another scale, in works of architecture"*[1].

In their common need to relate a design's physical properties to its aesthetic implications, weaving and architecture share a trait

worthy of further exploration.

The history of textile use in architecture is broad. The most visible form of woven material today is tensile membrane structures. However, rather than concentrating on a single physical material, I chose to focus on the process of weaving as an instructional analogy in the design process. For example, in architectural design this analogy can inform the interlacing of ideas, people, place, space and construction. The comparing of weaving and architectural design from the analogical/conceptual viewpoint constitutes the basic premise of this paper.

Fig. 2. *The First Walls Were Woven* from 'Socrates' Ancestor'

WOVEN CONSTRUCTION

Before applying the weaving analogy to abstract notions of space or culture, it is helpful to first understand the history of physical woven construction. In terms of architecture, weaving in its fabric form has been used in tent structures for thousands of years. However, the history of planar wall construction also has weaving in its roots. The earliest building walls were likely woven. In 1851, Gottfried Semper published his theory of the *Four Elements of Architecture*. Basing his theory on the form of the primitive hut, he categorized its construction into four basic elements of *Hearth, Roof, Mound* and *Fence*.[2] For the last of these, the *Fence*, he proposed that the walls of ancient houses were not made of stone but rather of hanging cloth or woven 'mats', thus suggesting the idea of the wall as a textile hung off of the supporting structure, similar to the curtain wall today. To construct these walls, branches and grasses of differing sizes were interlaced to form a supportive structure that in colder climates was covered with a weather resistant shell of mud and/or leaves. Without this additional protective layer the cold and damp climate would be allowed to penetrate. This type of construction, generally known as waddle and daub, was common up to about a hundred years ago with the woven support always hidden. Even our closest modern relative to the woven wall, plaster on lath, has been generally replaced by gypsum board construction. The permeable nature of the exterior woven wall is a major reason why we do not see more buildings utilizing this technique. They are best adapted to tropical climates where the temperature is relatively constant and airflow is encouraged. However, woven screens still work well as barriers to sunlight and vision. When combined with a sealed envelope they make an effective system against the elements. The advent of new materials and joining methods has shifted the focus of construction away from what Kenneth Frampton calls "wet" techniques such as masonry.[3] The current trend of "de-materializing" glass walls into separate "dry" systems of structure, enclosure and shading/climate control opens up new opportunities to appropriate the woven wall. The desire to admit an abundance of light without excessive overheating or ultraviolet damage creates one role for woven screens as shading devices in exterior walls. They can also be extremely effective as vision screens to increase privacy or hide undesirable views.

STUDIO PROCEDURE

This paper describes the use of the weaving analogy as an instructional technique in my fourth-year architecture design studio. The impetus for the course arose through the prominence of the textile school in our university. Previous collaborations with the school have dealt with the production of fabric structures. However, I wanted to engage its people and facilities to investigate how the two disciplines also share other ideas about construction and form. Architecture students see what is involved in the production of woven structures and textile students see the possibilities of weaving with non-fibrous materials. The studio follows one program throughout the semester divided into four topics of weaving and architecture that range from the literal to the theoretical. Though the studio course requires a linear format, the analogy excels as a reminder that design is a non-linear process that requires constant re-evaluation of site, program and construction throughout a project. The weaving model, in its capacity to intertwine varying elements and patterns, demonstrates the need to consider the many possible combinations of major and minor influences on the design. Following are the descriptions of how each of the projects employed the weaving analogy.

THE STRUCTURE OF WEAVING

As students typically have had little experience with the process of weaving, the first project introduces them to the basic patterns and techniques involved. In this phase they work directly with members of the textile school. A general goal of this design studio is to examine how materials and methods of construction influence and direct the design process. Weaving provides an excellent example of how materials and patterns of textiles have a critical influence on the outcome. The specific goal of the project is to study the characteristics of actual weaving through the empirical, hands-on *making* of an object at full-size. Weaving a textile by hand reveals much about the tactile qualities of the materials not evident by sight. In the same way, creating a piece of architectural construction by hand reveals qualities of the materials not evident in representational drawings. Architects have become separated from the tactile

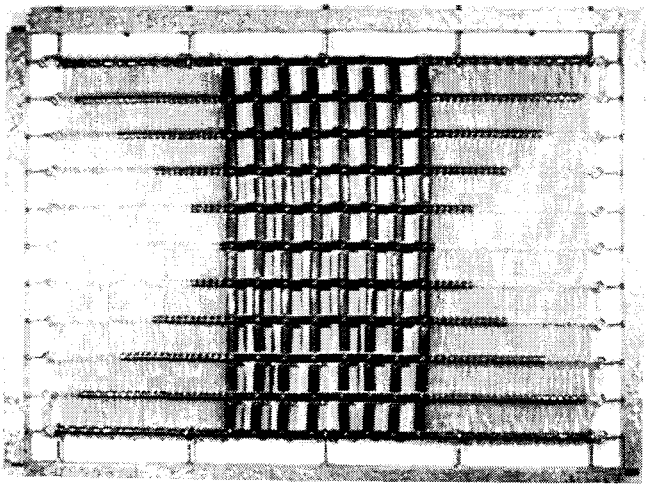

Fig. 3. Woven Sun-screen (by Richard Kelly and Cody Falco)

experience of construction. "Our materials come to us already ground and chipped and crushed and powdered and mixed and sliced, so that only the finale in the long sequence of operations from matter to product is left to us; we merely toast the bread".[4] Both architecture and weaving students need to understand the physical properties of materials that they normally represent by electronic pixels on a screen. To test this idea, students divide up into groups of two to design and build a three-foot by four-foot sun-screen panel as a prototype for a shading device. They are first given a tour of the textile school's weaving facilities where they watch both hand and power looms in action. They see first hand how the process of production and the structure of the weaving inform the final appearance; how plain, twill, satin or tri-axial patterns produce varying results. Professors from the textile school act as consultants and reviewers for the architects as they design their screens. Instead of typical fibrous materials, they are required to use materials associated with building construction such as wood, metal and plastic. This places the project in-between the realms of architecture and textiles (more akin to basket weaving) which means neither the architect nor the weaver is an expert but both can contribute equally. While students utilized basic layout drawings to confirm overall dimensions, many of the design decisions were made during construction by adapting available hardware and materials to meet their intentions. Properties of the materials dictated many of the decisions. For example, many materials proved to be too stiff for weaving and had to be replaced. The project required at least one of the materials to be metal so for most of the students it was their first hands-on experience with cutting, drilling and welding steel, copper or aluminum. The empirical knowledge about the properties of metal gained by physically working it can not be matched by representational means. Through trial and error they learn how an initial concept can change over time as issues of real construction influence and affect revisions in the design. They understand how materials used for weaving are critically dependent on the manner in which they are assembled.

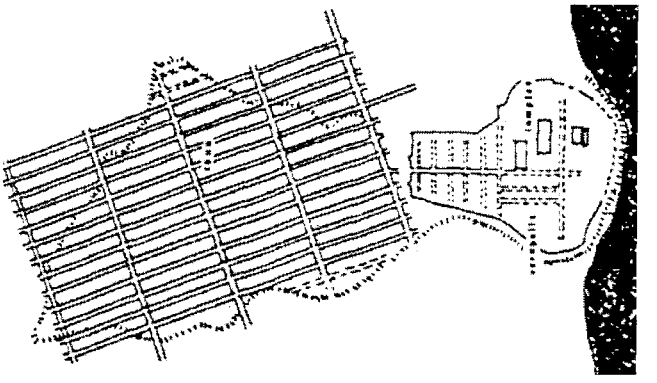

Fig. 4. Greek City Plan from 'Socrates' Ancestor'

REWEAVING THE CONTEXT

This is the initial phase of the major building design project where students utilize concepts of weaving to analyze the urban space around their site. It is generally accepted the orthogonal geometry of American city plans originally derived from Greek city grids. However, these may have been derived from the structure of woven cloth. The tightly woven, right-angled patterns of cloth were seen as "harmonious" by the Greeks. This pattern may have been applied to the colonial cities as a way to create a "harmonious" and recognizable living environment in a foreign and hostile land.[5] As mentioned previously, there are many diverse influences that shape an urban fabric. While the physical objects such as buildings and streets are more obvious, invisible psychological and social factors can often have great influence. Students investigate the various patterns of their urban site to seek out weaving analogies. For this phase they analyze the contextual factors that influence a site and its people to determine a site design strategy. The location for the project is chosen in a prominent area of the city where the urban fabric has become "unraveled" and lost its sense of an urban place. The students must investigate its history, analyze the various factors that remain and propose a way to re-stitch their site to the fabric of the city through circulation patterns, built-form, and landscape design. Three groups each present an analysis of either the environmental, social or legal influences on the context. Each presentation is constructed in three dimensions and interlaced with the others to present a collective analysis. Time constraints limit the study of the urban fabric analogy to the immediate context. However this exercise provides an introduction to the way in which external factors impending on a site must be balanced and interwoven to recreate a harmonious urban environment.

WEAVING SPACE AND THOUGHT

With the introduction of the specific building program, many new requirements are added to the project. This broad range of seemingly unrelated conditions demonstrates the need to develop a strategy to integrate all the influences of a design.

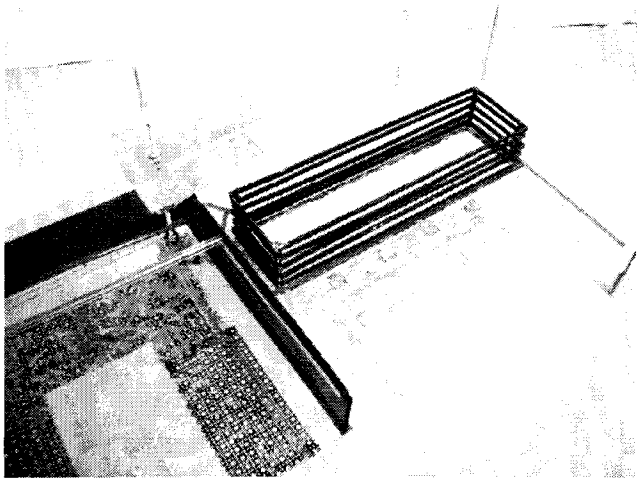

Fig. 5. Group Site Analysis Model

The weaving analogy is presented as a unique method to integrate the "Three C's" of a design: *Context, Culture* and *Construction. Context*, as previously examined, refers to all the climatic, social/cultural, legal and especially intuitive aspects of a site. *Culture* refers to the human behavioral aspects of a project such as the functions of the program as per occupant needs, the history of its people, and local traditions as a source of regional identity. *Construction* encompasses the basic concepts for the materials, structure, assemblies and services of physical building that influence the direction of initial design ideas. Having previously examined the context, students now concentrate on programmatic aspects to determine not only the relationships of spaces but also, more importantly, how the building can meet the diverse needs of the people who will use it. While the *Construction* aspect will be scrutinized in the next phase, students now develop a basic tectonic concept from the possible materials and structure allowed by legal code constraints and spatial requirements of the program. By sorting through these jumbled 'threads', they begin to establish priorities en route to developing a design concept. Just as woven cloth has major and minor threads and patterns, the students will compose a conceptual textile of ideas to integrate the various influences. The weaving analogy performs as an instructional vehicle for describing the non-linear design process.

The concept is then expanded into three-dimensional spaces that reveal the interwoven experience of architectural space and construction. They examine the overlap of light and shadow, solid and void, all within the aspect of movement in time. As Steven Holl states: "When we move through space with a twist and turn of the head, mysteries of gradually unfolding fields of overlapping perspectives are changed with a range of light-from the steep shadows of bright sun to the translucence of dusk."[6] Students need to understand a space is not static but continually changing as one moves around and through it, something rarely evident in orthographic drawings. They study complex interior spatial conditions by first establishing hierarchies between public and private, service and served space, vertical and horizontal circulation, bearing and non-bearing construction, as well as how they overlap, parallel and penetrate each other. Space is approached as a three-dimensional cloth pulled apart to reveal changing sizes, shapes and rhythms of space and structure. To illustrate this, the main product is a physical model of the structural system that reveals qualities of the spaces contained within. Too often models present the external form of a building without revealing the critical space inside. Therefore, students make templates from current floor plans that can be mounted to board and woven together with threaded rod 'columns' and basswood 'bearing walls'. By allowing the student to see inside the building, these "woven" study models reveal spatial and structural issues not always evident on computer or physical massing models. Threaded rods also allow for quick revisions by adjusting the nuts up or down and replacing floor plates to create new spatial conditions. As mentioned earlier, in both textiles and architecture, the inner structure plays an integral role in the overall form. Thereby through this exercise, students now begin to see the overlaps evident in the spatial, organizational, and especially the structural systems of a building.

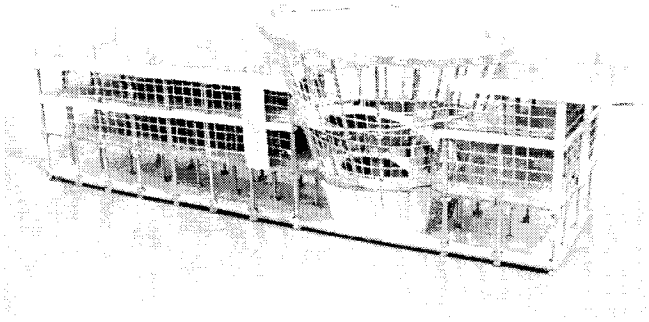

Fig.6 Structural Model (by Sara Harrison)

INTERWEAVING CONSTRUCTION

This phase centers on the constructive aspects of their design. With the advent of the iron frame in the mid-nineteenth century, the enclosing walls of buildings began separating into distinct structural, envelope and service systems. In 1852 Joseph Paxton gave a speech to explain the structural principle behind his "Crystal Palace." In it he compared the iron structural frame and the enclosing glass envelope to a "table and tablecloth". By this description he wanted to represent the glass skin as a tablecloth separate from the structure (table) that would now allow it to be "greatly varied to suit changing conditions and uses".[7]

Kenneth Frampton employs R. Gregory Turner's study, *Construction Economics and Building Design* to further describe the shift away from the monolithic masonry wall toward a division into his categories of *podium, services, framework,* and *envelope*. In terms of percentage of construction cost, the structure has been reduced while services and envelope now make up the

majority of the expense.[8] The simple bearing wall building has become rare. Instead it has been divided into separate systems providing support, comfort and convenience which, while allowing greater freedom for design, also create an abundance of information to coordinate. To understand how current systems of construction affect their design, students now study the enclosure in detail. They first complete their structural model by clothing it in an envelope of transparent, translucent or opaque cladding to convey their design intentions and thus adding another element to the weave. They then detail the skin by studying a portion of the enclosure critical to the concept and developing it at a larger scale in partial section, plan and elevation. Typically this is a wall section that depicts an important relationship between the concept and the structure, services, envelope and shading systems. They develop the wall section by selecting the specific materials and systems required to create assembly details. While students may desire an unbroken wall of glass, they must first address the complicated issues of supporting, shading, fire-rating and heating it. The goal of this exercise is to demonstrate how all the physical components concentrated at the perimeter of a building must be interwoven to allow each to function efficiently while still reinforcing the design concept.

For a textile to exist as a cohesive work, all the individual yarns and varying patterns must be bound together in a synergistic and integrated whole. Similarly in architecture, all the influences on the design must ultimately coalesce into a final product. Therefore for the final project of the course, a digital, compositional drawing is created that integrates the wall section with the most critical building design drawings into one interwoven layout similar to an analytique. Relevant plans, sections, elevations and three-dimensional drawings are interlaced with construction details in a drawing summarizing the design. Students take advantage of CAD's flexibility to overlay drawings of different scales and views and 'weave' them together by an appropriate graphic technique. This drawing becomes a comprehensive tapestry of the entire semester-long project in one technically precise document.

CONCLUSION

By the end of the semester students have studied the analogy of weaving in architecture from the hands-on to the virtual. After going through all phases, they can draw associations between themselves, their work and the larger world. To improve this course, the first objective would be greater involvement with the textile school. The class schedule for the weaving courses did not permit greater collaboration between both sets of students, however, there should be an opportunity for greater involvement in the future. The next step would be to improve the presentation of the figurative analogy. The students had more success understanding the weaving analogy through the literal projects such as the sun-screen, the threaded rod model and the technical wall section drawings. Finding better ways for them to understand the abstract notion of weaving an idea or space could be further developed.

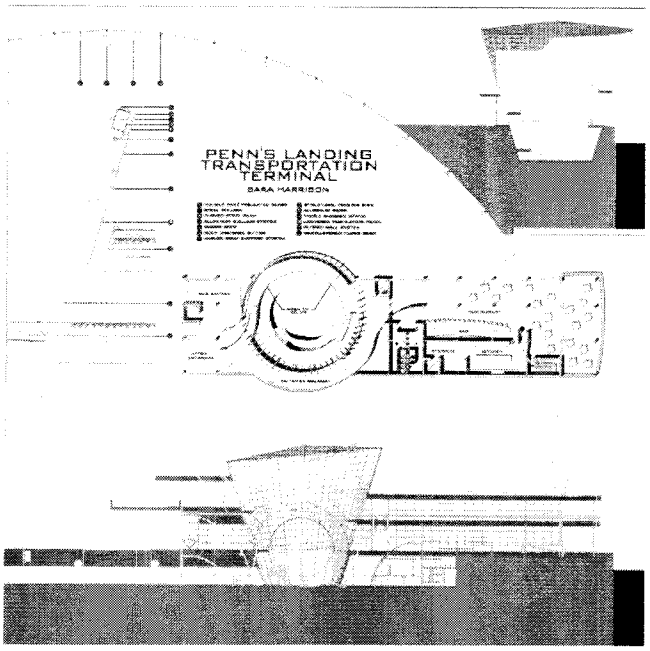

Fig.7. Compositional Drawing (by Sara Harrison)

Whether used in this particular studio format or in a general studio, the weaving analogy has relevant application to architectural design. Students are always searching for a way to make sense of all the information they acquire in college. Beyond studio, they receive indoctrination in professional courses on structures, building construction, environmental systems, history, and professional management that can be applied to their design projects. Yet they often question the need for their liberal arts courses that reveal little evident application to their main area of study; design studio. Weaving, as an analogy, is a useful tool for explaining the benefits, indeed the necessity, of a wide range of knowledge. Architects must continue to operate as generalists to acquire a multitude of ideas that someday may be retrieved and woven into another tapestry of architectural design.

NOTES

1 Anni Albers, *On Weaving* (Middletown Connecticut: Wesleyan University Press, 1965)
2 Wolfgang Herrmann, *Gottfried Semper: In Search of Architecture*, (Cambridge, Massachusetts: MIT Press, 1984)
3 Kenneth Frampton (Editor), *Technology, Place and Architecture, The Jerusalem Seminar in Architecture*, (New York: Rizzoli, 1998)
4 Albers
5 Indra Kagis McEwen, *Socrates' Ancestor, An Essay on Architectural Beginnings*, (London: The MIT Press, 1993)
6 Steven Holl, *Intertwining*, (Princeton: Princeton Architectural Press, 1995)
7 Herrmann
8 Frampton