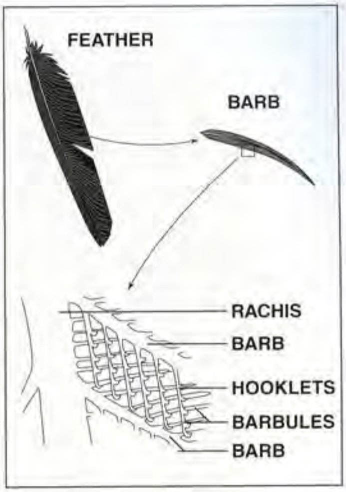
Violet-tailed sylph

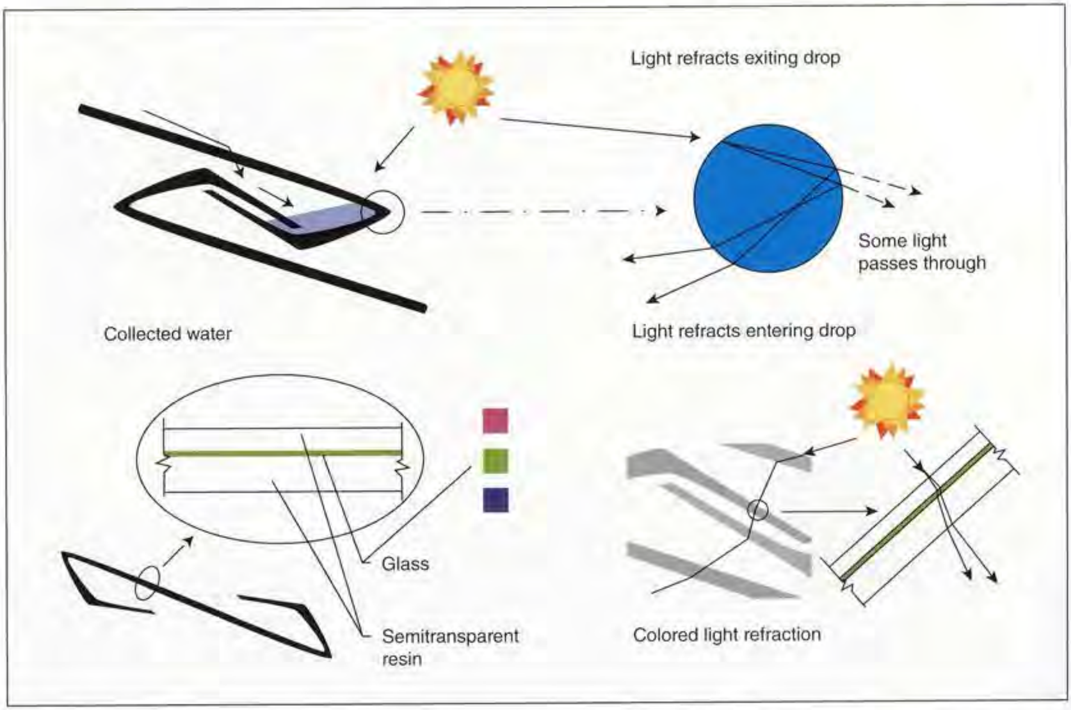
Aglaiocerus coelestis

Phylum:	Chordata	**Family:**	Trochilidae
Class:	Aves	**Genus:**	*Aglaiocercus*
Order:	Apodiformes	**Species:**	*A. coelestis*

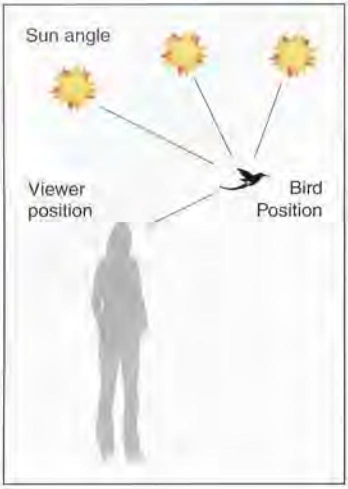
Photograph courtesy of J. Rothmeyer

Project Documentation The pavilion's panelization and joint system is inspired by the hooked barbules in a hummingbird's feather and the implementation of principles of light refraction magnified by water. One level of refraction is developed through the panels' materiality, composed of two layers of semitransparent resin and a thin layer of glass to provide additional qualities. A second level of refraction is established by understanding how light reacts differently when it hits and travels through water – resulting in variations in the colors of light dispersed. The hook joint creates small water pockets between the panels, thus enhancing the desired light deflection. Resource optimization and efficiency are crucial to the pavilion and its use as public space, hence the exploration and strategic implementation of a repeated module to produce communicative effects.

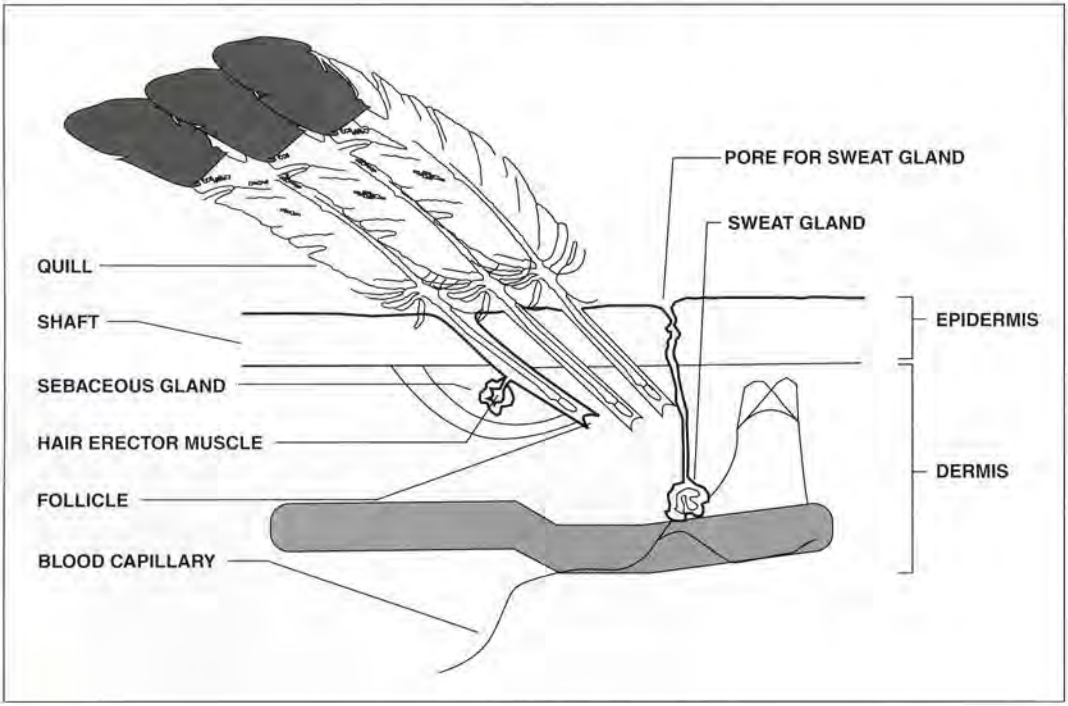




Mimicking the complex structure of feathers, the modules overlap, thereby magnifying the light refraction between layers, each made of glass and colored resins.

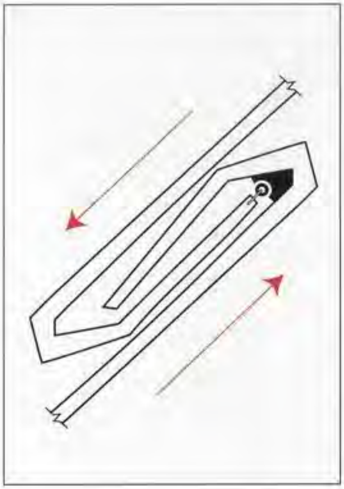


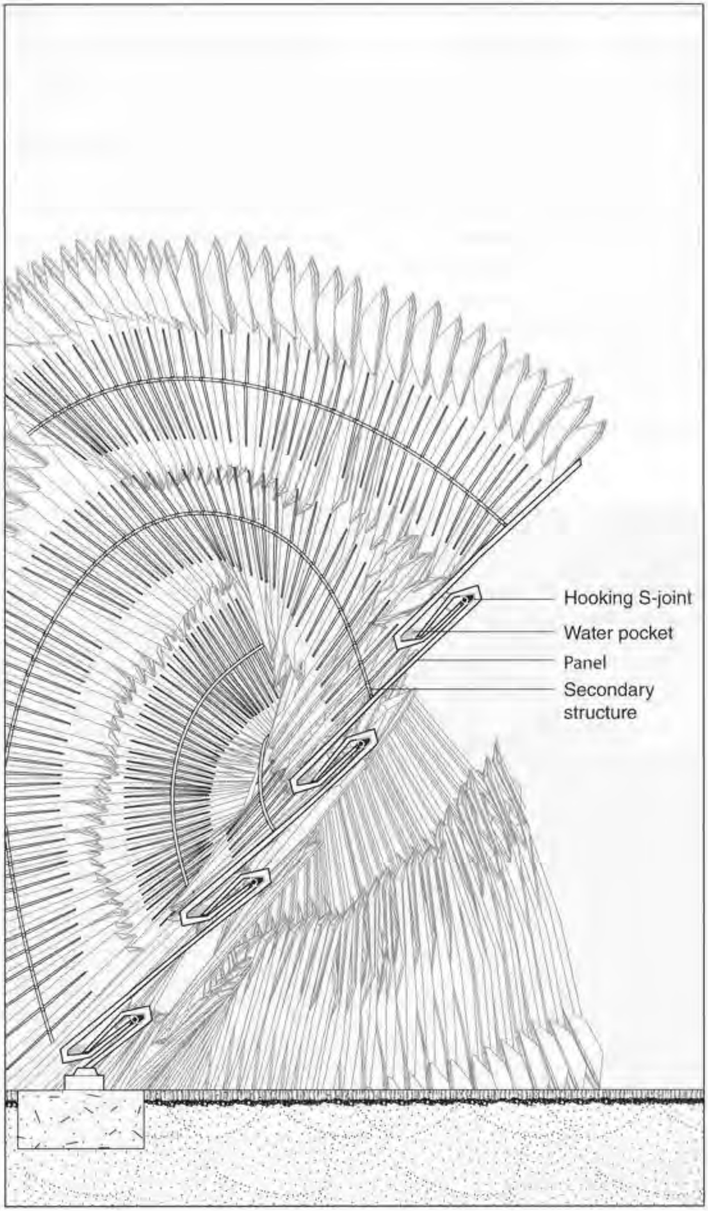
Interface between the Skin & External World Hummingbirds' feathers are functionally similar to other birds, yet produce unique iridescent colors. The shaft of the feather (or rachis) extends out as alternating thread-like barbs and barbules, which grow out at proper angles in order to hook with one another and maintain structural integrity, but at the same time remaining flexible enough to bend or disconnect without breakage. Feathers lie on top of each other, keeping only the iridescent tips visible. The keratin protein found in feathers provides flexibility and integrity, and acts as a natural insulator. Contour feathers cover the body and appendages of birds. These feathers have an expanded vane that provides the continuous surface necessary for flight. Changes in the angles of these feathers allow for changes in the amount of feather brilliance observed from different positions. Some feathers are flat; others are curved.



Some feathers, for instance on the gorget and crown, resemble flat mirrors, and light that hits them can be reflected in only one direction. The sun, observer (bird or human), and bird must be aligned properly to view the brilliance of the plumage. When no light shines on these feathers they appear black. Other feathers, like those on the back, are curved inward to resemble concave mirrors. These curves come in many angles, allowing for light to be refracted to the observer at different directions. The section shows feathers insert into bird skin through the epidermis and dermis.

The pavilion acts as a beacon during activities and events, becoming a glimmer of coloration when observed from the city. The colorful variations of refracted light infiltrate the internal spaces, amplifying the sensorial experience promoted by the physical environment.





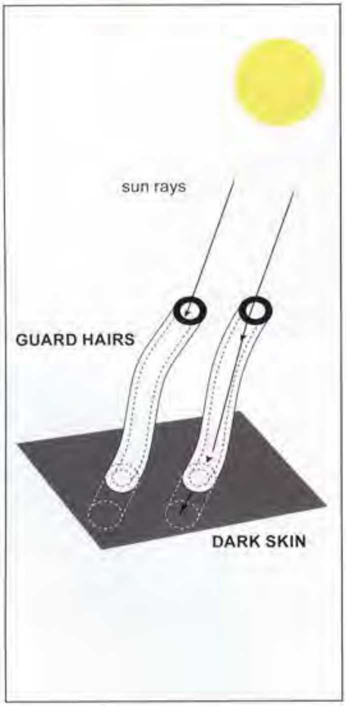
The structure displays a broad spectrum of color variation throughout the pavilion. The modular panels are arrayed to reflect and refract the sunlight at varying angles. The color brilliance is ultimately enhanced through the combined effects of the semitransparent panels and water pockets. The panel joints form an S-like shape to interlock with one another, forming a small cavity to trap water.

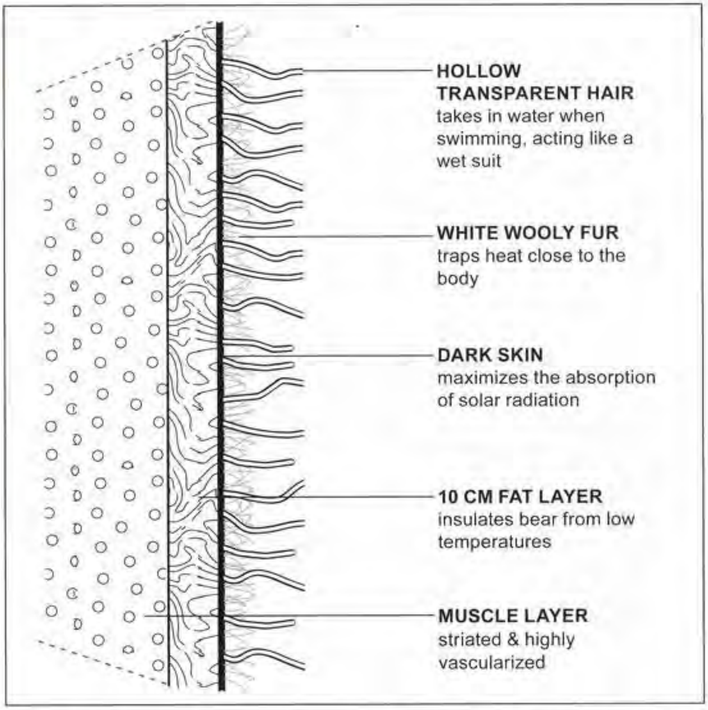
Polar bear
Ursus maritimus

Phylum:	Chordata	**Family:**	Ursidae
Class:	Mammalia	**Genus:**	*Ursus*
Order:	Carnivora	**Species:**	*U. maritimus*

Photograph courtesy of M. Johnson

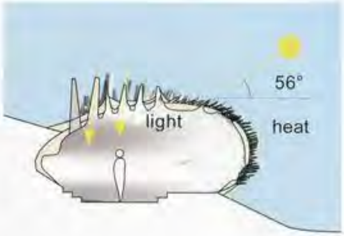
Interface between the Skin & External World Arctic temperatures can reach −45°C (−49°F) during the depths of winter. The polar bear's primary defense against the cold is its skin. Externally, polar bears are insulated by a thick, white fur coat that covers almost the entire body, including the soles of the feet. The fur is composed of two layers. The dense white underfur provides the main source of insulation by trapping warm air close to the skin and, conversely, by preventing contact by ice and water. In the outer layer, longer guard hairs are hollow and transparent, lacking pigments which also act as camouflage in the snow. Polar bears molt during the summer. Beneath the skin within the hypodermis, polar bears are further insulated by a layer of fat. Additional features, such as black skin, particularly on exposed areas such as the nose and tongue, allow the bears to absorb solar energy and prevent additional passive heat loss.

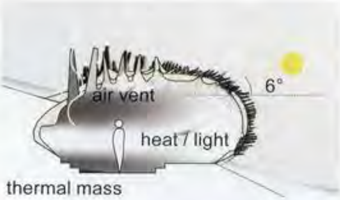


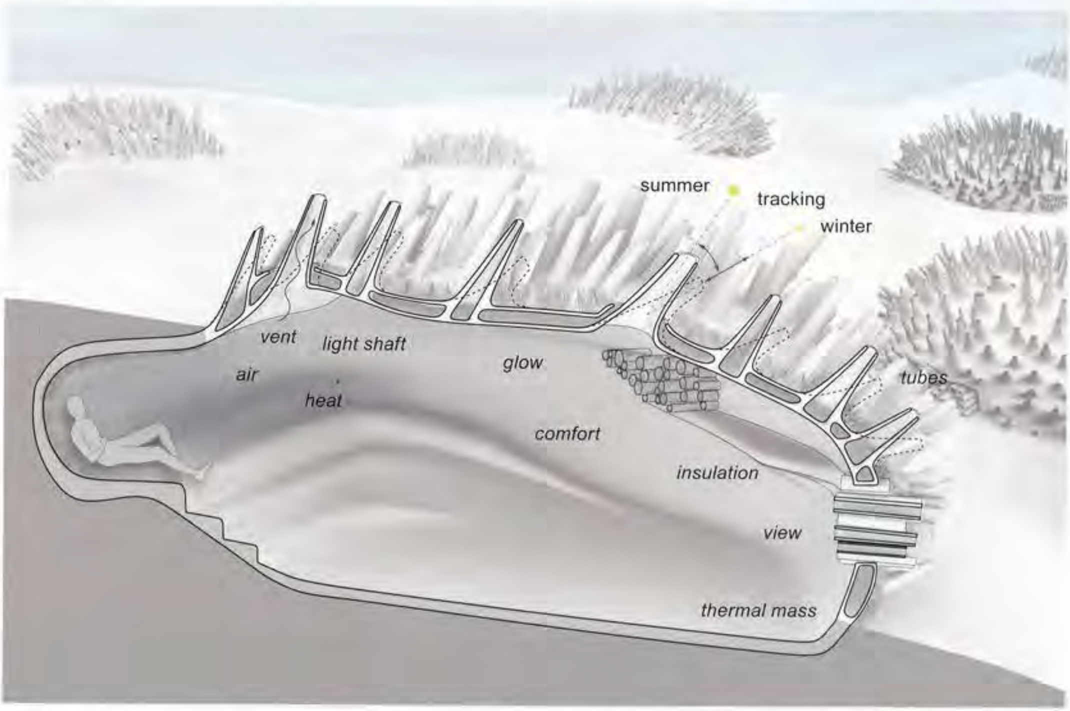


Fur is the polar bear's primary defense from the harsh cold. The dense underfur traps warm air close to the skin, warming the body. Longer, hollow guard hairs protect the underfur from the elements. The skin is also effective in providing protective layers that are capable of trapping water as the bear swims in order to reduce heat loss. Beneath the skin, a thick layer of fat provides additional insulation. It has been proposed that the hollow hairs guide UV radiation to the skin, similar to fiber optic cables, but this now seems unlikely. (Photograph courtesy of D. McShaffrey)

Project Documentation The envelope is a storage for heat and light which minimizes the use of active systems and maximizes the use of passive systems. The storage of heat and light within the active envelope varies according to seasonal changes. During the winter, light and heat are transferred into the unit, where heat is conserved within building-integrated thermal storage in the form of PCM. During the long, cold summer nights, light is managed and minimized while the heat is still being collected. This variability in conveyance and conservation of heat and light is accomplished via sensors within the movable tubes which track the sun angle and optimize the heat accumulation. The thick envelope assembly controls a number of crucial factors, including thermo-physical properties of the materials, the outdoor climate, and the operating schedule of the compact dwelling.

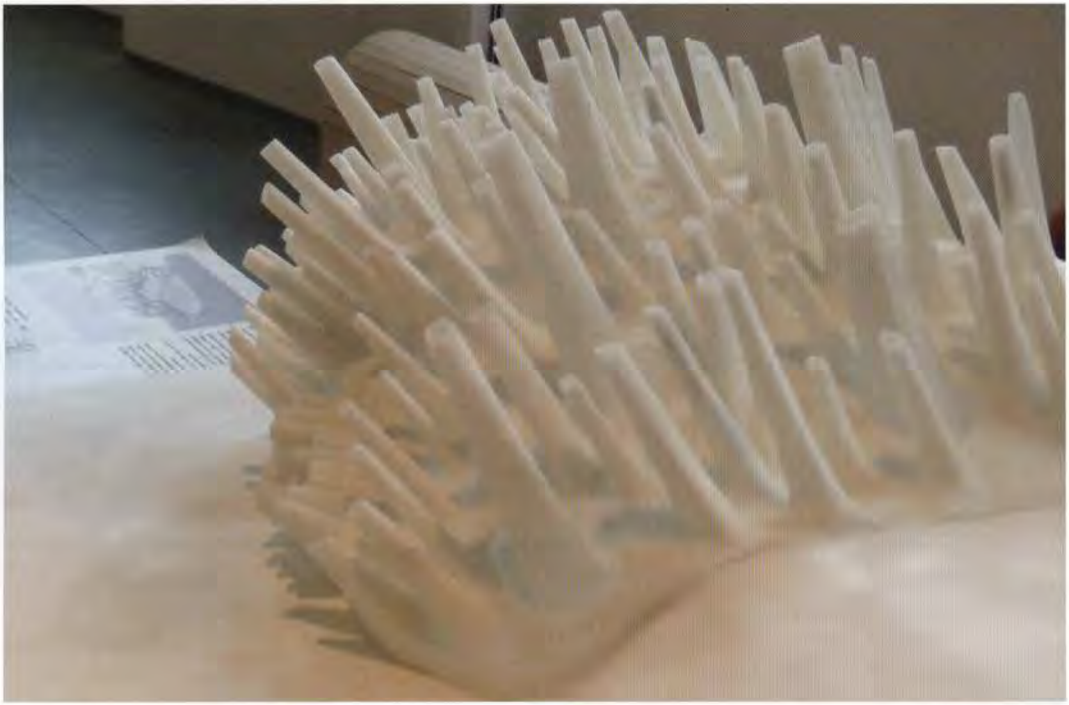




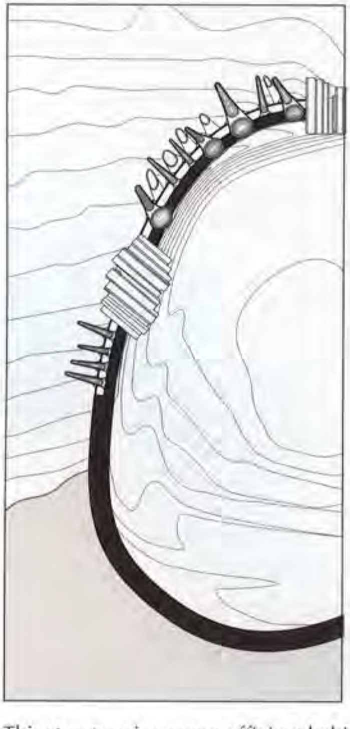


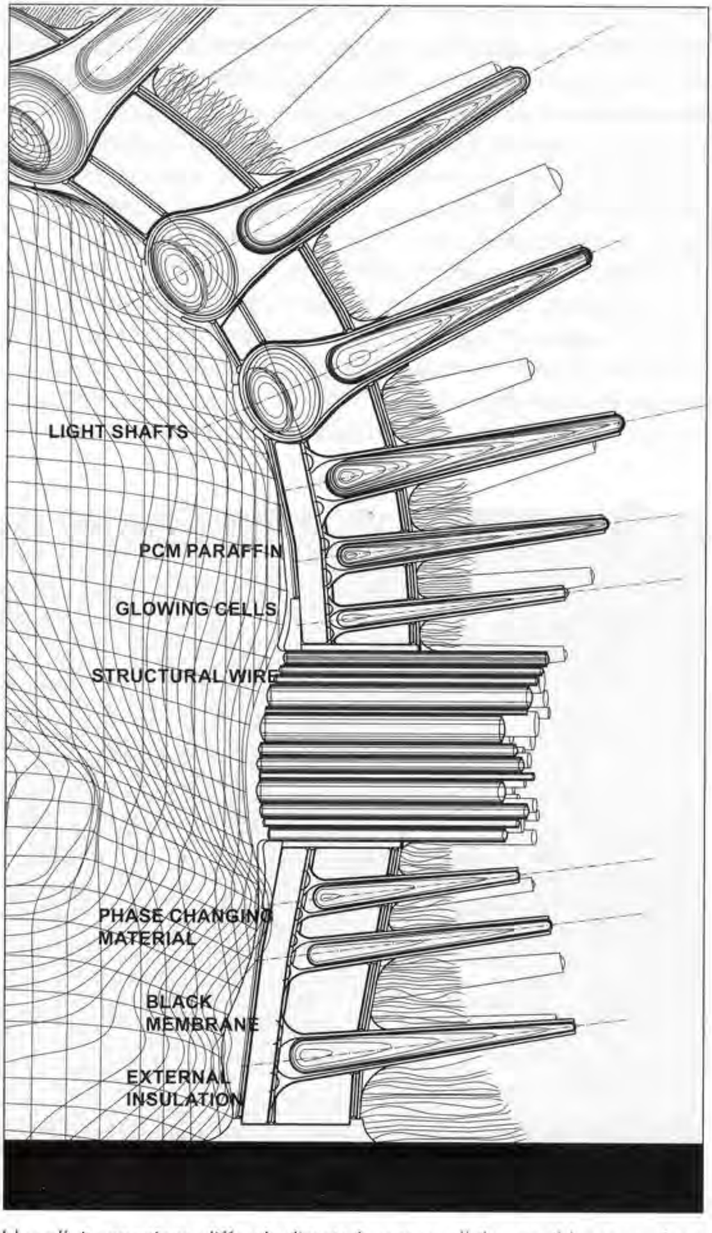
The dwelling is articulated around a compact central space to avoid energy dispersion. Each area satisfies multiple programmatic functions. For example, the lounging area is the living space as well as the sleeping space, while the steps allow for small gatherings to observe the sky by looking through the scattered openings on the ceiling.

Proto-Architectural Project This project mimics the physiological and behavioral adaptations which have allowed the polar bear to survive in the planet's harshest weather conditions. The project attempts to optimize natural local resources to provide energy needed to regulate human thermal comfort. The compact living units are partially embedded in the earth, similar to the bear's hibernation den. The units' southwest orientation optimizes the heat gain from the sun. The sun's energy, heat and light, is harvested by the active building envelope composed of hollow re-orientable fur-like glass tubes and travel to the insulating strata where the energy is stored, conserved and slowly released into the compact pod. The phosphorescent cells embedded in the phase changing material (PCM) collect light, which is slowly released at night creating an atmospheric sky-like vaulted ceiling.



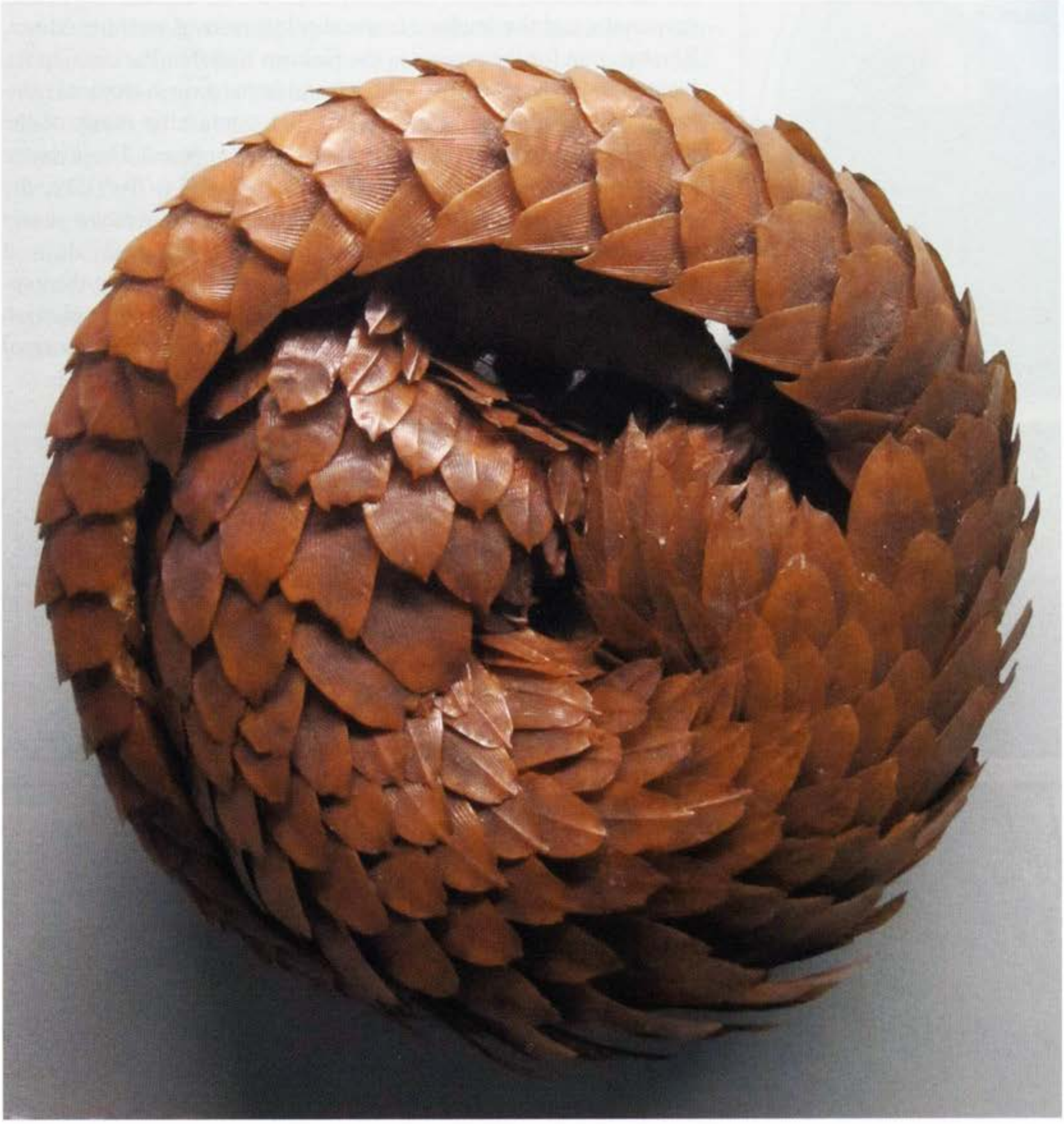
Studies of optimized shapes were facilitated by computer modeling to aid in understanding and generating complex geometries. Computational/digital studies were further developed through testing with rapid prototyping and by engaging three-dimensional drawings to further explore the inherent spatiality. These preliminary investigations are necessary to proceed in the development and fabrication of full-scale mockups to test the feasibility of current ideas and material strategies.





This structure is a super-efficient habitable cell. Its openings, diffusely directed, capture all the possible energy from the sun, accumulating light and heat and dispersing them through high-tech materials and technologies. In exploiting the available energy of the sun, this unit is a comfortable shelter, welcoming life and providing protection from the relentless environment of the extreme north.

Tree pangolin
Manis tricuspis

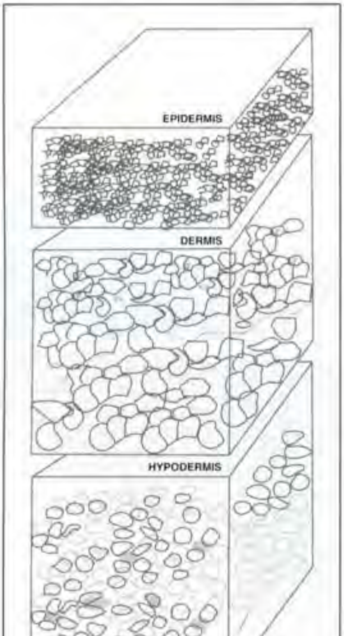


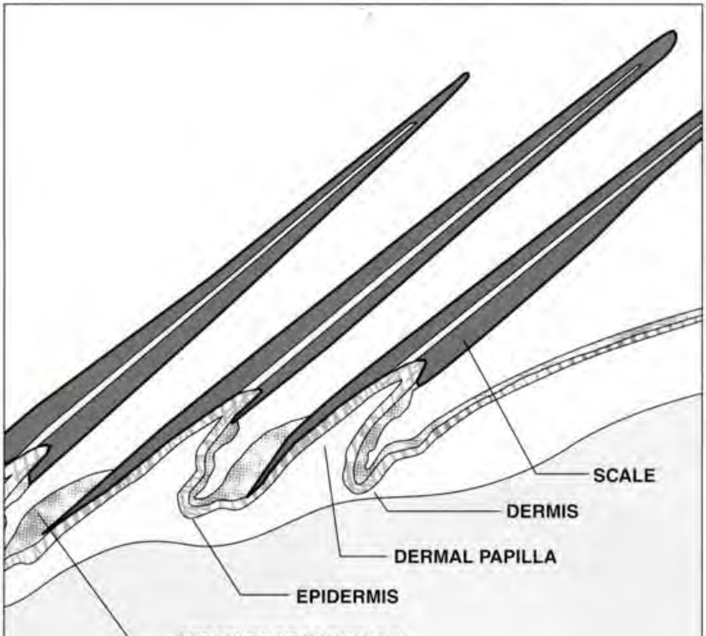
Phylum:	Chordata	**Family:**	Manidae
Class:	Mammalia	**Genus:**	*Manis*
Order:	Pholidota	**Species:**	*M. tricuspis*

Photograph courtesy of E. Simpson

Interface between the Skin & External World Like all mammals, the pangolin's skin is composed of three layers: the hypodermis, dermis, and epidermis. However, the overall physical appearance of the pangolin is dominated by large, hardened, plate-like scales that protect the animal from predators and prey. The scales are actually keratinized cells that grow from raised papillae protruding from the surface of the skin. The scales of newborn pangolins are soft but harden as they mature. The exposed outer and inner surfaces of the scales may fray through wear, but are replaced by newly keratinized cells from the middle layer.

Critically, the pangolin's skin system provides a hard protective system that maintains sufficient flexibility for the animal to climb or dig. The scales have a corrugated surface, which prevents excessive localized damage from everyday wear and tear.

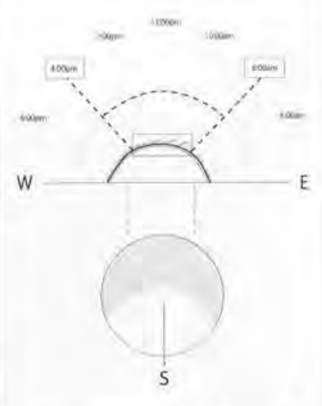




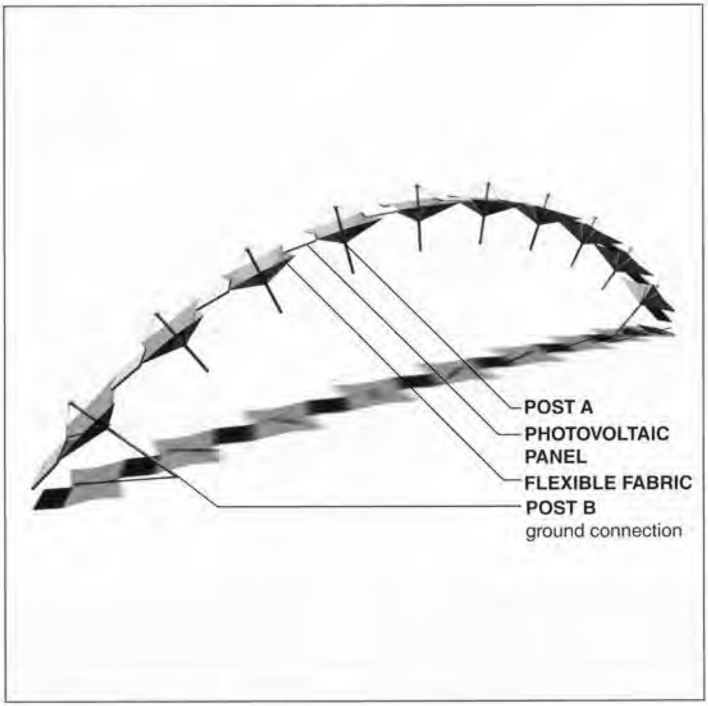
The illustration shows a detail of a cluster of the pangolin's scales. The skin and scale section show the connection of the scale to the skin and the raised papillae from which the scale growth occurs. (Photograph courtesy of K. Benirschke; diagram adapted from D. Visset; copyright credit Editiones Belin, 2006)

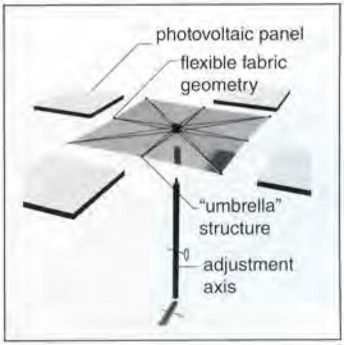
Project Documentation The shelter is designed for transportability in a series of basic pieces: photovoltaic panels, flexible translucent fabric, and a connecting umbrella-like structure. Whereas the pangolin's skin system provides protection against prey and predators, the adaptability of this shelter focuses on providing protection from undesirable environmental conditions. To address the necessity of energy, the design clads the modules with photovoltaic panels so that energy becomes readily available.

Assembly of the shelter is a multi-step process that begins by expanding the structural umbrella to stretch the protective fabric. Next, the photovoltaic panels are attached to the basic unit modules, which are then attached to form a stable arch, creating structural rigidity for the shelter. Finally, rows of unit modules are repeated until the desired volumetric space is achieved.

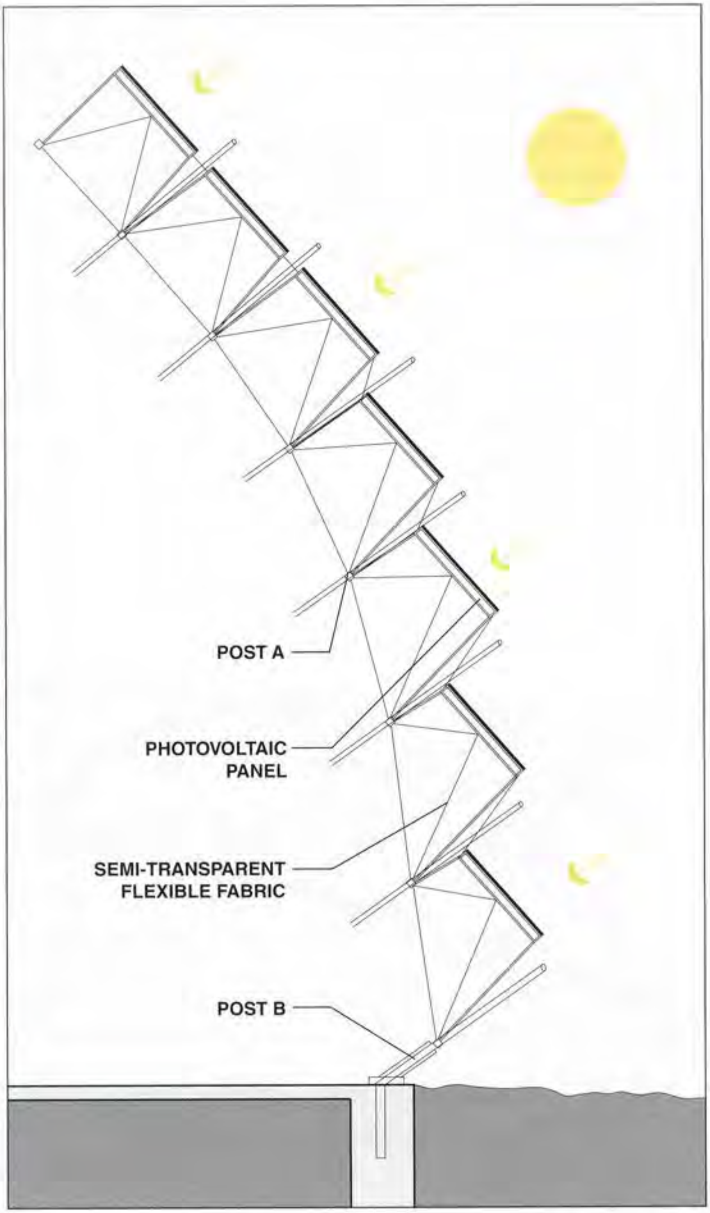


maximum solar yield diagram





A series of assembled modules lock in place to form a stable arch. The rigid photovoltaic panels are oriented to act as a protective shading element as well as to capture solar energy for use in the shelter. Right middle: singular assembled module. Right bottom: exploded diagram of an assembled module.



The diagrams illustrate the flexibility derived through the shelter's kit-of-parts assembly. En route to a disaster, the shelter elements are disassembled and shipped in small containers to make transport more effective. By opening or closing the assembled modules, the shelter envelope can be expanded or contracted to adapt to surface area and volume needs.

Inspired by the protective and flexible qualities of the pangolin skin system, the nomadic modular shelter provides protection from environmental elements while producing electricity for its inhabitants. The translucent envelope made of fabric allows an abundance of light and natural ventilation to pierce through, while maintaining a rigid tactility through principles of tensegrity.