

4.195. **Special Problems in Architectural Design.** Alexandros Tsamis- Jimmy Shen  
Exercise III: **Material Deployment Investigation**

In contrast to most 3d modeling environments which treat material merely as a “wallpaper” attached to a designated geometry this exercise focuses on an entirely different perception. Through the study of a series of precedents that are retrieved from various areas of creative expression such as craft, product design, art and architecture, students are introduced into the logic of material performance and its incorporation within the design process.

According to the techniques used in each of the precedents, a matrix was created divided in three major categories: *substance, component and thread.*

*Substance* refers to ‘raw’ material properties, meaning properties that are directly derivative from the intrinsic nature of material such as its transparency, colour and elasticity. In this category, the connections between different materials occur mostly in the realm of chemical interactions, rather than external bonds and connections. Performance characteristics are the outcomes of potent fusions and material layering in various scales of reference. A liquid form of plastic, for instance, falls into this category.

*Component* refers to techniques of distributing a basic unit along various geometric configurations. In this case, the specific geometry of the element is predetermined and remains in most cases unaltered; what varies significantly is the positioning of one unit in relationship to the others. Performance characteristics emerge through a combinatorial logic of component distributions. A Byzantine brick, for instance, falls into this category.

*Thread* refers to the intertwining connective logic between linear yarn-like components. The word “thread” is a generic geometric term describing a material having very long length compared with its cross-sectional dimensions: possessing a very high aspect ratio. Although a thread as an entity being employed in construction could also be characterized as a component in a linear form, the effects of its linearity are so overwhelming that one could claim that it loses its individuality as a component when becoming part of a larger web. In this case, complexity can potentially emerge as a result of the manipulation of one single component. When threads converge and overlap, they are usually not traceable as units within the network of induced relationships.

The boundaries between the three material deployment techniques are not considered fixed and in many cases precedents are resultants of overlapping territories. Students are encouraged to treat the three aforementioned techniques as ‘boundary conditions’, and re-examine/re-use their studio proposals through a logic of performative material deployment.

#### component 01 – baidarka kayak

The baidarka kayak meshes small pieces of bone into a wooden superstructure in strategic zones requiring maximum flexibility. This technique becomes an early example of a composite material with non-homogenous properties, since the of bone, wood and leather, contribute to locally vary the boat's rigidity along its length. An exterior performance parameter, such as the floating behavior of the boat on waves, becomes the incentive to manipulate not only its shape (as it happens in the design of all boats), but also its locally adjusted material composition.

#### component 01 – Witte Arts Building

The attempt in this project by Office Da is to register on the building's skin the effects exerted by local, interior and exterior, technical parameters such as light, drainage and circulation, and allow them to become factors of local deformations. A deformation is accordingly defined, not only through the revelation of a geometric disorder, but also through the material composition of the envelope. In an attempt to locally shift from one spatial condition to the next, the architects manipulate the Flemish bond in a manner that produces areas of thick massive wall and areas of lightweight porous skin constantly registering the change of activity in the interior.

#### thread 02 – Issey Miyake: *Seamless*

Through this project, Miyake challenges the most deeply rooted assumptions in cloth making, which entail weaving a fabric, cutting it in pieces and sawing the pieces together to produce the final cloth. Miyake on the other hand, proposes a seamless production through which the clothes would be weaved directly as one unified entity using a computer controlled machine. Through this process, the designers are able to specify locally the density and the type of the woven pattern – to make for instance the cuffs of a shirt more elastic than the neck.

#### thread 02 – The Somali Tent

The Somali tribe in Africa manufactured the prefabricated and portable nomadic house known as Aqal, which is a readily erected and dismantled hemispherical dome, 1.5 - 2.3 meters in height and is constructed of three component parts: >> 1. semicircular shaped poles that give it its strength and form. >> 2. vertical poles used for reinforcement.>> 3. and layers of woven mats made of grass acacia fibers and animal hair used for covering and decoration.

#### thread 02 – Stealth airplane

Recent developments in the aviation industry have led to the construction of airplanes manufactured entirely of composite materials. Making composite

structures is more complex than manufacturing most metal structures. To make a composite structure, the composite material, in tape or fabric form, is laid out and put in a mold under heat and pressure. The resin matrix material flows and when the heat is removed, it solidifies. It can be formed into various shapes. In some cases, the fibers are wound tightly to increase strength. One useful feature of composites is that they can be layered, with the fibers in each layer running in a different direction. This allows materials engineers to design structures that behave in certain ways. For instance, they can design a structure that will bend in one direction, but not another. In comparison to pure materials and assemblies, composite materials present the advantage of yielding a certain kind of performance orchestrated to respond to fluctuating external circumstances, such as the different forces that will be exerted in different parts of the aircraft during flight.

thread 02 – *Column* by Lilian Eliot

The piece entitled "Column" is made of pandanus, rattan and acrylic paints. As Martina Margetts comments: "The apparently random structure and texture of Elliot's piece is a deceptively 'primitive' work with a controlled technique." In this case study the weaving strategy apparently defies the basic principle of weft and woof grid. The complex texture seems to emerge out of an interweaving of "threads" with different rigidity, size and color in multiple directions. Since no explanation is offered, the amount of control in this process cannot be determined.

substance 03 – turkish bow

In his History of Warfare, John Keegan observes that the bow can be seen as the first machine, since it employed moving parts and translated muscular into mechanical energy. The Turkish bow, which dates as early as 5000 years ago, is one of the first composite bows and "is consisted of a slender strip of wood or a laminate of more than one - to which were glued on the outer side (belly) lengths of elastic animal tendons and on the inner side (back) strips of compressible animal horn, usually that of the bison. The glues, compounded of boiled-down cattle tendons and skin mixed with smaller amounts reduced from the bones and skin of fish, might take more than a year to dry and had to be applied under precisely controlled conditions of temperature and humidity.

substance 03 – a new approach to rubber

Driven by the intention to yield a parallel aesthetic performance derivative from the material synthesis of the composite, the project uses as matrix of the composite a semi-transparent material, in order to reveal the inner reinforcement pattern. The material composition of the case study is rubber for the matrix and PVC coated fiberglass screen mesh over bars for the reinforcement. Although the layers of reinforcement in a composite material are conventionally used to

strengthen it and augment its performance, this case exemplifies that the intricacy of reinforcement patterns can be put in effect for alternate causes, such as the creation of dense and loose areas of material.