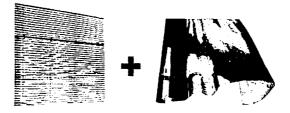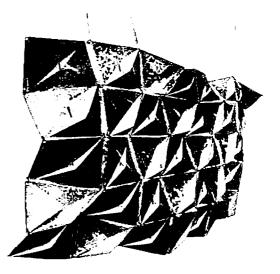# In-Out Curtain

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IN-OUT Curtain is a prototype design for an operable screen that combines ideas from origami and digital production, focusing in particular on creating a flexible and user responsive system. Conceived as hybrid drape/Venetian blind, IN-OUT Curtain is operable both at the overall and modular level, and can change shape in section as well as in plan. It is designed to function as a transformable room partition, enclosure screen, or window shade whose form can be altered by hand to address movement, interaction, and light.
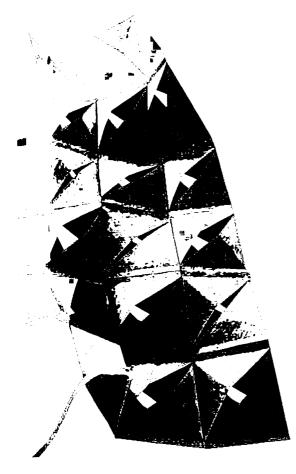

Origami, the act of folding, is both everyday craft and historical Japanese art form. It is unique in that it is linked to mathematics equally through geometry and topology. Geometrically, origami construction relies on sets of points, lines and Euclidean shapes. At the same time, each origami object is a topological construct, formed without tears or ruptures to the original material. Together, these define a structure of making three dimensional volumes out of two dimensional material, usually paper, through the simple act of folding. In its most pared down description, origami follows a few simple axioms that rule how points and lines can be connected, and out of which complex figures can be made either through single sheet constructions, or by arranging them in repetitive combination, called modular origami.
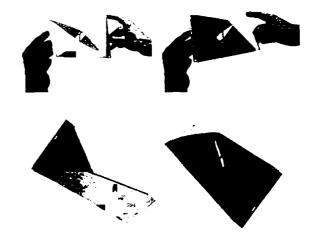

IN-OUT Curtain takes principles from modular origami such as using folds and creases to form individual volumes, and connecting the pieces together through self-similar interlocks to form a collective whole. Unlike origami however, which commonly uses identical fixed modules, this project sought to find simple organizational folds that could work for a subtle variety of module sizes to afford different overall curtain sizes, shapes, and deformations. Moreover, it was imperative that the modules perform by changing shape individually and in concert with one another.

The design process consequently began by looking at the possibilities and constrains of the digital tools and building materials at hand, and subsequently alternated between digital and analog production. There is ample documentation on the advantages of CAD/CAM, and digitally streamlined production processes have yielded a wealth of compelling and sophisticated architectural explorations. As with all tools of production,

however, the very techniques that open these investigations have their own set of constraints, or rather, gear particular ways of working. Where digital production readily allows the construction of fluid and permutated shapes, and suggests opportunities for mass customization, final manufacture often results in fixed, if highly specific, forms. As well, though CAD/CAM techniques are still relatively recent in architecture, the type and variety of software and tool generated construction techniques has arguably become somewhat predictable, including waffle and diagonal grid construction, surface milling, and contour lamination.
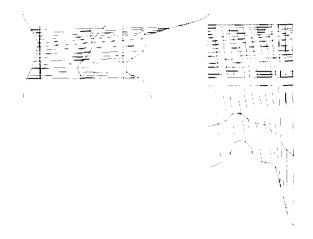

IN-OUT Curtain attempts to challenge these prevailing techniques and conflate the fluid potentials of digital fabrication, in this case two dimensional templating and laser cutting, with the design of a flexible system that engages the viewer/occupant. The design process therefore looks both at the specificity and precision of digital fabrication with the

ability to alter the end product at will. IN-OUT Curtain did not begin with an a priori form, but rather, relied on material properties to determine minimum and maximum allowable geometries for each module. Made initially from paper cardstock, and later thin wood veneer, each module is made up of cut, perforated, folded, and interlocked laser-cut sheets. The overall design combines the modules into a field that works together as an operable surface structure.
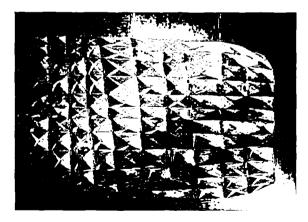

Ultimately, IN-OUT Curtain uses simple material resistance to generate its transformable quality. Each module is designed so that it holds two distinct shapes, IN and OUT — a closed/concave shape, and an open/convex one. Both positions rely on internal tensions to maintain their place, and to also have a degree of elasticity to be able to switch back and forth between the two. When linked together, the modules have the ability to translate their individual deformation onto adjacent areas creating a curtain of multiple shape variation.
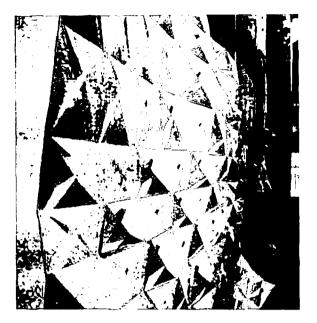
The overall pattern in the prototype version is derived from room location, light direction, and movement. The pattern is easily altered for each application, so long as the basic geometries of the modules fall within ranges that allows their operation. This depends primarily on the width to height ratio of the modules, and angle of internal creases -- essentially, the smaller the height to width ratio, or shallower the angle, the greater the deformation. This allows the curtain to not only be designed in its overall dimensions for a particular space, but to also be systemically responsive in terms of its internal deformations. In the end, the project attains a flexible design and manufacturing system where the geometries for the unfolded, flattened module templates are calculated and differentiated using sets of simple proportional commands.

By employing such digital design techniques, IN-OUT Curtain seeks to perceptually elevate the relatively ordinary materials used.

Conceptually, the project is inspired by some of the work of installation artists such as Ann Hamilton and Eva Hesse, where certain similarities with products of digital production come to mind. For example, near repetition of systems of elements, transformation of recognizable materials, and perhaps most distinct, the visceral response one has when viewing the work as the result of obsessive hand labor — labor often seen as in the purview of the low arts or crafts. With digital production, the nature of this labor and craft is necessarily redefined. However, IN-OUT Curtain attempts to make referential alliances to such everyday handicrafts like as stitching, quilting, and origami paper folding while simultaneously creating a synthetic and intelligible outcome.

Lastly, programmatic and individual interactivity, and the resulting perceptual performance, is considered here through the designed flexibility of the final form. IN-OUT Curtain is never in a permanent state, either in shape, or when against a window, by transmitting an ever changing, glowing multi-faceted light.