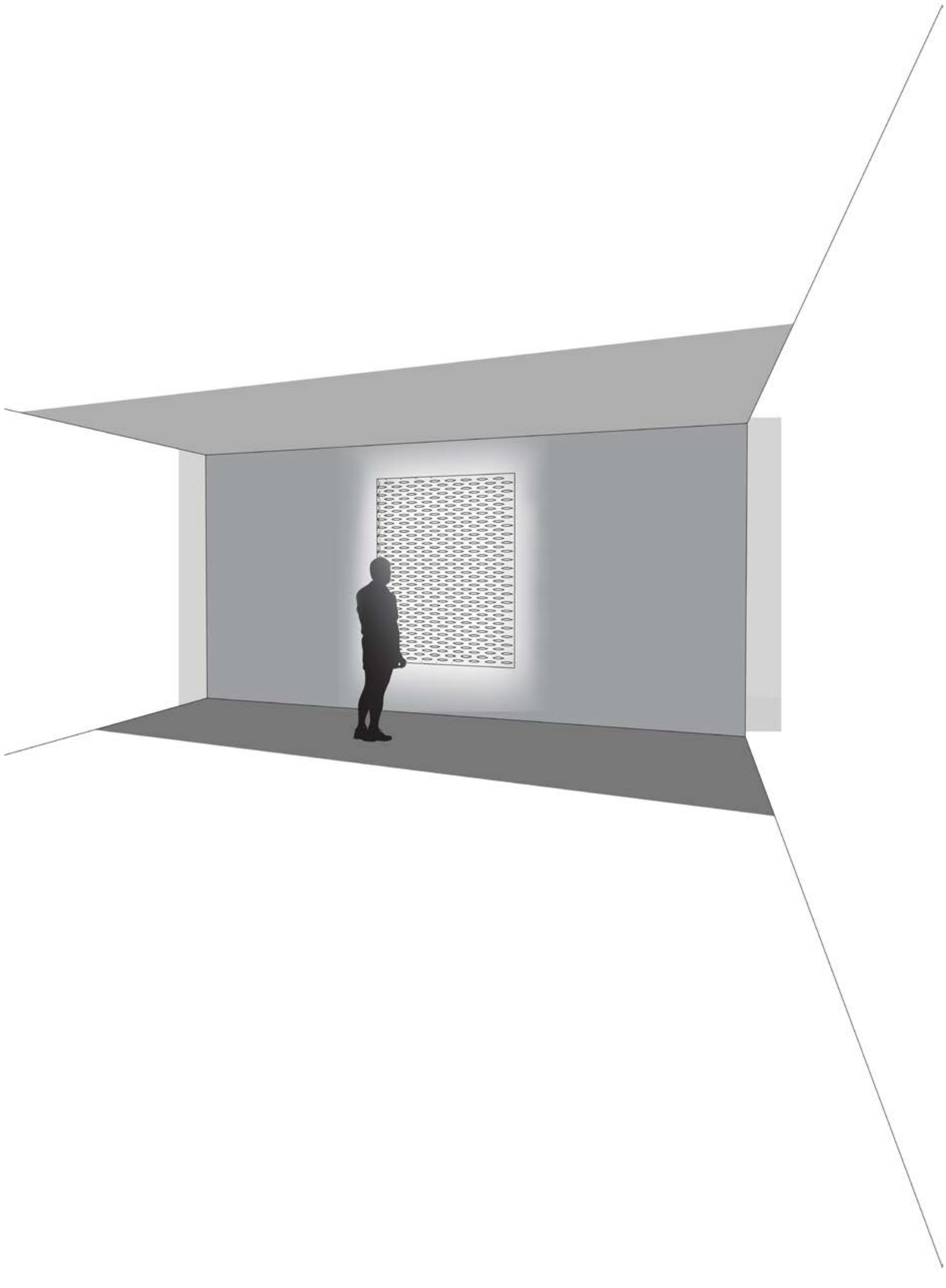
flexible apertures

figure 1
daylight illuminates the natural beauty of wool. cuts and folds mitigate the sun's harsh glare. the wool itself also mitigates indoor air quality, acoustics, and thermal comfort.



statement of interest

The ever changing cycle of the sun's arc through the sky communicates to us on a near subliminal level. Morning sun streams through our window, creating a familiar light level that reaffirms it is time to wake up. Lower angled winter sun reaches farther into our rooms, illuminating the walls differently than in summer. Our relationship to daylight as a natural system not only regulates our biological rhythms, it also affects us psychologically. When we have the chance we position ourselves in interior space often according to the amount of light we prefer to work in, dine in, or relax in. An appropriate quality of light can add richness to these acts that we spend most of our days doing. We dwell in the interior with daylight acting as a major connection to our outside world and our relationship to the larger environment. Therefore having the ability to control the amount of light that comes into our space, maintain views out, and reject uncomfortable glare and heat is crucial to well designed interiors.

But the need for more flexible mitigation of light through building apertures is not limited to the daytime. Particularly in our urban centers, overhead streetlights blast illumination through our windows. Research has shown that light levels affect our health through the way light suppresses the hormone melatonin. Melatonin allows us to fall asleep, so any light that reaches us during our sleep cycle is working against the health benefits of deep rest. Alertness, mood, mental agility, and physical performance are all affected by when and how much light our bodies are exposed to at night. Although blackout shades can help provide us with darker environments for better sleep, unless they are mechanized for automatic detraction, they consequently block morning sun that helps us wake up naturally.

Other devices such as rolling shades, blinds, and curtains are the traditional methods used by people to adjust and adapt the light reaching into their space. Often these methods require us to sacrifice view to the exterior or aesthetics of the room in order to protect from sun. For example, opaque curtains can be tied back for view out but then give no protection from solar glare. Translucent curtains, cellular, and rolling shades allow light in but taint view out. Venetian blinds function beautifully as light shelves, reflecting light into the room while allowing adjustment for views out. However their rigid linearity only allows them to be opened in one direction, from either top to bottom or bottom to top. The same goes for vertical blinds. Their generic materiality, slatted appearance, and mechanical workings can also detract from the aesthetic comfort of a room.

There are other dynamics occurring in our interior environment that also need to be mitigated which are far less apparent than the sun's flow of illumination. On an invisible level, our interior environments are toxic with the flows of off-gassing and Volatile Organic Compounds (VOC's) from plastics in furniture, fire resistant fabrics, and chemicals in finishes of all kinds. In industrialized countries, we all absorb these toxins through the air and our very skin, impregnating our bodies with chemicals like formaldehyde or methylene chloride.

There are a few materials that help alleviate the toxicitiy of our interior environments by reabsorbing the chemicals released by furniture, fabrics, and finishes. Wool is a stellar material that does a significant job at restoring indoor air quality by locking toxins in its natural fibers. Additionally, wool is a tactile and texturally beautiful. Lighter shades of wool diffuse light shining through it, creating lovely lantern-like effects, further enriched by shade and shadow from folds in the fabric. (see fig 1)

There are two final dynamics occurring in our aging urban centers such as New York that can also be mitigated by the unique properties of wool: acoustic and thermal control. Acoustically, street noise from cars, trucks, pedestrians, businesses, and residential neighbors can be detrimental to our concentration and sleep. Thermally, buildings lose more heat through their windows than robust wall construction, particularly in older buildings.

As a student of Parsons School of Constructed Environments, I have been influenced by the unique cross disciplinary nature of the studio program. Lectures, classes, and groupwork within the Lighting, Architecture, Interior, Product, and Fashion design disciplines have inspired me to examine issues, extrapolate lessons, and synthesize potential innovations that can cross design boundaries. When examining the inflexibility standard window devices present as a way to adjust my interior environment, knowledge from the different disciplines at Parsons begin to weave together ideas for better and more beautiful design.

project proposal

My proposal for the Michael Kalil Fellowship Grant is to research and develop a series of wool window coverings that better embrace the natural daylight cycles , rejuvenate indoor air quality, and allow more adjustability for controlling personal preference in one's light, sound, and thermal environment. By three-dimensionalizing the standard curtain to create small scale light shelves, light scoops, and shading elements, we can use lessons developed for high performance architectural facades in mitigating sunlight. Thick wool has a degree of structural integrity that allows it to hold geometries conducive to molding light. The depth and texture of the wool also creates folds and patterns of shade and shadow, adding richness to the expression of light through the aperture and the beauty to the overall interior space.

By perforating this volumetricized curtain with patterns of cuts and folds, clear views to the exterior are maintained while allowing controlled light to pass through. The formal system of creating these folded patterns in wool is a major part of my research. For example, how can cuts be made that block much of the light from street lamps while reflecting in morning sun? Or how can the curtains fold and unfold to mitigate light throughout the day? Cuts through the covering that create horizontally oriented folds will act as small scale light shelves, creating diffuse light ideal for working while still animating the room with patterns of light. Other folds oriented more vertically could be ideal for east and west facing windows, controlling low angle sun. Because the wool is a planar surface and not like linear Venetian blinds, the potential for variation and flexibility in the size and placement of these cut-and-fold patterns is enormous. This in turn allows for greater control and beauty in the light brought into a room, and a new way to interface with the aperture as a whole.

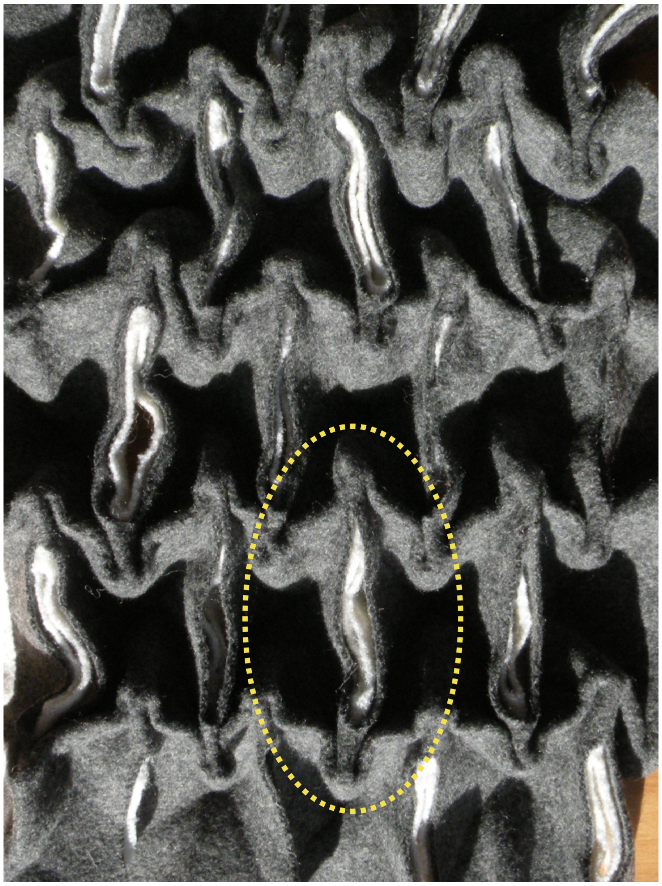
Color, seen purely as a percentage of reflectance to mitigate views and thermal properties, is also a part of my research. By making the exterior facing side of the window covering white with a reflectivity of 80-90%, solar gain can be greatly curbed in the summertime. However the highly reflective white makes views to the exterior visually taxing. By making the interior facing side a darker color wool with a lower reflectance, views through the covering to the exterior are clearer. However, color can also be used to increase thermal comfort in the room. Can patterning the folds and cuts through the two layers of wool create a window that increases solar gain in the cooler mornings and repels it in the afternoons, based on how the lighter and darker layers of wool fold around each other? Can the perforations be designed to work with a climate's prevailing wind currents and allow ventilation in the summer? Can cords be incorporated through the fabric that let the user adjust tension in the covering and therefore change the size and shape of the folded perforations, allowing for more flexibility and control over their environment? Are there alternatives to cords which would allow the user to interface with the covering in a more natural way?

Tying into all of these research questions are questions about fabrication and pattern making. Can a feedback loop of digital design tools such as Grasshopper and manual experimentation such as with origami help develop these three dimensional patterns? Can their manufacture b efficient enough to make them an affordable, beautiful, and flexible option for residential use?

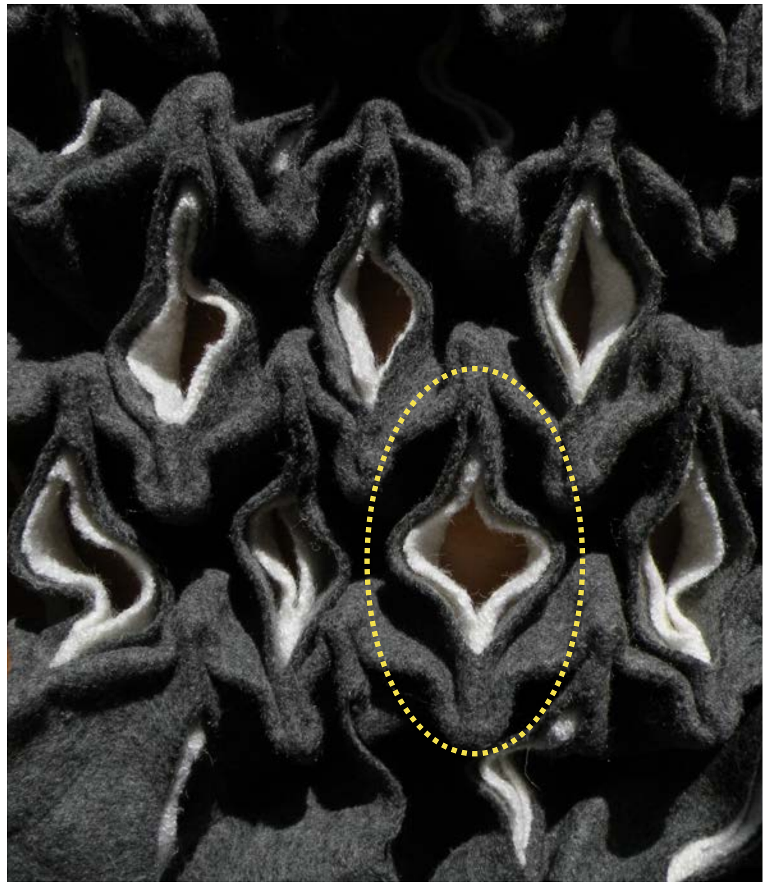
Finally, I am interested in evaluating my work: analyzing the window covering variations for reflectances, light levels, improved indoor air quality, views to the exterior, acoustic noise suppression, and thermal gains.   More quantitatively, I would like to evaluate new ways the inhabitant uses and feels about the change in the window aperture, lighting, and overall mood of the interior created by this intersection of natural daylight systems with textile and fabrication technology.

budget outline

Wool	*$25/yd*	*60 yds*	*$1500*
Thread	*$4/spool*	*15 spools*	*$60*
Cord	*$2/yd*	*30 yds*	*$60*
Hanging rods	*$30 ea*	*1 qty*	*$30*
Sewing Needles	*$5 pack*	*2 qty*	*$10*
Air quality test	*$80*	*1 qty*	*$80*
Light meter	*$40*	*1 qty*	*$40*
Sound (decibel) meter	*$80*	*1 qty*	*$80*
Participant evaluation printings	*10 sheets*	*$0.10/sht*	*$1*
Total			*$1861*



closed position



open position: possible from compressing the folds of the origami mockup, spreading the cuts to allow light and views. this is one aspect of my research that with exploration, could discover new ways users could interface with their apertures, allowing for greater flexibility.

experimental mockup

figure 2
the following images are of a mockup I did to demonstrate one generic variation of my proposed ideas involving folded and cut wool patterns for window coverings. my proposed research would further develop the ideas presented here to create openings more tailored to mitigating specific sun angles and light conditions. for example, how can a window covering block streetlamp light while allowing in soft morning light by redirecting it?

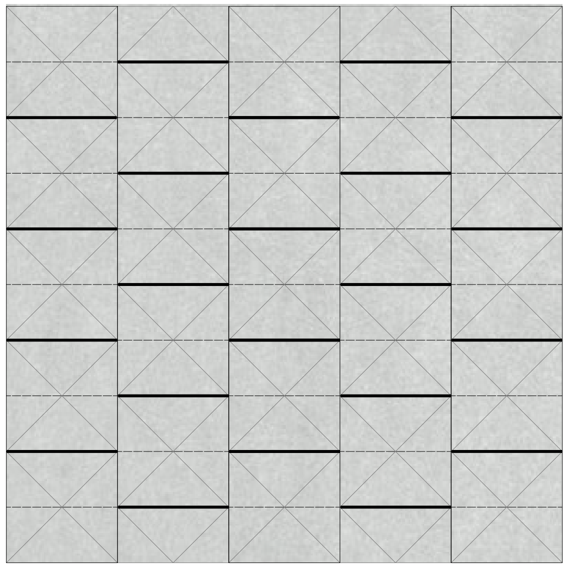


figure 3
diagram of the folding and cutting pattern traced onto the wool of the example mockup. upward folds along the black lines, downward folds along the gray lines, cuts along the thickest lines.

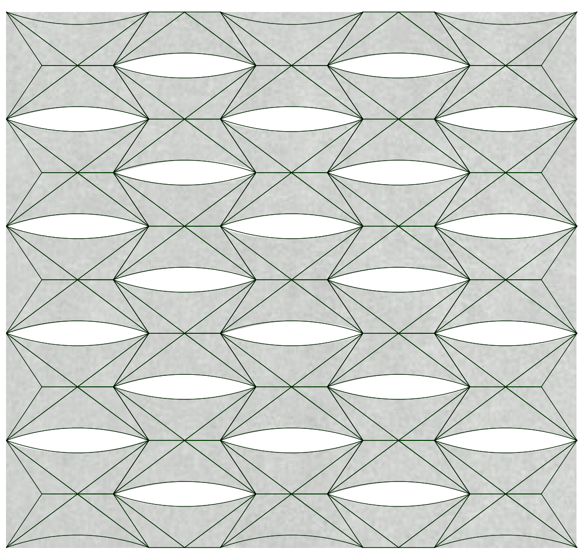


figure 4
an elevation diagram of the example mockup after being cut and folded. the perforations act as small scale light shelves, bouncing daylight into a room and allowing views to the exterior. both of these aspects could be developed to a further degree of function and beauty with my research proposal.

exterior

interior

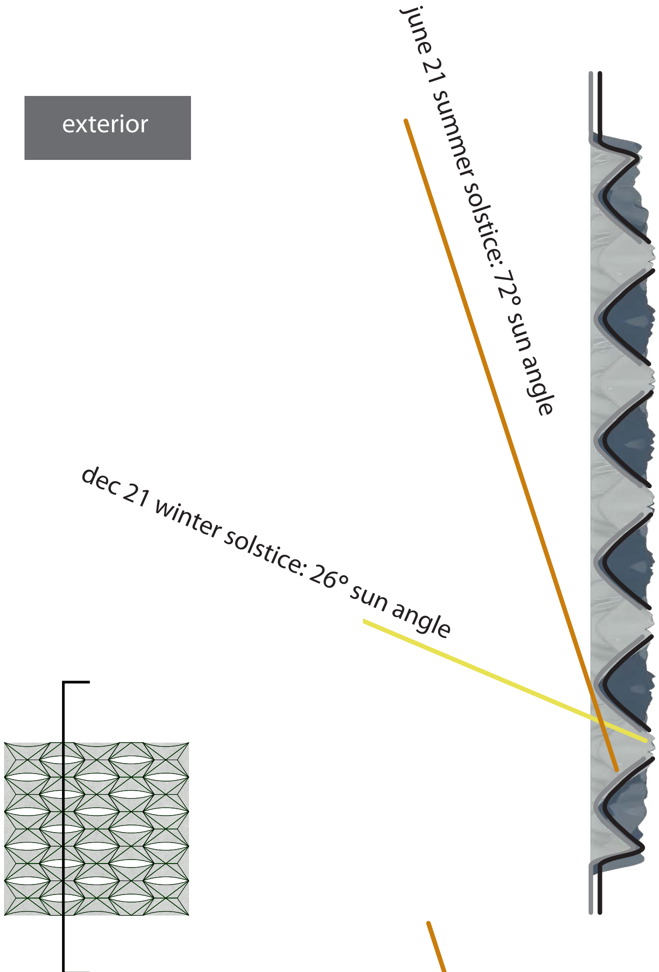


figure 5
section cut (a)
with the mockup's cuts oriented horizontally, the pockets created by the folds of the wool act to block higher angle, more intense summer sunlight into the room. this indirect lighting is bright while limiting glare, making for a pleasant interior. lower angle winter light is allowed in for thermal comfort.

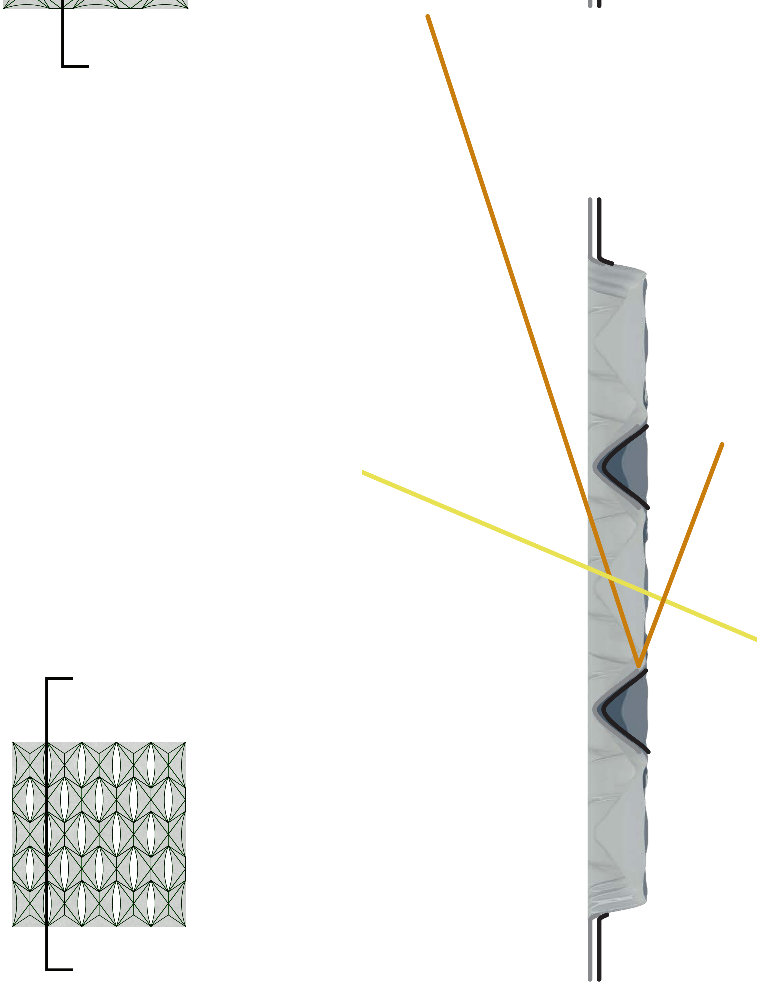


figure 6
section cut (b)
with the mockup's cuts re-oriented vertically, low angle morning and afternoon sun is bounced and redirected into the interior while still blocking higher angle summer light. my research proposes to study variations not only in the way these cuts and folds can be made in the wool to achieved desired lighting, but also the way these cuts and folds could change when the fabric is drawn up with cords., giving the user more flexibility.