Biomimicry

Biological Mentor: Example 2

by Deann Garcia, Wai-Jing Man, Shanna Ruyle & Alyssa Yatabe (2014)

Comments:

Very good work. The problem statement from the design brief was clearly stated, and it was also rephrased for biology. The biological rephrasing could've been sharper, but I see you're using phrasing from AskNature's taxonomy, which probably helped your search. You had more than four strategies from different mentors, including two from AskNature and one from another source. Each strategy was illustrated and described, including organism names & citations / URLs. Great that you specifically titled sections "manufacturable version" to frame your presentation concretely. Good presentation--it could've been more concise, you actually didn't need so many images of each idea, but not a problem.

Your strategies #1 (lotus leaf) and #5 (Morpho butterfly) are the same, but that's okay--if you find the same strategy being used by several different organisms, that usually means it's a good strategy. They're probably the most promising strategy here. The earthworm EOF strategy is very interesting, never heard of it before, but I don't think it'll work in the manifestation you're describing on jeans. The high-contrast ultra-black might reduce the need for washing because its contrast might hide dirt better; or it might actually show dirt more, I don't know, but would be interesting to try. I'm not convinced of the practicality of #4's rubbing patches, but I love the creative reframing of the jeans as not being a singular product and being an ecosystem, would be interesting to explore what other ideas that could generate.

TARGET BLUE JEANS

BIOMIMICRY FROM MENTORS

Week 12 | Assignment 12.1 | 11.20.14

Deann Garcia, Wai-Jing Man, Shanna Ruyle & Alyssa Yatabe

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BIOLOGICAL REPHRASING

DESIGN BRIEF PRIORITY:
Decrease environmental impacts during use phase
Metric: 50% reduction in water use; 75% reduction in electricity use

BIOLOGICAL QUESTION:
How would life protect itself from external forces (such as unfavorable temperature, build-up of debris, and abrasion) using locally abundant resources?

PRELIMINARY STRATEGY EXPLORATION

STRATEGY: Wing surface self-cleans
ORGANISM: Morpho Butterfly
CITATION: http://www.asknature.org/strategy/f7044d096233ab3467a75d1337fd52ad#.VGviNlPF99o

STRATEGY: Body resists soil adhesion
ORGANISM: Dung Beetle
CITATION: http://www.asknature.org/strategy/548209da4a08f51745721ac9d54b4f96#.VGvjuVPF99o

STRATEGY: Wing scales regulate heat while enhancing the brightness of color
ORGANISM: Ultrablack Butterfly
CITATION: http://www.asknature.org/strategy/9abb17b27c6a15d202031601fad5ffe5#.VGwMrNbD9_0

STRATEGY: Body sheds dirt particles
ORGANISM: Stonefly Larvae
CITATION: http://www.asknature.org/strategy/7a4e1949950e53125cd448e00fe8bb7d#.VGwY8_mUeSo

STRATEGY: Stretchable architecture resists breakage
ORGANISM: Bull Kelp
CITATION: http://www.asknature.org/strategy/6e94142795b41ee219eba00edd62f503#.VGwa4lPF99o

STRATEGY: Color resists bacteria
ORGANISM: Parrots
CITATION: http://www.asknature.org/strategy/0c72993e62464390affa57ab413aec87#.VGwedki7mig

STRATEGY: Completely drying out
ORGANISM: Bdelloid Rotifer
CITATION: http://www.asknature.org/strategy/3e5009da1724085f6205d206c844e9ff#.VGwhOUi7mig

STRATEGY: Hydrophobic surface from molecular structuring
ORGANISM: Lotus and Rice Leaves
CITATION: http://dns2.asia.edu.tw/~ysho/YSHO-English/1000%20China%20%28Independent%29/PDF/Adv%20Mat14,%201857.pdf // http://www.mdpi.com/1420-3049/19/4/4256/htm

STRATEGY: Hydrophobic sand resists water
ORGANISM: Sand containing organic matter
CITATION: http://www.sciencedirect.com/science/article/pii/S0022169400001827

STRATEGY: Convex geometry resists adhesion
ORGANISM: Pumpkin
CITATION: http://www.sciencedirect.com/science/article/pii/S1672652907600109

STRATEGY: Electric current reduces friction
ORGANISM: Earthworm
CITATION: http://www.sciencedirect.com/science/article/pii/S1672652907600018 // http://eol.org/pages/3126801/details

STRATEGY: Multi-species cooperation/ providing ecosystem services
ORGANISM: Fir, Oak and Cherry Trees with Lichen, Moss and Mushrooms
CITATION: http://leafleaping.blogspot.ca/2014/11/a-good-freeze-and-time-with-trees.html

STRATEGY: Acceptance of a certain level of debris
ORGANISM: Fir, Oak and Cherry Trees with Lichen, Moss and Mushrooms
CITATION: http://leafleaping.blogspot.ca/2014/11/a-good-freeze-and-time-with-trees.html

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STRATEGY #1: Hydrophobic surface from intentional molecular structuring repels liquids and self-cleans

ORGANISM:

Lotus Leaves (and other similarly structured plant leaves)

STRATEGY SUMMARY:

A phenomenon known as superhydrophobicity is commonly found in plants which have found a way to clean dirt particles from the surfaces of their leaves, using water droplets which collect on the surface. The surface of a lotus leaf is not flat; it is made up of microscopic ridges that are at an angle of near 160 degrees (referred to as the water contact anle). This causes droplets of water, held together by surface tensions, to slide off the surface. Foreign dirt particles cling to water droplets as they roll by, because there is more surface area and surface tension on the water droplet then on the leaf surface.

MANUFACTURABLE VERSION:

Nanotechnology can be used to create surfaces that mimic this texture and pattern. When applied to the top surface of a fabric, they can display the same properties of hydrophobia and surface self-cleaning when sprayed with water.

Currently, flourochemicals and silicone treatments have been developed that can be applied to fabrics or used ask a paint or surface treatment which mimic the surface properties of the lotus leaf. Application to a pair of jeans results in a surface which has DWR (durable water repellent) properties. Such jeans could be cleaned by simply spraying with a water bottle, and allowing the water droplets to run down and off the fabric surface, taking dirt particles with them.

REFERENCES:

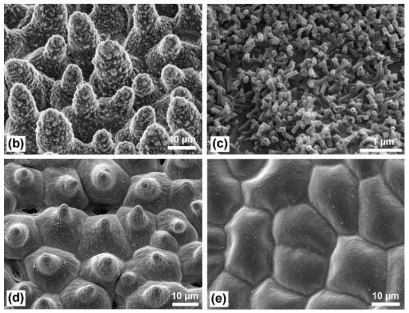
http://en.wikipedia.org/wiki/Lotus_effect

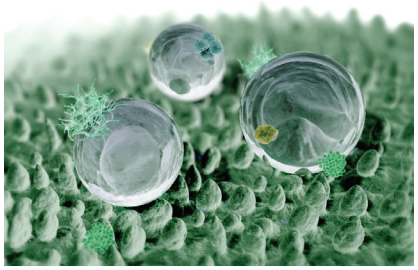
http://dns2.asia.edu.tw/~ysho/YSHO-English/1000%20China%20%28Independent%29/PDF/Adv%20Mat14,%201857.pdf

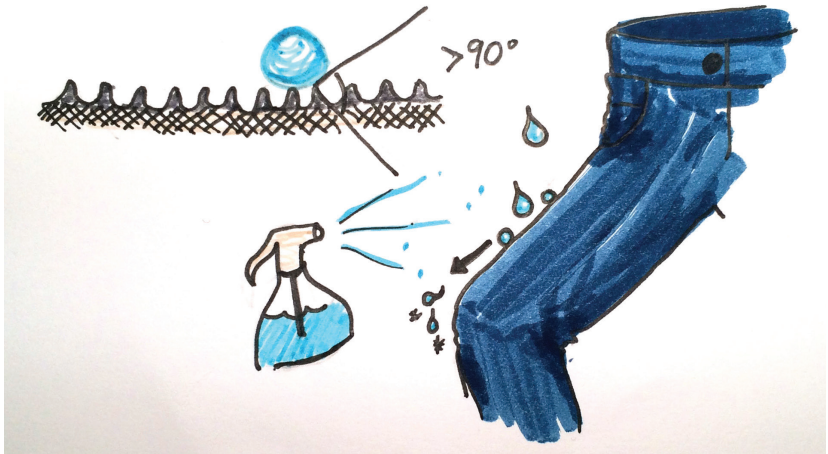
http://www.mdpi.com/1420-3049/19/4/4256/htm

http://www.beilstein-journals.org/bjnano/single/articleFullText.htm?publicId=2190-4286-2-19

http://www.easywildflowers.com/quality/ner.lu2.jpg







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STRATEGY #2: Ultra-black pigments assist in thermoregulation and make colors more attractive and bright

ORGANISM:

Green Birdwing and Ultrablack Butterflies

STRATEGY SUMMARY:

Wing scales are shaped like honeycombs, which absorb more light than would differently shaped scales. V-type ridges adjacent to one another have lower refraction values than other shapes, such as flat scales. As a result, black scales appear super-black, offsetting the colors around them, and making other colors appear brighter in comparison. In addition, the black scales keep body temperature up by absorbing and regulating heat from sunlight.

MANUFACTURABLE VERSION:

Super-black, ultra dark jeans could be woven and coated with a honey-comb shaped surface treatment. Such jeans would be useful in cold climates or in the winter, to absorb light and heat and keep the wearer warmer than a traditional pair of jeans.

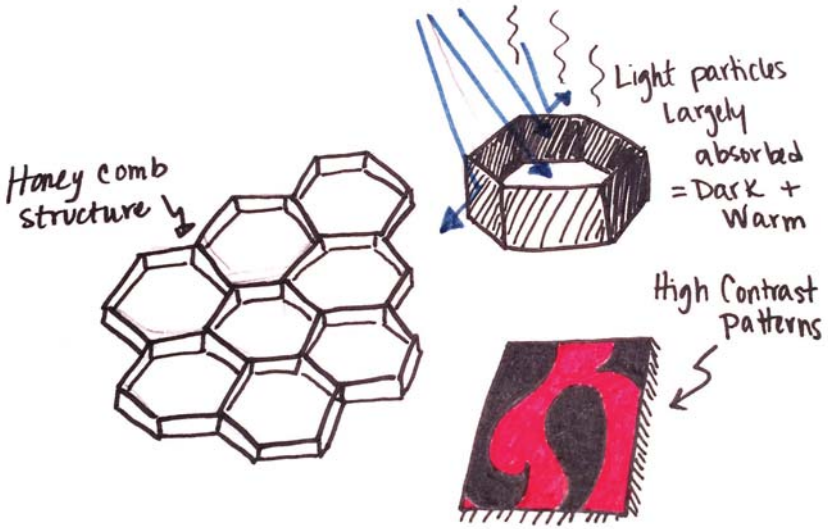
Additionally, jeans could feature bright color patterns, placed adjacent to super-black areas. The resulting patterns would have a higher contrast value and therefore appear brighter to the eye. Jeans then become eye-catching and more attractive to other people, fulfilling the fashion-oriented outcomes of wearing jeans: attracting the attention of others.

REFERENCES:

http://www.asknature.org/strategy/9abb17b27c6a15d202031601fad5ffe5#.VG2DuNbD9_1

http://www.nature.com/news/2004/040128/full/news040126-4.html

http://en.wikipedia.org/wiki/Papilio_ulysses



STRATEGY #3: Electric current reduces friction

ORGANISM:

Common earthworm

STRATEGY SUMMARY:

When an earthworm is moving through soil, the flow of a thin layer of water is formed in the vicinity of the earthworm's body surface, otherwise known as electro-osmotic flow (EOF). The water is extracted from locally available water supplies from the interstitial spaces of the soil. This microscale EOF acts as lubrication between the earthworm and the moist soil and reduces surface adhesion.

MANUFACTURABLE VERSION:

Option 1 is a durable water repellent (DWR) finish added to the fabric. Newer DWRs contain short perfluoroalkyl chains which are less toxic to the environment (but still have potential byproducts of concern) and have comparable soil & water repellency to long chain DWRs (P05 Project Team).

Option 2 is a remanufacturing of the fabric into a layered fabric. The base layer would be cotton which has good moisture wicking properties and is comfortable against the skin. Moisture is transferred to the shell layer, spandex, which provides elasticity and allows the water to remain on the surface rather than absorbing it.

REFERENCES:

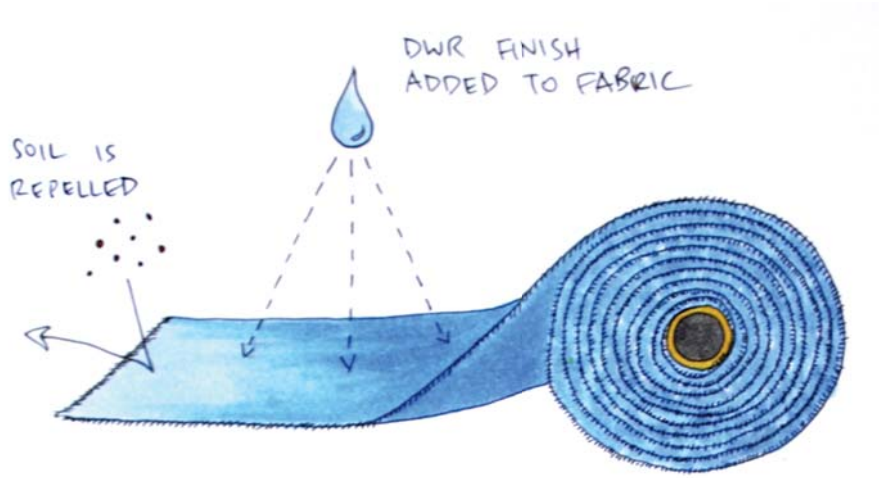
Gao, Fengge et al. "A Preliminary Study of the Surface Properties of Earthworms and Their Relations to Non-Stain Behaviour". *Journal of Bionic Engineering 7.1* (2010): 13-18. Web. 19 Nov 2014.

"Lumbricus terrestris". *Encyclopedia of Life.* EOL. n.d. Web. 18 Nov 2014. <http://eol.org/pages/3126801/details >.

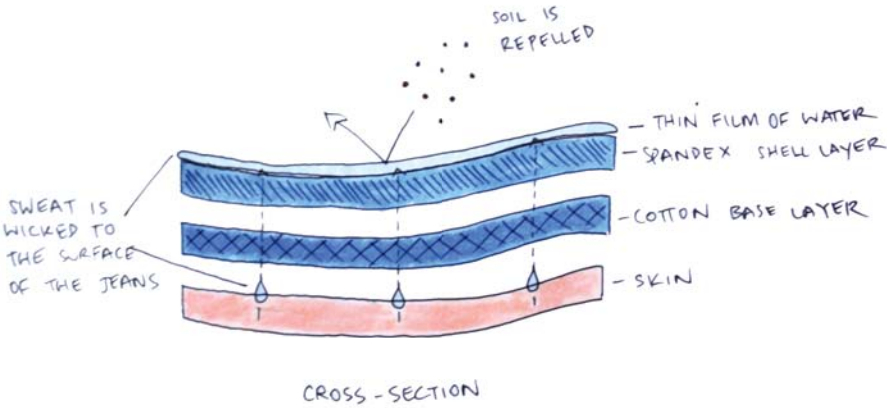
P05 Project Team. "Durable water and soil repellent chemistry in the textile industry - a research report". *P05 Water Repellency Project 1* (2012): 1-52. Web. 19 Nov 2014. <www.roadmaptozero.com/df.php?file=pdf/DWR_Report.pdf>.

Zu, Y.Q. and Y.Y. Yan. "Numerical simulation of electroosmotic flow near earthworm surface". *Journal of Bionic Engineering 3.4* (2006): 179-186. Web. 18 Nov 2014.

OPTION 1



OPTION 2



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STRATEGY #4: Multi-species cooperation / providing ecosystem services

ORGANISM:

Fir, Oak and Cherry Trees with Lichen, Moss and Mushrooms

STRATEGY SUMMARY:

Multi-species cooperation allows for stronger ecosystems.

"Ecosystems are dynamic entities—invariably, they are subject to periodic disturbances and are in the process of recovering from some past disturbance."[1]

Since jeans, too, are "subject to periodic disturbances," of physical debris or odor that requires the consumer to use water and electricity to remove, creating an ecosystem within the jean would allow for the consumer to use less.

MANUFACTURABLE VERSION:

To turn a pair of jeans into an ecosystem, services need to be added. To use the least additional materials possible, back pockets could be recruited for debris and freshening services to the whole jean. While the exterior of the pocket could function as a fashion detail, the interior side could include a debris removal surface and a freshening surface. These surfaces could be incorporated into one or both of the pockets. The pocket that would provide the service would need to be developed to be removable. The debris removal could be as simple as a textured rubbing surface and the freshening service could incorporate a product such as Reviver, a reusable surface freshener or PureAyre, a food grade freshener that would need to be developed into a surface based treatment.

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[1] "Ecosystem." Wikipedia. Wikimedia Foundation, 18 Nov. 2014. Web. 20 Nov. 2014. <http://en.wikipedia.org/wiki/Ecosystem>.

"Eliminate Foul Odors Instantly with PureAyre The All Natural Odor Eliminator Spray." Odor Eliminator. PureAyre.com, n.d. Web. 20 Nov. 2014. <http%3A%2F%2Fwww.pureayre.com%2F>.

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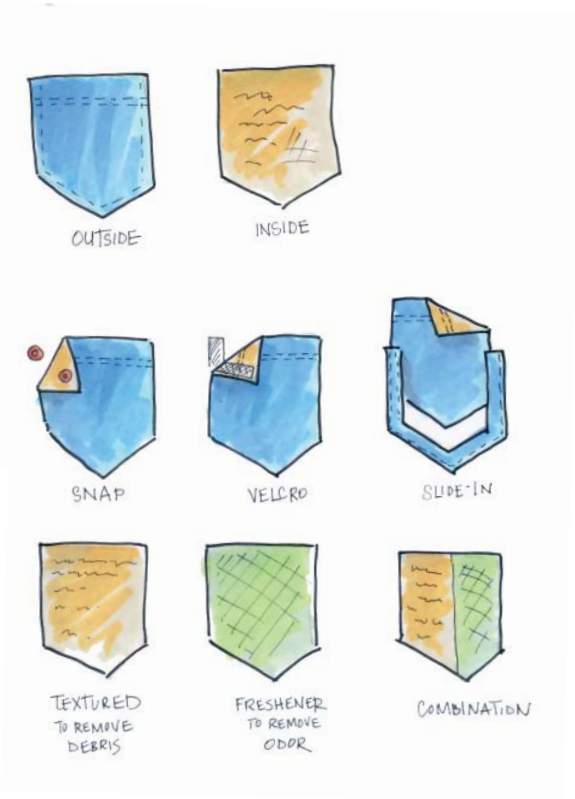

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STRATEGY #5: Wing surface self-cleans

ORGANISM:

Morpho Butterfly

STRATEGY SUMMARY:

The micro-topography of a morpho butterfly's wings features a rough surface that decreases the contact area and reduces adhesion forces on liquids. The self-attraction of the polar molecule allows liquids to then form into spheres, which are able to just roll off the wings taking dirt and contaminants along with them without using detergent or energy.

MANUFACTURABLE VERSION:

A finishing coating such as NanoSphere® can be applied to the surface of the denim fabric.

The NanoSphere finishing technology mimics the structure and properties of insect wings and plant leaves by adding a rough, textured surface structure at the nanoscale to textile fabrics. This creates an uneven surface that water cannot easily adhere to and allows it to simply roll off, removing dirt and other debris in the process. By coating the fingerings around the individual fibers of the fabric, NanoSphere is able to produce a hydrophobic, self-cleaning fabric that also remains breathable and flexible to the wearer.

REFERENCES:

GEBESHUBER, ILLE C., Prof. "Wing Surface Self-cleans: Morpho Butterfly." AskNature. N.p., n.d. Web. 18 Nov. 2014. <http://www.asknature.org/strategy/f7044d096233ab3467a75d1337fd52ad#.VGviNlPF99o>.

"NanoSphere®." Schoeller Tech Switzerland. Schoeller TECHNOLOGIES AG, n.d. Web. 19 Nov. 2014.

IMAGE SOURCES:

Butterfly: http-//www.stories-for-children.ca/morpho-butterflies

Scales: Courtesy of Carolina Biological Supply Company

NanoSphere: http://www.schoeller-tech.com/textil-technologien/nanosphere/#all