LYS

an innovative biomimetic lighting system

Deann Garcia

8.7.15 | A10.1d

LYS

an innovative biomimetic lighting system

Deann Garcia

8.7.15 | A10.1d

Purpose

This first draft is submitted for review and consideration. Initial designs are put forward in order to gather feedback and explore ways in which to improve, before final submissions.
Additionally, permission will be requested to create a prototype for testing and research.

Contents

Deann Garcia

BRIEF

What we are looking for?
Lys, Dannish for light, is the working name for a new interior lighting system. This will be a different concept in home lighting thanwhat the consumer has seen in the past. The system should be modular, super efficient, and should give the consumer the feeling of being bathed in warm sunlight. Today's consumer enjoys being outdoors, and we want to give them the same feeling in their own homes.

Purpose & Goals
This new system is to be a connected lighting system that fulfills the lighting requirements for an entire space or dwelling. It's modular, interconnecting nature allows for ease of scale change, and can replace all the existing lighting in a home. These new lights will have qualities which remind the users of the best of the outdoors: warmth, brilliance, and that feeling of well-being that one receives from a dose of vitamin D.
Visually, the design will be clean and unassuming, not overly adorned or over-designed. It will fit into the existing Herman Miller catalog of design.
The lighting system should satisfy the requirements of the biomimetic house. Consumers are used to their heating, cooling, and other technology responding to their needs and learning from their behavior.
Ultimately, this design should reach new, outdoor-oriented consumers for Herman Miller, in a natural extension of the brand.

What will Lys do?
1 • Light up the room
2 • Feel like sunlight
3 • Accomodate different sizes and shapes of rooms
4 • Adapt to times of day
5 • Adapt to inhabitant's behavior
6 • Improve the mood of the inhabitant

What functions must Lys perform?
- Illuminate spaces
- Distribute energy (light)
- Eliminate glare and squinting
- Convert radiant energy
- Facillitate group cooperation after dark
- Create and regulate localized ecosystems
- Protect systems from light changes
- Adapt to behavior
- Adapt to changes in light
- Be assembled into different structures
- Absorb or filter energy
- Promote mental well-being

Who is Lys for?
The consumer which Lys will reach is an outdoor afficionado. S/he feels his/her best when out in nature, enjoying the best their local environment has to offer.
This person can't live outdoors all the time, though. So we want to bring that feeling of natural, warm, soothing light to the home. The consumer wants to have that feeling of peace and relaxing that s/he gets from nature, even when working, doing chores, or lounging around the house. S/he associates these feelings with an increased quality of life.
Of course, like all Herman Miller customers, this person has a great respect for impeccable design, and an appreciation for clean, modern lines, and high quality goods.

Who we are
Herman Miller is a furniture company based in Michigan, in operation since 1923. The name has become synonymous with modern design thanks to the work of great designer such as Charles and Ray Eames, Isamu Noguchi, and Yves Behar: titans of industrial design. Herman Miller seeks to bring products to the consumer that are beautiful, functional, and improve the lives of the user. Additionally, Herman Miller prides itself on high standards of responsibility and quality. We value transparency, inclusiveness, and improving the world around us as much as we value design.

HermanMiller

Deann Garcia
8.7.15 | A10.1d

PROCESS

LAP 1

Identify: What function will is perform?
The design needs to distribute light (energy)

Interpret: Translate to biology
Move light around in a way that is strategic and purposeful

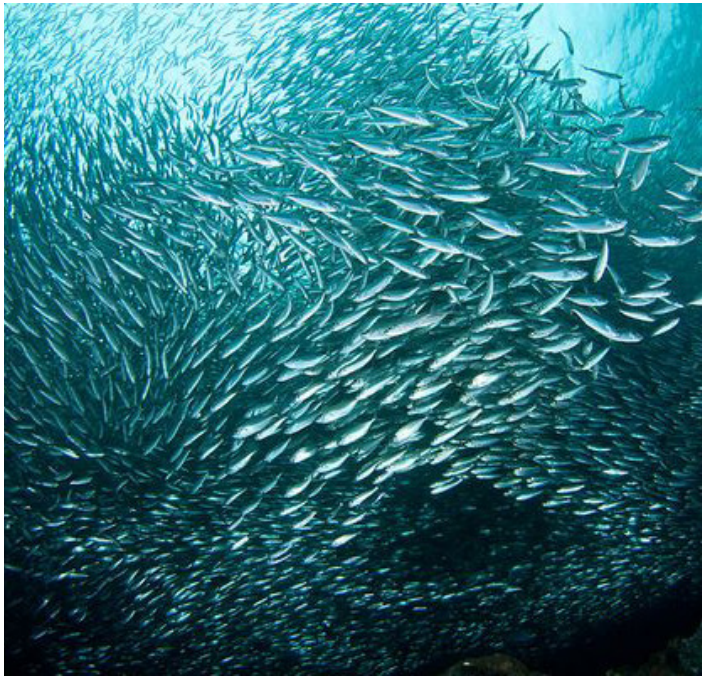
Discover: Natural models
Organism: Sardine
Strategy: Increasing light refraction using layers of crystals set at 90 degrees to each other, eliminating polarization

Description: The skin of some prey fish such as sardines is made up of layers of scales. Underneath these are an array of guanine crystals, which reflect light. It's been found that two different types of crystals occur in fish such as the sardine, reflecting light in two directions, at 90 degree to each other. This makes them the most reflective non-metallic surface known in nature. No matter the direction light hits the fish at, it is always reflected, meaning that no light is polarized and the "glare" off the fish is never tempered by angle of refraction. It is assumed that the flash indicative of these fish when they swim in large schools and the light hits them confuses predators and makes them harder to catch.

Abstract: Reverse engineer
Place reflective scales built from a metallic substance at 90 degree angles, in a "scatter" pattern upon the surface of the light-emiting device. The light will be amplified visually, especially at certain angles which might be desired.

Emulate: Design
• Reflective, angled panels could scatter light throughout a room, lighting more area than a single location light

Evaluate: Does it work?
The strategy creates light that is extra bright and unable to be tempered. While this might make the lighting system more efficient, it may also be too intense or create too much glare for interior use.



Deann Garcia

LAP 2

Identify: What function will is perform?
The design needs to distribute light (energy)

Interpret: Translate to biology
Move light around in a way that is strategic and purposeful

Discover: Natural models
Organism: Orange Puffball Sea Sponge
Strategy: Structural arrangement of spicules in bundles to move light to deeper regions of the body, allowing photosynthesis to occur away from the surface

Description: This primitive sea sponge, which is part of a family of organisms that may be some of the earliest life forms, has the ability to pull silicon from sea water and low temperature and neutral pH. This silica is arrange into bundles of tiny spicules, which refract light downwards into the deeper layers of the body. This allows photosynthesis to happen nearly anywhere in the organism, instead of only on the surface. The building of the silica cells has already been mimicked in the production of solar cells at low temperature with less energy, but the transfer strategy can also be applied to move light from outdoors to indoors.

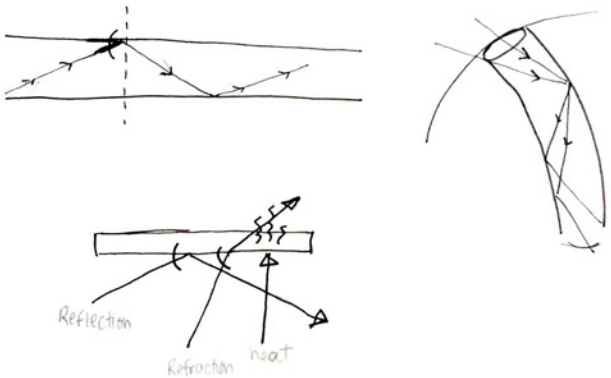
Abstract: Reverse engineer

Use tubes created from glass or glass-like material to bounce light from an entry point to an exit point, with little to no escape of energy, by capitalizing on the angle of reflection.

Organism: Begonia
Strategy: Lens-shaped scales in the leaves direct light towards photosynthetic cells, increasing the amount of available light that reaches cells which can use it

Description: Some Begonias which live on the floors of dense forests have cells which act as focusing lenses for collecting and directing light. These cells on the upper surfaces of leaves are transparent, and focus the small amounts of light that reach the forest floor on the cells within the leaves that can convert the light to energy. This gives them an advantage in areas where light is difficult to come by due to the dense plant structures in the canopy of the forest.

Abstract: Reverse engineer
Use lenses to focus dispersed light and bend or direct it in a desired direction.



HermanMiller

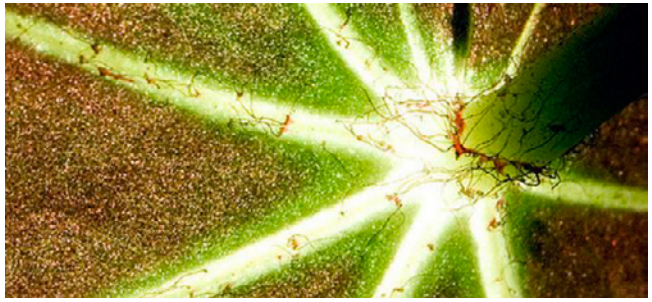
Deann Garcia

Emulate: Design

- Fiber optic cables transfer light from the outside to the inside
- Lenses at the ends of the fiber optics send the light to the desired location
- Lenses on the outside draw light toward fiber optic wires, enhancing the amount of light that enters each one.

Evaluate: Does it work?

The orange puffball's tubules closely resemble fiber optic cables, a proven technology which is highly feasible in application. Lenses are also very basic technology, which could be used in the collection of light, to amplify what reaches a fiber optic entry point.



Deann Garcia
8.7.15 | A10.1d

LAP 3

Identify: What function will is perform?
Adapt to change in light quality or amplitude

Interpret: Translate to biology
React to increases or decreases in sunlight to find balance or equilibrium, or regulate the amount of light which reaches an organism, or part of an organism.

Discover: Natural models
Organism: Sunflower
Strategy: Phototrophism or heliotrophism - the flower continually follows the sun across the sky throughout the day, always facing toward the light

Description: A "tropism" is an external response to stimuli, in this case, to light. The tip of the plat acts as the light sensor, and the middle portion is where the curving happens that allows the flower to follow the light. A chemical called auxin, which causes elongation, moves to the shaded side of the plant, pushing it toward the light source. In sunflowers, heliotropism in the bud stage causes all flowers in a group to point one direction (usually east), and they hold this position after flowering.

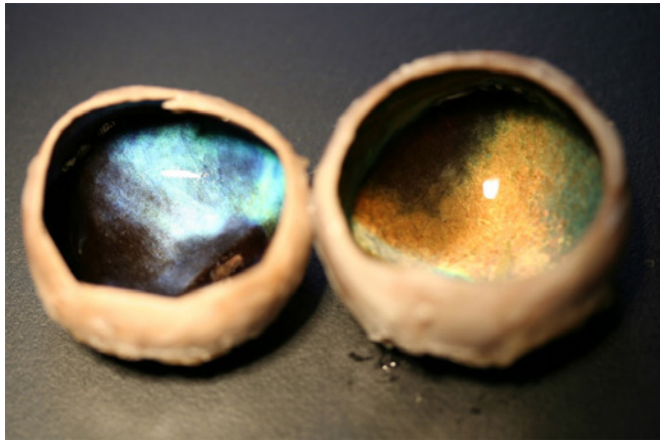
Discover: Natural models
Organism: Reindeer
Strategy: Extreme changes in lighting between summer and winter in the Arctic trigger changes in the color of the reindeer's eyes, to amplify sight.

Description: During the long dark of winter, reindeer eyes are constantly dilated. A flap drops down, increasing the pressure behind the eye and changing the color of the retina. The color reflects the best wavelengths for seeing in the dark.

Abstract: Reverse engineer
Gyroscopic devices could be used to follow already known and calculated patterns of the sun across the sky, based on geographic location and time of year. Alternatively, more directly inspired by natural processes, chemicals which swell or shrink based on exposure to light can be used to tilt the angle of a light collector, increasing the total amount of light that can be collected through out the day.

Emulate: Design
- Gyroscopes keep the opening pointed always at the sun, with the main opening always on the tip of the roofline

Evaluate: Does it work?
If the light collector on the outside of the house could always point toward the sun, no matter where the sun might be, light could be collected throughout the daylight hours. This could be a very useful function.



Deann Garcia

LAP 4

Identify: What function will is perform?
Adapt to change in light quality or amplitude

Interpret: Translate to biology
React to increases or decreases in sunlight to find balance or equilibrium, or regulate the amount of light which reaches an organism, or part of an organism.

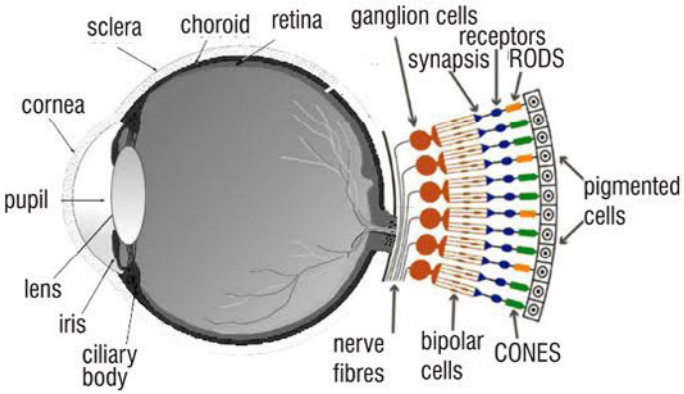
Discover: Natural models
Organism: Human eye
Strategy: Adjust to changes in the amount of light in an area by changing the amount of light let in (pupillary reflex) and changing the sensitivity of rods and cones in the eye to be at the optimal "setting" for a given light situation

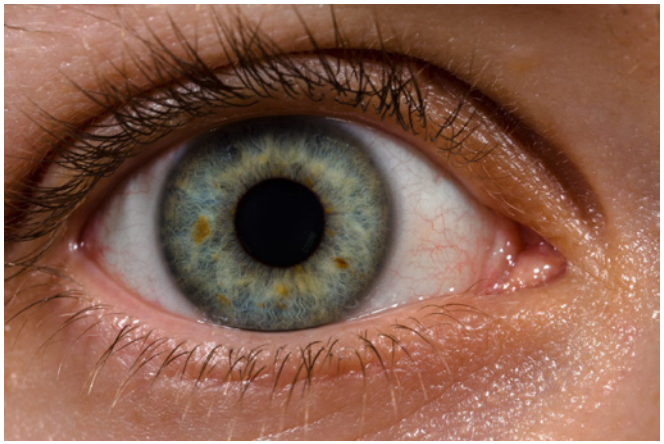
Description: Moving from a bright area to a dark one, the pupil expands in size to let more light in. At the same time, the rods and cones adjust from photopic to scotopic vision over the course of 5-30 minutes, changing the way the eye processes light. Rhodopsin, a biological pigment in the eye, photobleaches instantly in response to light, and takes time to adapt when light is absent. Rods take longer to regenerate than cones, and only cones can perceive color. Therefore, once rods have taken over in a dark environment, color is only seen in terms of light and dark. Adaptation to dark depends upon the intensity and duration of light, the location of a specific rod or cone on the retina, the wavelength of light, and the speed at which rhodopsin is able to regenerate.

Abstract: Reverse engineer
An aperture opening allows varying amounts of light to pass through based upon size. Under brighter light conditions, or more intense light, the opening reacts by shrinking, and restricting the total amount of light that passes through. Under low-light conditions, the aperture opens wide in order to allow the maximum amount of light to enter.

Emulate: Design
- Less light is allowed inside during peak hours in order to dim a room, using an aperture on the outside
- Indoor apertures allow light to be shut off or dimmed from the inside.

Evaluate: Does it work?
By adjusting the amount of light that enters the device, the total luminance of the interior light can be controlled successfully. However, the usefulness of reducing the amount of incoming light is questionable. It's most likely more important to amplify existing light than reduce it. Individual dimmers on the inside are more useful.





Deann Garcia

LAP 5

Identify: What function will is perform?
Be assembled in different ways to adapt for different environments

Interpret: Translate to biology
Be capable of being broken down into smaller parts and still survive. Be able to grow in different shapes and orientations in reaction to environmental factors.

Discover: Natural models
Organism: Fungi
Strategy: Modular organism structure. Each part (cell) contains all the functions of the organism, so that each small part can live independently.

Description: Fungi often have a branching structure with an overall shape that is determined more by environmental factors than by determinants within the organism. Each cell is capable of reproducing and living independently.

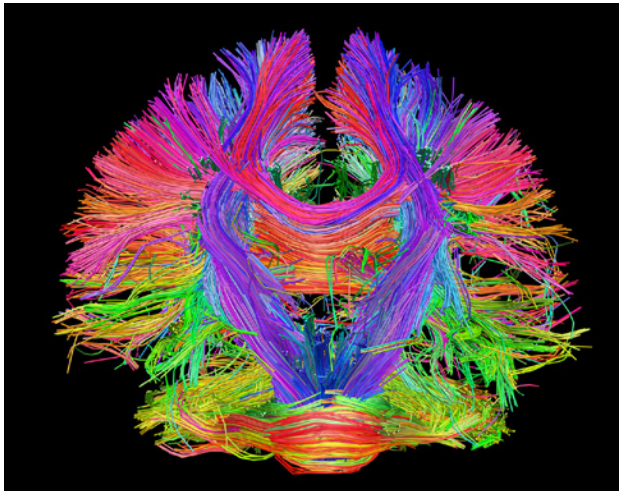
Organism: Human brain
Strategy: Highly connected structure of hierarchical modularity makes each unit within the structure highly networked and capable of producing redundancies in the case of unit failures.

Description: The human brain contains many smaller units which each has a unique and complicated function. If one unit is damaged, however, it is often capable of creating a redundant or duplicate function in another unit. This is made possible by the fact that each functional unit of the brain is to highly networked through the nervous structure.

Organism: Wasp
Strategy: Pack nests together using shapes that fit without gaps (hexagons) in order to be efficient with space.

Description: Wasp nests are built from hexagonal shaped material that resembles paper. The wasps fill the shapes with food or larvae. The hexagonal shape of the nests enables the nest to fit close together without any gaps, for efficiency of space as well as structural integrity.

Abstract: Reverse engineer
Networks and connections between functional units create great protections against damage from separation through redundancies.



HermanMiller

Deann Garcia

Emulate: Design

- Self-contained units could be locked together to form larger lighting units, or small ones, as needed
- Networks of fiber optic cables could spread light throughout a highly connected system of light emiting units
- Create units that nest together without any gaps, so that the units can be configured in ideal ways for each space.

Evaluate: Does it work?

Small units with great flexibility would be ideal for the design problem at hand. While strongly networked systems are resilient and resistant to damage, that is not an issue that is at hand here. In this case, the networks might become cumbersome and difficult to manage.

Deann Garcia

SUMMARY

Function
Distribute light (energy)

Strategy

Reflect light, like a sardine

Transfer light, like a sea sponge

Focus and direct light, like a begonia

Function
Adapt to changes in light

Strategy

Follow the light, like a sunflower

Change the size of the aperture, like a human eye

Change color and pressure, like a reindeer's eye

Function
Be assembled in different ways

Strategy

Be modular, like a fungi

Have hierarchical modularity, like the human brain

Fit closely and without gaps, like a wasp nest

Deann Garcia

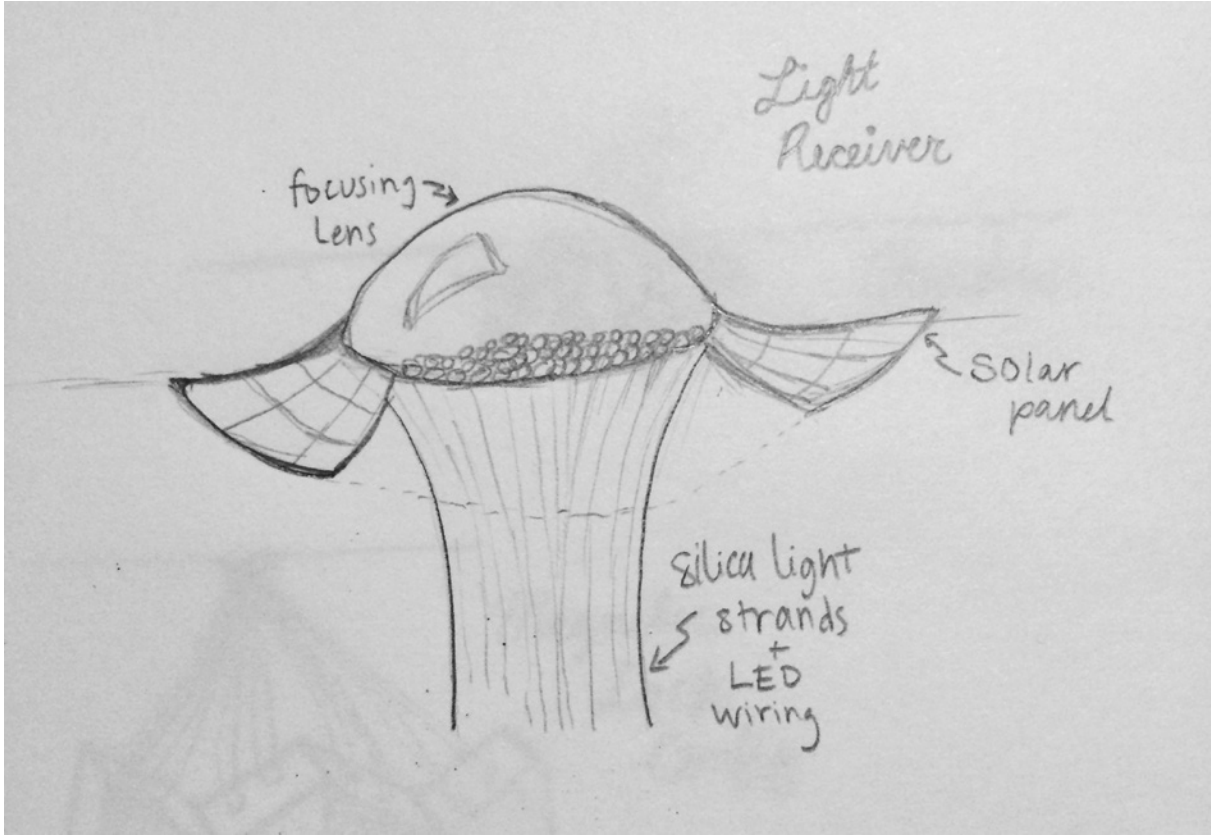
PRESENTATION

Final Design

The completed design draws upon several strategies identified in the design spiral process. The design consists of a system of fiber optic wires which draw light from the outside of a house into the inside rooms. Large lenses above each cluster of fiber optics increase the amount of light that each collects.

On the inside of the house, angled panels scatter light in areas that require all-over light, while smaller units direct light into nooks and crannies and areas that require more intense lighting. The units are modular and can be assembled however is best for a given interior space.

A sensor located on the rooftop unit helps to guide the behavior of the system. When light is plentiful, the secondary lighting system (LEDs) are inactive. When light is blocked (by clouds, or the earth's rotation), the secondary lights kick in.



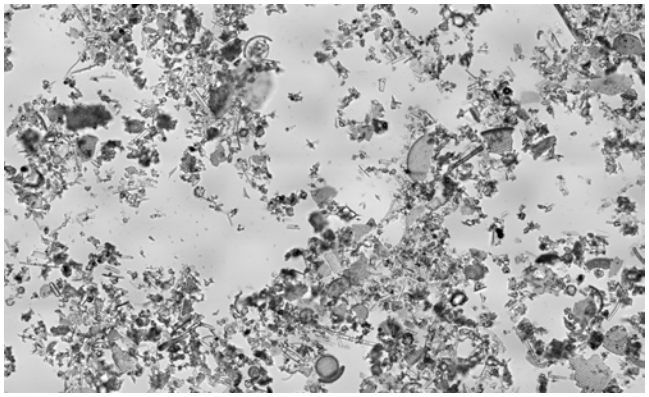
LYS

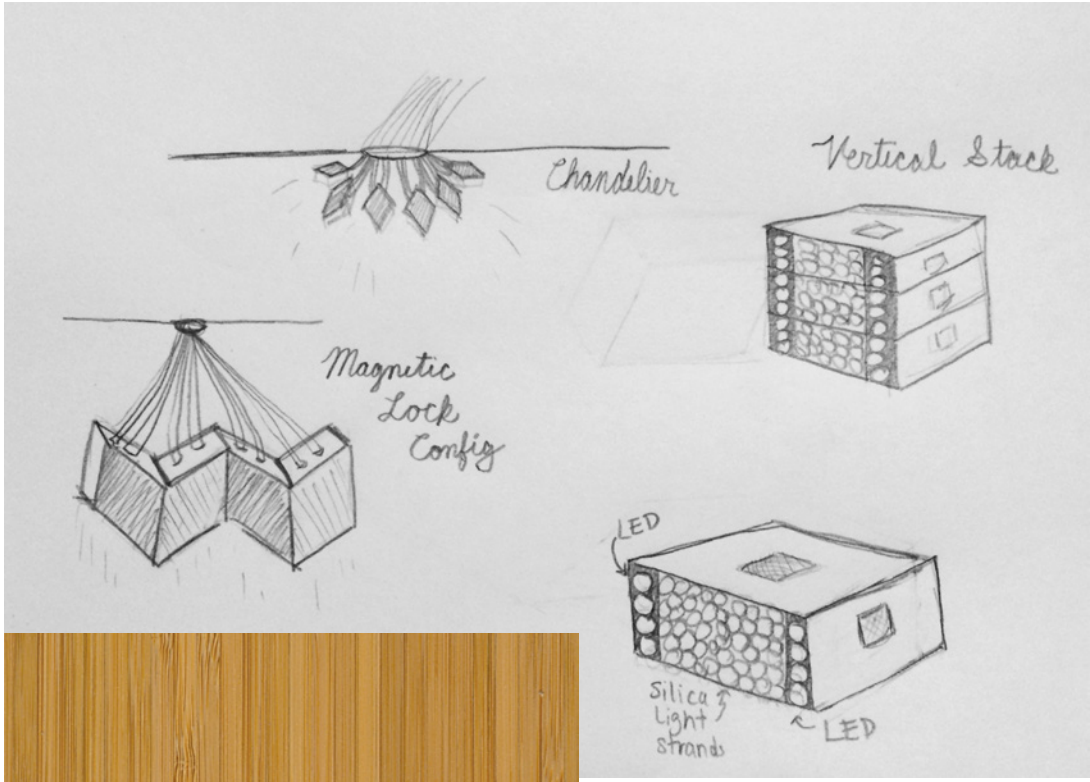
an innovative biomimetic lighting system

Deann Garcia

8.7.15 | A10.1d

In order to account for times when there is no outside light to be had, each unit is equiped with two rows of LED lights. The lights are powered by solar panels which wrap around the edges of the light receiver. During times of excess power generation, other devices can be plugged into the solar panels for charging.
Magnets on the edges of the light units allow for easy configuration into different hanging or stacking units where extra light is needed.
Materials used include bamboo and oceanic silica. By using natural materials that don't require harsh chemistry or high heat for production, the units can be manufactured with minimal impact.





HermanMiller

Deann Garcia

EVALUATION

Condition 1: Life Adapts and Evolves

How is Lys successfull?

Lys is locally attuned and reponsive.
The lens that focuses the sun's light follows it in its path across the sky. This maximizes the amount of light collected, and relies upon being tuned in to the location and movement of the sun by time of year and time of day. The sensor in the device monitors the light intake at all times and triggers the most appropriate light source.

Lys integrates cyclic processes.
The light only can collect light during the day time, when outdoor ambient light is plentiful. This puts it in a cyclic pattern, where it light pours in then shuts off. It changes by time of day and time of year.

Lys uses free energy.
Lys uses no energy from the grid. It thrives entirely off energy available all around, streaming down from the sun all throughout the day.

Lys uses simple, common building blocks.
The units are modular and can be snapped together to create fixtures that emit more light, or kept small and individual for small or focused lighting needs. Regardless of the size, the parts that make up the units are the same.

Lys is resourceful and opportunistic.
By drawing upon readily available ambient light, Lys transfers the light that is already being produced to more strategic or desirably locations, rather than consuming energy to create more light that didn't exist before.

Lys is redundant.
Multiple sources of light (LED and sunlight) and multiple sources of power (solar and grid) make the system resilient throught redundancy.

Lys uses feedback loops
The built-in sensor learns as it collects data about sun position and user behavior, optimizing the system as it gathers feedback and adjusts accordingly.

Condition 2: Life Creates Conditions Conducive to Life

How is Lys successfull?

Lys optimizes rather than maximizes.
The strategy of collecting and distributing existing ambient sunlight, as opposed to using energy to generate light, will never result in the brightest rooms possible at all times. But, it will always be the most efficient use of energy while in use.

Lys uses benign manufacturing.
By collecting light, there is zero impact in the manufacturing of light for an indoor space. Low impact and natural materials, like bamboo and oceanic silica instead of hardwoods and glass, reduce the need for hard chemicals and high heat.

Lys merges form and function.
The design of the light emiting units draws upon principles of close packing. They are both effective in directing light, and in locking together into larger fixtures when needed. The form enables the units to be customized so that they function most appropriately for each use case.

Lys is multifunctional.
When excess power is generated by the solar panels, other devices can be plugged in and powered, adding functionality to the lighting system.

PROPOSAL

Proposal: Create a prototype
After following the design spiral process for multiple cycles, exploring the identification, translation, discovery, abtraction, and emulation phases several times, a final design has been developed. Now, it is vital to create a prototype to test the design of the product. The only way to verify that the principles from biology have been used correctly and effectively is to create it and put it through the rigors of testing.
We propose that the next step in the product development process be to fund the development of a prototype for just this testing purpose. The product can then be evaluated for technical effectiveness, consumer acceptance, and commercial viability.

Proposal: Incorporate Lys technology into the Herman Miller line
At this juncture, Lys is the only system of its kind on the market. If the system is proven to be effective, attractive, and have consumer appeal, it is proposed that the technology behind it be incorporated further into the Herman Miller line.
Rooftop units could potentially be installed in many houses in a standard size and format. There is no need for design adjustments to be made to this part of the product in order for it to mesh with other fixtures. Herman Miller could expand the line to include many other styles of fixture, different finishes and matertials, sizes and shapes. The silica light strands could simply be engineered to plug into the backs of many existing products in the Herman Miller line.
The expansion of the line could add many efficiencies and make for a broader appeal for the design. Most customers could be served with different needs and desires, and of course, price point restrictions.

If the Lys system were to be adopted by Herman Miller in the form presented herein, it could truely become a game changer in the home lighting industry. Expansion into office and industrial space would be a natural and inevitable next step, should the concept be proven through use.