Biomimicry

Biological Mentor: Example 1

by Stefanie Koehler, Shannon Rahkola, and AnnMarie Thomas (2011)

Comments:

Very good work. The problem statement from the design brief was clearly stated, and it was also clearly rephrased for biology. There were more than four strategies, including two from AskNature and one from another source. Each strategy was illustrated and described, including organism names & citations / URLs. Great presentation--nice layout, as well as the images of the biological mentors and quality product implementation sketches.

The cocklebur mentor has the existing product Velcro, which is fine, a good idea, but would've been nicer to mention that. For the mussels, nice finding the JoinLox product that does that. For the cat claw hooks, I'd want to see how it's built, how the hooks all move together but don't come loose on their own. The honeycomb won't help with attachment, but might save cushioning material and provide breathability. Its modularity is an interesting idea, for grades of softness. I doubt the suction cups would hold well. The ligament idea is interesting--what specific materials did you have in mind?

Steelcase :: Modular Seating

Biological Mentors For Green Redesign

ORIGINAL PROBLEM PATTERN

- Time-consuming to take apart
- Very difficult to separate materials
- Materials have no recycled content
- Materials are not able to be recycled (except the steel leg option)
- Chair weights about 40 lbs, 18 kg each

CURRENT DESIGN PRIORITY

Design for disassembly, recyclability and reuse.

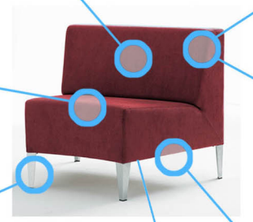
METRIC :: 90% of chair materials kept out of the landfill system

BIOLOGY PROBLEM QUESTION

How would nature create a structure which could be taken apart easily?

STRATEGIES FOR REDESIGN

CIRCA CHAIR MATERIAL BREAKOUT



FRAME :: Plywood
- Cut, finished , glued, and screwed together

UPHOLSTERY :: Fabric (various types)
- Plants harvested, fabric fibers made into thread, woven together and treated to be fire-resistant

CUSHION :: Polyurethane Foam
- Injection molded into various densities, layers and glued onto the chair frame

UPHOLSTERY PROTECTION :: Plastic film
- Extrusion blow molded LDPE film processed, cut and stacked over the chair to protect the foam, stapled to the frame with the upholstery fabric

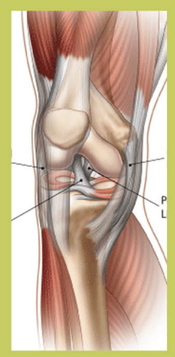
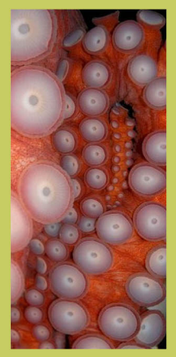
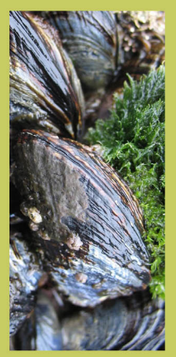
LEGS :: Wood or Metal (Maple, Walnut, or Steel)
- Wood leg milled, stained, and bolted onto the bottom of the chair - Steel sheet is stamped, texturized and shaped into the form-Rubber grip is glued to the bottom

FASTENERS :: Steel staples, screws and bolts
- Hundred of staples used to fasten the fabric to the frame, screws used for the frame construction, and bolts for the legs

MISCELLANEOUS :: Randoms
- Little parts and pieces that are used in the various 'sub-assemblies' of the chair, such as adhesives, plastic strips and washers

PLACES TO APPLY REDESIGN STRATEGIES

Creating easy-to-disassemble parts based on nature's solution.

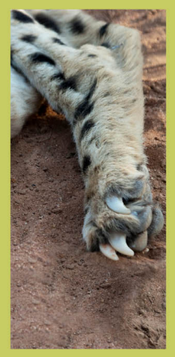


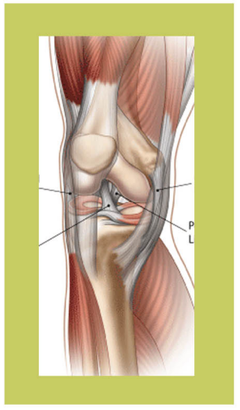

Image Sources :: Coalesse.com, asknature.org, breg.com/patient_education, science20.com/squid_day/squid_who_make_glue-84481, jonastonboe.com

Steelcase :: Modular Seating

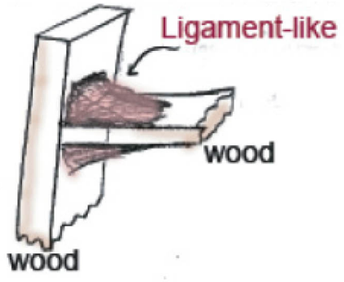
Biological Mentors For Green Redesign

Creating easy-to-disassemble parts based on nature's solution.

STRATEGIES FOR REDESIGN



ATTACHING THE FRAME

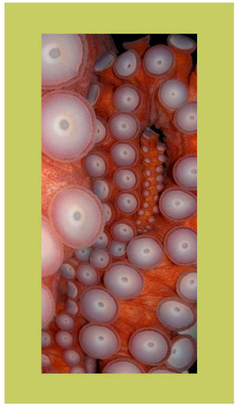


Biological Mentor :: Human Body

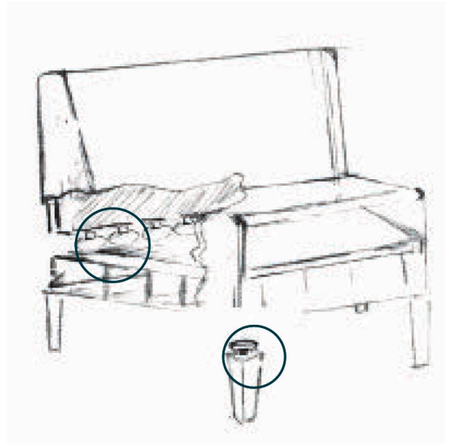
Strategy :: Biodegradable Joints
Ligaments which hold together bones in many mammals, and then biodegrade when the animal dies

Application ::
Instead of staples or glues, a ligament-like polymer could be made which degrades either (a) after a certain amount of time, or (b) when exposed to specific conditions (like very high heat).
Designing such a material seems feasible, but would require some material science and chemistry research.

Reference/Source ::
"Cat's Paws and Catapults" by S. Vogel



JOINING THE CHAIR PARTS



Biological Mentor :: Squid/Octopus

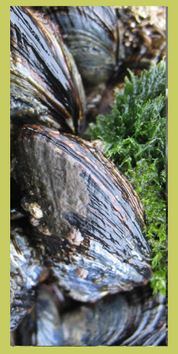
Strategy :: Strong Bonding
A squid has many "suction" organs on their tentacles. These tentacles secrete a chemical glue (also found in flat worms and a handful of other organisms) that gives additional adhesion to the surface that it is attaching to such as seaweed or grass to hide from predators. They have also been know to attach to other animals such a whale, leaving behind intense suction ring marks when removed. The tentacles also secrete a chemical to release the suction and glue from its attachment. It is a duel process of a suction cup with a "bonding" glue.

Application ::
This process could be used to attach and disassemble parts of the chair. Using injection molding to create several natural latex suction cups that are attached to the chair with a natural and environmentally safe glue that is similar to what is secreted by the squid upon adhesion. The second step of ungluing process is applied when chair is disassembled.

Reference/Source ::
Source: http://www.science20.com/squid_day/squid_who_make_glue-84481

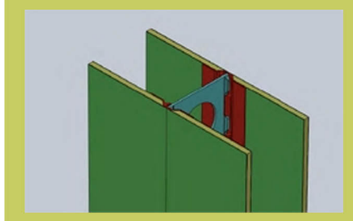
Steelcase :: Modular Seating

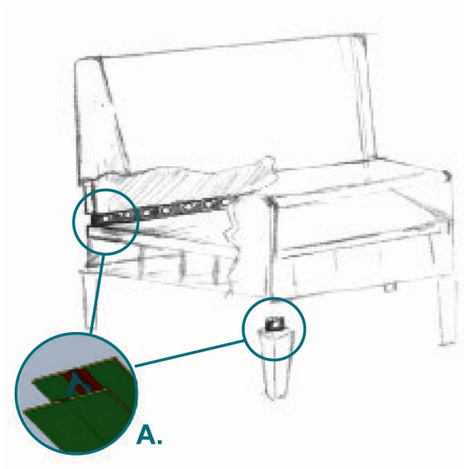
Biological Mentors For Green Redesign



JOINING THE CHAIR PARTS

JOINLOX JOINTS





Biological Mentor :: Clams and Mussels

Strategy :: Strong Bonding

Several small little intermeshing hooks that attach the parts of the chair together. Similar to the way that clams and mussels attach themselves to rocks or hard surfaces in the ocean with brute strength. The way they do this is by locking many tiny 'hooks' on the ends of byssus threads under tiny overhangs and crevices in the rocks they attach to. This would eliminate all nails and screws- thus making disassembly easy in a "break apart" fashion. This system could be used to connect the seat and back of the chair together along with attaching the legs to the chair.

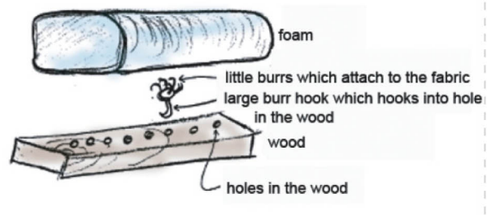
Application ::

Scaling the Joinlox idea down to be used on the Circa redesign for linking the components together and eliminating screws is a viable option for easy disassemble and recycling of the chair. The connectors would be made using injection molding with biocomposite made up of organic fibers and recycled plastic. Recycled metal for the hooks on smaller components is an additional option.

Reference/Source ::

www.asknature.com, www.joinlox.com

AFFIXING THE CUSHION



Biological Mentor :: Cocklebur Plant

Strategy :: 'Sticking' two parts together

The cocklebur plant has hooks on it that stick to fuzzy things.

Application ::

We could replace staples with a strip of burr attachments. Perhaps we could embed them in the wood on one side with bigger hooks that fit into holes drilled into the wood. The burrs themselves would ideally be made out of a biodegradable plastic. Given their shape, it's possible that 3D printing or injection molding methods could be used.

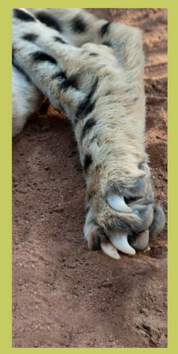
Reference/Source ::

"Cat's Paws and Catapults" by S. Vogel

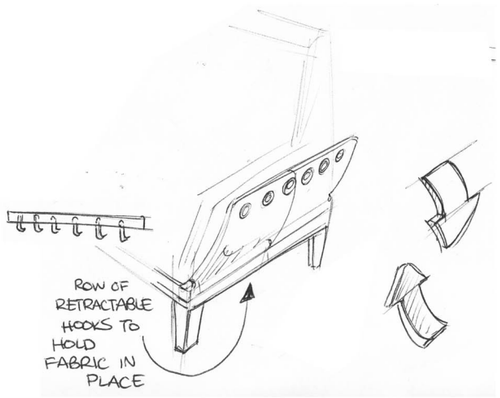
STRATEGIES FOR REDESIGN

Steelcase :: Modular Seating

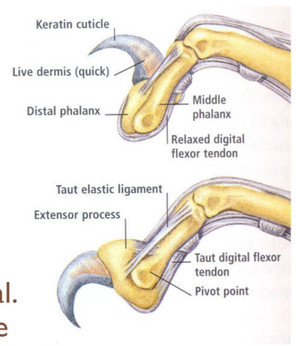
Biological Mentors For Green Redesign



AFFIXING THE UPHOLSTERY



Biological Mentor :: Cats

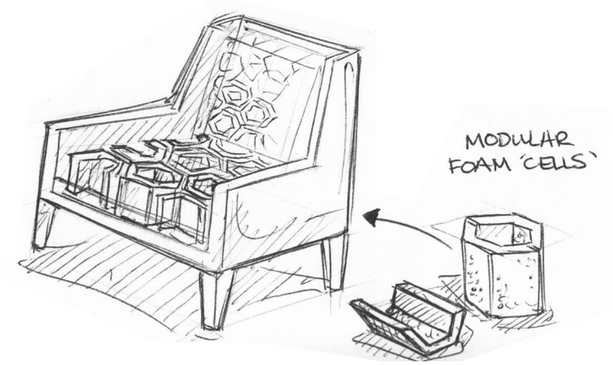


Strategy :: Retractable Claws
Cats have claws that are designed to retract with the use of a contacting ligament.

Application ::
Use the lion's ability to retract its claws as a means of fastening the fabric for quick removal. All of the fabric hooks retract together in one motion for fast disassembly. The design of the cat's claw ligament could be made using an all-metal fastener that is a singular sub-assembly.

Reference/Source ::
www.asknature.com, jonastonboe.com, yourpetsbestfriend.com

MODULAR CUSHIONING



Biological Mentor :: Bees and Wasps

Strategy :: Nesting cells support heavy weights
"The hexagonal cells of bees and wasps create an extraordinarily strong space-frame, in particular in the vertical bee comb with two cell layers back to back with half a cell's shift in the position to create a three-dimensional pyramidal structure."

Application ::
Use the honeycomb form to create a foam cushion that is made up of separate hexagon-shaped foam pieces (or cells) that can be removed and replaced. Foam of various densities can be utilized, which allows the foam cushion to be upgraded based on the someone's personal seat pressure preference. If part of the cushions gets damaged or worn-out over time, that section can be replaced without the need to replace the whole cushion.

Reference/Source ::
www.asknature.com

STRATEGIES FOR REDESIGN