Lightweighting

Example 1

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

Comments:

Brainstorm Whole System Map: Stef, Shannon, & AnnMarie, very good job. Once again, the color-coding is good. It's less clear this time than it was the first time, though, because you're breaking down the physical parts of the chair and it's sometimes hard to tell the difference between those colors and the colors for other lifecycle stages; you could fix this by having very different palettes for the two sets of colors. (e.g. all blue/green tones for some, all orange/yellow tones for the other, or something.) A bunch of the ideas weren't about materials reduction per se, but about material substitutions (which we'll do later). Remember, even though you don't want brainstorms to squash ideas, you do want to stay on topic, steering whatever ideas into something about the problem at hand (here lightweighting.) But you did have a bunch of good ideas. Using a web net instead of the foam, Aeron-style; the rods and cable structure; the idea of a middle support determined by lines of force. Those're solid stuff. You could've even busted out and gotten a bit crazier. The hanging chair was a good wilder one.

The sketches you included with the brainstorm were great! Interestingly, one of them looks like a very novel folding design for the chair, which would let it be more efficient in transportation but still not require the effort of assembly by the user.

Final Recommendations: Excellent that you did a CAD model of the chair! It's a little unfortunate that the winning design was a materials substitution rather than a reduction of material. But once you chose your finalists, it was of course exactly right that you chose the winner by which one reduced eco-impacts the most. And it was good that you restated your business goal from your design brief, to keep your eye on the ball. I couldn't tell from this presentation what the biggest eco-impact components were, but seem to recall them being the plywood and foam from earlier analyses.

The presentation was great overall. Great that you got a better image of the chair, it looks much better. There was one serious typo ("LCAs are chosed") and a couple smaller ones (like "it's" instead of "its"), but the layout and design was great.

AnnMarie Thomas, Stefanie Koehler, Shannon Rahkola
Group Steelcase - MCAD Collaborative Product Design

:: Circa Chair System Map :: showing the steps along the whole process of creating this chair

* Areas of Environmental Impact

CHAIR PARTS (Sub-system that relates to the brainstorm concepts)

- Internal Frame
- Cushion
- Upholstery Fabric
- Legs
- Fixtures/Adhesive
- Combo of Parts
- Whole Chair

electricity use
waste
Water use
Storage /Stock (for example a university storage area before it goes to the classroom)
Wholesale - to other stores
Retail Stores - to customers
Distribution Outlets

fossil fuels/electiricty
Transportation - How heavy is the chair (40 lbs) and how far does it travel to get to the consumer?

Transportation : Refurbish center to the distributor again
electricity use, waste
Refurbish

Transportation : Consumer to Manufacturer/ Refurbish Center for Repair

Transportation : Manufacturing to Distribution (factory in Michigan to store/ distribution center in Minnesota)

Transportation : Distribution to Consumer (distribution center in Minneapolis to AnnMarie's house)

Manufacturing
electricity use
Fossil Fuel use
Pollution (water, air, soil)
Water use
waste

Transportation : Materials to Manufacturing (few hundred miles within factory in MI)

Electricity use
Mineral use
Waste
Fossil Fuel use
Mining and materials
Petroleum Extraction
Timber Harvesting
Plant Harvesting and Textile Production
Chemical Synthesis and Plastic Production

What's in the chair: Wood (frame, legs), foam (seat), metal (staples, bolts, washers, fixtures), fabric, plastic (plastic wrap like stuff between foam and seat), elastic-fabric bands

maple or walnut solid wood
Elastic-fabric bands
Plastic Upholstery Film (type? HDPE?)
hardwood plywood
Components of the Circa Chair - insert breakout sketch -
Stainless steel fixtures (staples, bolts, washers)
Polyurethane Foam (various densities)
Upholstery Fabric (type?) - chemical treatment for stain resistance

USE

Building
Floor Surface
Wall covering/surface
Ceilings and Fixtures
Lighting - Natural vs produced
User Interaction
Artwork and Decor

People
Groups of people
Bodily fluids
Information booth
Advertisements
Private vs Public

Items Coupled with the chair 'USE'

Other chairs
Tables, other items in the Circa product line
Plants, vase
Trash and trash bins
Blankets, pillows, slip covers
Luggage
Essential cargo - oxygen tank, baby carriage

Activities people engage in with the chair :
- Sit, sleep, read, write, eat, drink, spill, clean, play on, jump, perch on different surfaces
- Wait, watch, listen, attend to kids, use as foot rest, use as a table surface, gather with others
- Move around/rearrange

Transportation : Refurbish center to the consumer again

Water pollution, air, soil systems
Landfill
Incinerator

End of Use

Transportation : Consumer to Landfill site

Transportation : Consumer to Recycling Center

Product Disassembly and Materials Sorting
Product Collection/ Retrieval

Recycling

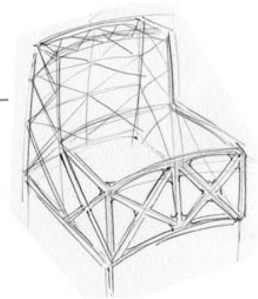
electricity use, easte

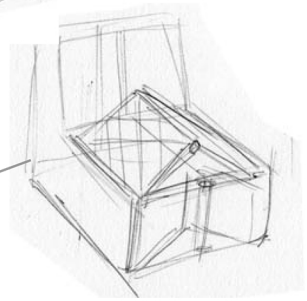
coupling products - pillows, fabric cleaners, etc (water, electricity use, resource depletion)

Transportation : Recycling Center back to materials processing / manufacturer

:: Idea Brainstorm ::
reducing energy consumption and environmental impacts through LIGHT-WEIGHTING

1. Get rid of all metal fastener in the frame and replace with slotting/dovetails/etc
2. Get rid of the staples and instead design a way that the fabric can be tucked i and fastened by the frame
3. Get rid of the wooden frame and replace it with an inflatable frame
4. Get rid of the plywood frame and use bamboo instead
5. Get rid of the foam and use inflatable cushions
6. Three legged chair design
7. Stools instead of chairs- no back needed
8. Floor cushions- no frame needed
9. Do a force analysis and see if we can remove unnecessary/overengineered elements from the frame, or reduce the size of any of the wooden pieces
10. Replace the frame with hollow metal (aluminum?) frame
11. Hanging chair-replace frame with a seat/backrest and hang it instead of having it stand on its own
12. Composite frame with a molded shape of “seat” for comfort. Get rid of the cushions and fabric.
13. One back shared by two chairs (back to back)
14. A recycled composite material (100% recycled High Density Polyethylene-#2 can be recycled) rail held by two screws to hold fabric down.
15. Interior frame and chair legs made from recycled 100% recycled paper product to mimic look and feel of maple. (http://www.richlite.com/countertop/media/Combined%20Richlite%20Sustainability%20Brochure.pdf)
16. Use only fabric that can be composted: cotton, hemp, tencil, bamboo, or wool. Sourced and produced sustainably. Use only natural dying, metal free chemical dying, minimizing effluents and good water management systems.
17. No staples or screws used throughout. Frame is puzzle pieced together (similar to AnnMarie’s “sketch chair” concept. Foam for cusioning made with natural, organic, latex rubber. Can be composted. Fabric is slipcovered over. Customer puts chair together.(keeps similar look and feel of current chair)
18. The chair is made of sea grass woven around a recycled paper product created to mimic the look and strength of wood.
19. A felt frame made from recycled PET bottles that becomes S-shaped. To replace the plywood frame and metal legs-weighs less-can be recycled.
20. One circular seat that fits up to four. Tubular center (trunk) shared by users of chair as the chair back.
21. Use tension to hold the cushion and fabric tight to the chair frame - no staples or adhesives.
22. Design the fabric to be removable for easy cleaning, customized designs, customized materials depending on use (ie. fabric that repels dog hair, etc) - increased lifetime
23. Include instructions for caring for the upholstery or even a 'approved (low-impact) fabric cleaner'
24. Make the body frame and legs into one piece - not requiring the legs to be attached separately
25. Use a laminated plastic 'honeycomb' sheet instead of plywood
26. Use a biocomposite (soy plastic material) that can be injection molded into create an 'airy' frame
27. Build a frame of thin metal tubes to create a frame structure of trusses and crossbars
28. Create a network of springy materials as the cushion rather than PU foam
29. Make a collapsible frame, removable cushions, and removable seat covers - the chair can be assembled by the distribution outlets or by the consumer
30. Make an elastic web net as the cushion rather than the foam
31. Create a cushion with multiple sections so that one can be replaced if it gets damaged - rather than replacing the whole cushion
32. Use a fabric that repels water while being soft, similar to leaves with tiny 'hairs' on it that can repel water
33. Create a 'hollow' frame of the rectangular form that can work like an accordion allowing the user to change the shape of the chair from convex to concave or straight.
34. Create a folded paper interior frame
35. Use a series of rods and cables to construct the frame, held together with tension
36. Follow 'lines of force' to increase support in the middle of the chair while reducing the support (and materials) on the sides
37. Cut long 'natural' curved holes in wood frame to reduce the weight of the plywood frame





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Individual LCAs as performed through Sustainable Minds

LCAs are chosed from brainstorm ideas and narrowed down by ideas that best fit the business objective.

Business Objective:

To lessen the environment impact of the chair through better material choice and product design, while not increasing it's cost for either the manufactuing nor the consumer.

Top concept scenario:

The top concept scenario was chosen based on the biggest improvement as compared to the baseline LCA. The concepts will be explored through sketches and descriptions of the winning design and the reasoning behind the winning choice as it pertains to the business objective.

Chair LCA Concept Scenarios	**TRACI Points**	**Carbon Footprint**	**Sustainable Minds Scorecard**
Baseline	1.0x10^3 mPts/func unit	93 CO2 eq. kg/func. unit	*baseline*
Get rid of all metal fasteners in the frame and replace with slotting/dovetails/etc Get rid of the staples and design a way that fabric can be tucked in and fastened by the frame.	950 mPts/func unit	92 CO2 eq. kg/func. unit	*7.4% performance improvement*
Interior frame and chair legs made from recycled paper product to mimic look of wood.	**890 mPts/func unit**	**93 CO2 eq. kg/func. unit**	***13% performance improvement***
Interior frame is made from "lightweight" metal tubes (using trusses rather than the current plywood frame. *Changed frame material to secondary aluminum and recycled at end of life.*	930 mPts/func unit	85 CO2 eq. kg/func. unit	*9.3% performance improvement*

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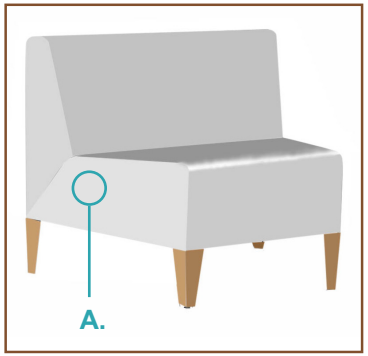
Winning Design

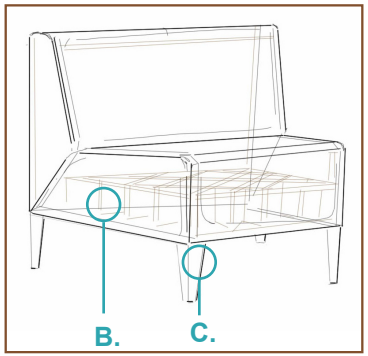
We have chosen to go with a design where the wooden plywood frame that forms the skeleton of the chair is replaced with material made from 100% recycled paper product.

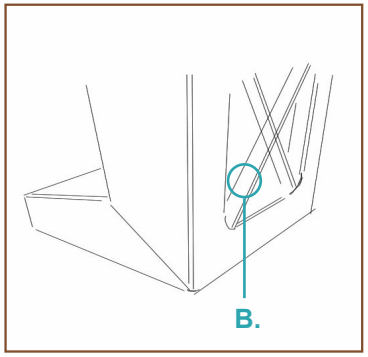
As was viewed on the previous page, the LCA chart depicts that all three of our concept ideas that were settled on from our brainstorm list, resulted in a performance improvement. However, since we had to choose one “winner” at this stage we decided on the recycled paperboard frame as it had the lowest number of TRACI points. This concept would require minimal redesign of the manufacturing process as it would require the replacement of only one material, and thus should entail only minimal assembly line and tooling changes. This integration into the current manufacturing plant’s capabilities, Makes it a more desirable choice economically and environmentally.

We have chosen to go with a design where the wooden plywood frame that forms the skeleton of the chair is replaced with material made from 100% recycled paper product This product mimics the look and strength of the current wood material. It gives the visual look of maple. This material lightens the impacts on the environment over the wood products being used in the current chair design featured by Steelcase. By simply changing out one material for another with little change in the manufacturing process or the look and feel of the current design, we found a 13% overall performance improvement.

TRACi Points	Carbon Footprint	Sustainable Minds Scorecard
860 mPts per total life	Total=93 CO_2 eq. kg/func unit	**13% improvement**







A. *Exterior chair resembles current design*

B. *Interior frame material redesign-product chosen is a paperboard based on the following material change benefits:*

- 100% Post Consumer Waste Paper
- FSC certified
- Contributes to LEED points
- Uses an innovative and ecient WE™ (Waste-to-Energy) manufacturing system that captures toxins and re-circulates heat to greatly minimize fuel consumption, pollution and carbon emissions.

C. *Leg will mimic the look of maple*

D. *Richlite http://www.richlite.com*