Nike SB Dunk Sustainable Redesign LCA

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Nike SB Dunk Benchmark Vs. Modular Skate Shoe Redesign





This LCA compares the original Nike SB Dunk with a redesigned modular skate shoe system focused on reducing material complexity, improving durability, and shifting high-wear damage from the full shoe to a replaceable protective frame.

GOAL, SCOPE + FUNCTIONAL UNIT

GOAL

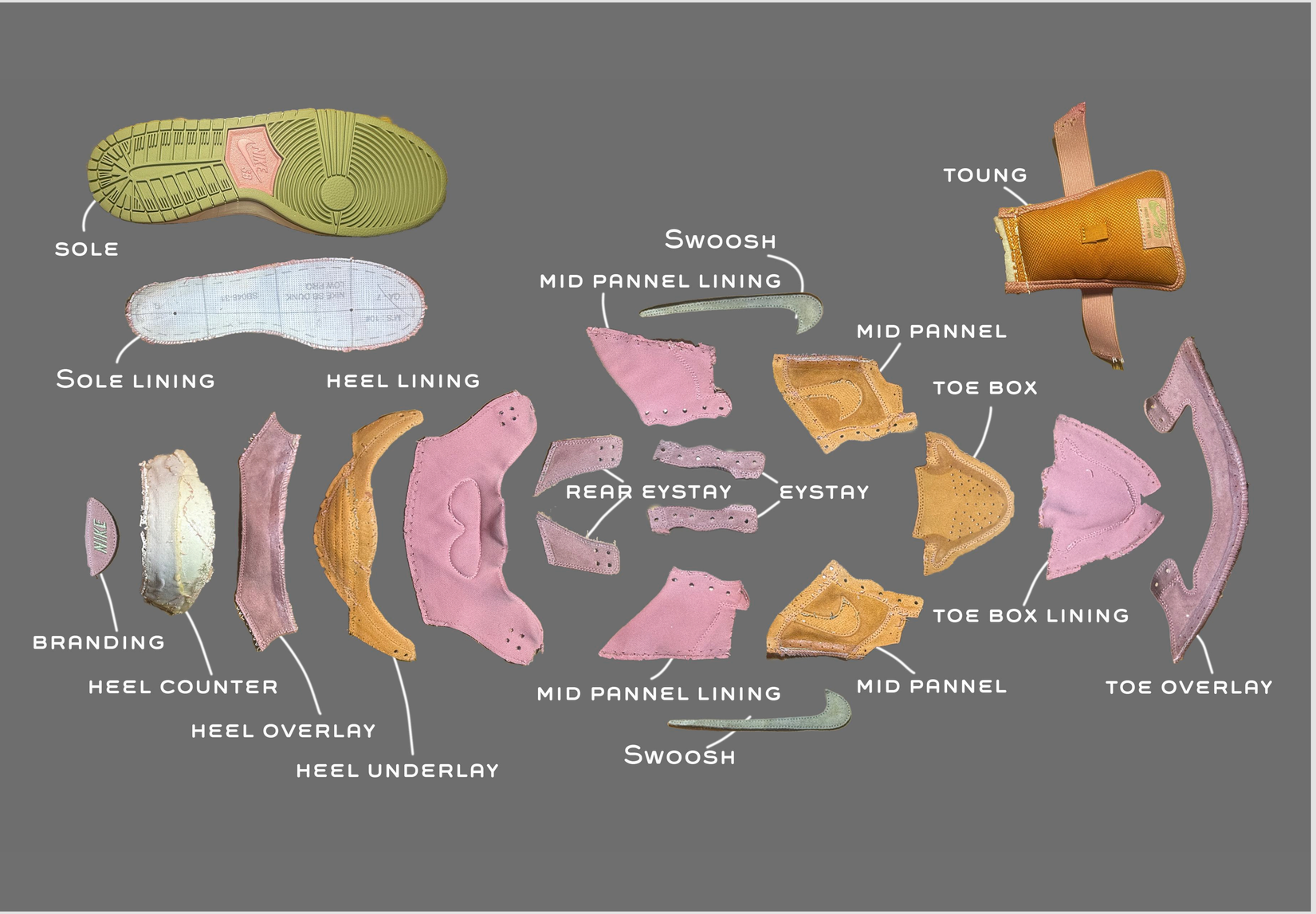
Compare the lifecycle impacts of the original Nike SB Dunk and the modular skate shoe redesign to understand how changes in materials, construction, durability, and replacement strategy affect overall environmental impact.

FUNCTIONAL UNIT

1 pair of shoes used daily for one year for everyday wear + skateboarding

Cradle-to-Grave

Raw Materials
↓
Material Processing
↓
Manufacturing + Assembly
↓
Distribution
↓
Use + Maintenance
↓
End-of-Life



Benchmark Knolling

- Numerous overlapping materials and components
- Adhesives permanently bond most upper layers
- Complex construction limits separation and recovery

Bill Of Materials

Part Number	Material Group	Component	Part	Material / Material Category	Description	Quantity	Weight in g	Total Weight (g)
B-001	Pig Suede Leather	Upper	Toe Overlay	Pig suede leather	Front exterior overlay around toe	2.0	14.0	28.0
B-002	Pig Suede Leather	Upper	Toe Box	Pig suede leather	Perforated front toe panel	2.0	10.0	20.0
B-003	Pig Suede Leather	Upper	Mid Panel - lateral	Pig suede leather	Outer side quarter panel	2.0	9.0	18.0
B-004	Pig Suede Leather	Upper	Mid Panel - medial	Pig suede leather	Inner side quarter panel	2.0	9.0	18.0
B-005	Pig Suede Leather	Upper	Eyestay - lateral	Pig suede leather	Outer lace hole panel	2.0	5.0	10.0
B-006	Pig Suede Leather	Upper	Eyestay - medial	Pig suede leather	Inner lace hole panel	2.0	5.0	10.0
B-007	Pig Suede Leather	Upper	Rear Eyestay - lateral	Pig suede leather	Rear lace stay piece	2.0	3.0	6.0
B-008	Pig Suede Leather	Upper	Rear Eyestay - medial	Pig suede leather	Rear lace stay piece	2.0	3.0	6.0
B-009	Pig Suede Leather	Upper	Heel Overlay	Pig suede leather	Exterior heel wrap panel	2.0	12.0	24.0
B-010	Pig Suede Leather	Upper	Heel Underlay	Pig suede leather	Base heel side panel	2.0	10.0	20.0
B-011	Pig Suede Leather	Branding	Swoosh - lateral	Pig suede leather	Outer side Nike Swoosh	2.0	2.0	4.0
B-012	Pig Suede Leather	Branding	Swoosh - medial	Pig suede leather	Inner side Nike Swoosh	2.0	2.0	4.0
B-013	Polyester Textile	Lining	Toe Box Lining	Polyester textile	Interior lining behind toe box	2.0	5.0	10.0
B-014	Polyester Textile	Lining	Mid Panel Lining - lateral	Polyester textile	Interior lining behind side panel	2.0	4.0	8.0
B-015	Polyester Textile	Lining	Mid Panel Lining - medial	Polyester textile	Interior lining behind side panel	2.0	4.0	8.0
B-016	Polyester Textile	Lining	Heel Lining	Polyester textile	Patterned interior heel lining	2.0	7.0	14.0
B-017	Polyester Textile	Footbed	Sole Lining / Insole Top	Polyester textile	Top cloth layer under foot	2.0	8.0	16.0
B-018	Polyester Mesh	Tongue	Tongue Exterior	Polyester mesh	Breathable tongue shell	2.0	8.0	16.0
B-019	Woven / Printed Polyester	Branding	Heel Branding Label	Woven polyester	Small Nike heel branding patch	2.0	1.0	2.0
B-020	Woven / Printed Polyester	Tongue	Tongue Label	Woven polyester	Nike SB tongue label	2.0	1.0	2.0
B-021	Woven / Printed Polyester	Interior	Size Label	Printed textile label	Inside size and product label	2.0	0.5	1.0
B-022	Elastic Textile	Interior	Elastic Tongue Straps	Elastic textile	Holds tongue centered	4.0	1.0	4.0
B-023	Braided Polyester	Closure	Flat Laces	Braided polyester	Main lace closure system	2.0	5.0	10.0
B-024	Plastic	Closure	Lace Aglets	Plastic	Small lace tips	4.0	0.2	0.8
B-025	PU Foam	Tongue	Tongue Padding	PU foam	Padded tongue cushioning	2.0	6.0	12.0
B-026	PU Foam	Collar	Collar Padding	PU foam	Padded ankle collar foam	2.0	8.0	16.0
B-027	PU Foam	Footbed	Insole Foam	PU foam	Removable foam insole body	2.0	18.0	36.0
B-028	TPU	Cushioning	Zoom Air Unit	TPU air bag	Heel cushioning insert	2.0	4.0	8.0
B-029	Thermoplastic	Structure	Heel Counter	Thermoplastic sheet	Internal heel structure	2.0	8.0	16.0
B-030	Nonwoven Polyester	Structure	Strobel Board	Nonwoven polyester	Base layer under footbed	2.0	6.0	12.0
B-031	Synthetic Fabric	Structure	Toe Reinforcement	Synthetic backing fabric	Internal forefoot support	2.0	4.0	8.0
B-032	EVA Foam	Sole	Midsole	EVA foam	White cushioning midsole	2.0	28.0	56.0
B-033	Carbon Rubber	Sole	Outsole	Carbon rubber	Textured traction sole	2.0	115.0	230.0
B-034	Polyurethane	Assembly	Adhesive	Polyurethane cement	Bonds upper and sole	2.0	6.0	12.0
B-035	Polyester Thread	Assembly	Stitching Thread	Polyester thread	Main structural stitching	2.0	2.0	4.0
TOTAL								**669.8**

- Material diversity increases manufacturing complexity and end-of-life separation.
- Multiple synthetic components support relatively small functional areas.
- Adhesives and laminated assemblies connect nearly every material throughout the shoe.

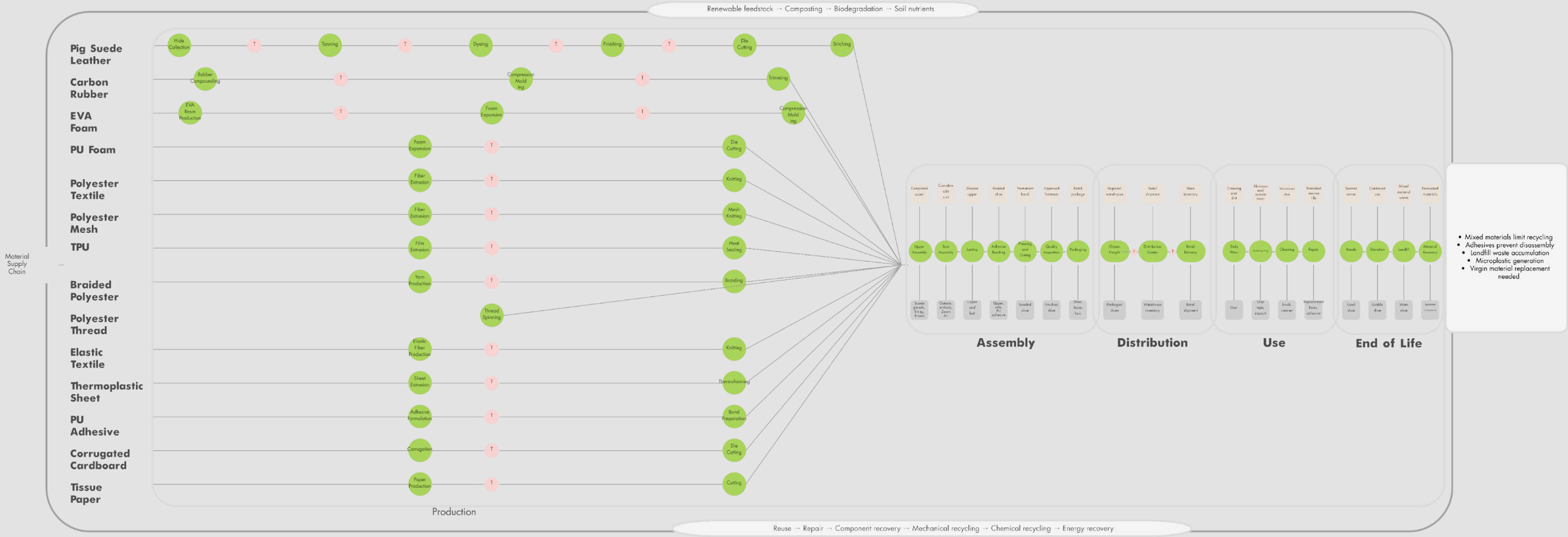
Life Cycle Inventory

Process Step	Material Input	Energy Use	Waste & Emissions
Pigskin Production	Pig hides, feed, water, veterinary inputs	Farming operations, transportation, refrigeration	Methane emissions, manure waste, land use impacts, water consumption
Leather Tanning & Finishing	Pig hides, chromium salts, dyes, finishing chemicals, water	Tanning drums, drying ovens, wastewater treatment	Toxic wastewater, sludge, VOCs, chemical residues
Polyester Fiber Production	Petroleum feedstocks	Polymerization, fiber extrusion, weaving/knitting	Greenhouse gas emissions, microplastic generation, production scrap
EVA Foam Production	Ethylene-vinyl acetate resin, blowing agents	Polymer processing, foam expansion, molding	Manufacturing scrap, VOC emissions, fossil fuel consumption
PU Foam Production	Polyols, isocyanates, additives	Foam expansion and curing processes	Chemical emissions, difficult-to-recycle foam waste
TPU Production	Thermoplastic polyurethane resin	Polymer synthesis, extrusion, thermoforming	Manufacturing scrap, fossil resource depletion
Rubber Compound Production	Natural rubber, synthetic rubber, carbon black, additives	Mixing, milling, vulcanization preparation	Air emissions, rubber waste, particulate matter
Textile Manufacturing	Polyester yarn, elastic fibers	Weaving, knitting, cutting, sewing	Fabric offcuts, fiber waste, wastewater
Leather Component Cutting	Suede leather panels	Die cutting, stitching operations	Leather offcuts, unusable scrap
Upper Assembly	Leather panels, mesh, lining fabrics, thread	Sewing machines, assembly equipment	Thread waste, rejected components
Tongue & Collar Assembly	Polyester mesh, PU foam, elastic textiles	Sewing and lamination operations	Foam scrap, textile waste
Midsole Manufacturing	EVA foam	Compression molding, trimming	Foam trim waste, process emissions
Outsole Manufacturing	Carbon rubber compound	Compression molding, vulcanization	Rubber trim waste, energy-intensive curing emissions
Zoom Air Manufacturing	TPU film, compressed air	Thermoforming, sealing, pressurization	TPU scrap, manufacturing rejects
Final Shoe Assembly	Upper, outsole, midsole, adhesives	Heating, pressing, bonding equipment	VOC emissions from adhesives, assembly waste
Packaging Production	Corrugated cardboard, tissue paper, inks	Paper production, corrugation, printing	Paper scrap, wastewater, energy use
Distribution & Shipping	Finished shoes, packaging materials	Ocean freight, trucking, warehousing	CO_2 emissions, packaging damage waste
Consumer Use Phase	Shoe care products, replacement laces	Walking, skateboarding, maintenance	Outsole wear particles, cleaning waste
End-of-Life Disposal	Mixed leather, foam, rubber, textile, adhesive materials	Collection and waste processing	Landfill waste, incineration emissions, limited recyclability

- Material production drives the largest upstream impacts, especially pigskin, leather tanning, polyester, foam, TPU, and rubber processing.
- Manufacturing adds energy use and material waste through molding, vulcanization, cutting, sewing, lamination, and adhesive bonding.
- End-of-life recovery is limited by mixed-material construction, with bonded leather, foam, rubber, textiles, and adhesives making separation and recycling difficult.

Process Tree

Nike SB Dunk Full Product Process Tree



Process Tree

BONDING

Multiple bonded layers prevent repair and recycling.

- Multiple material layers increase manufacturing complexity.
- Permanent adhesive bonding prevents material separation.
- High part count increases material and labor inputs

HIGH-WEAR SKATE ZONES

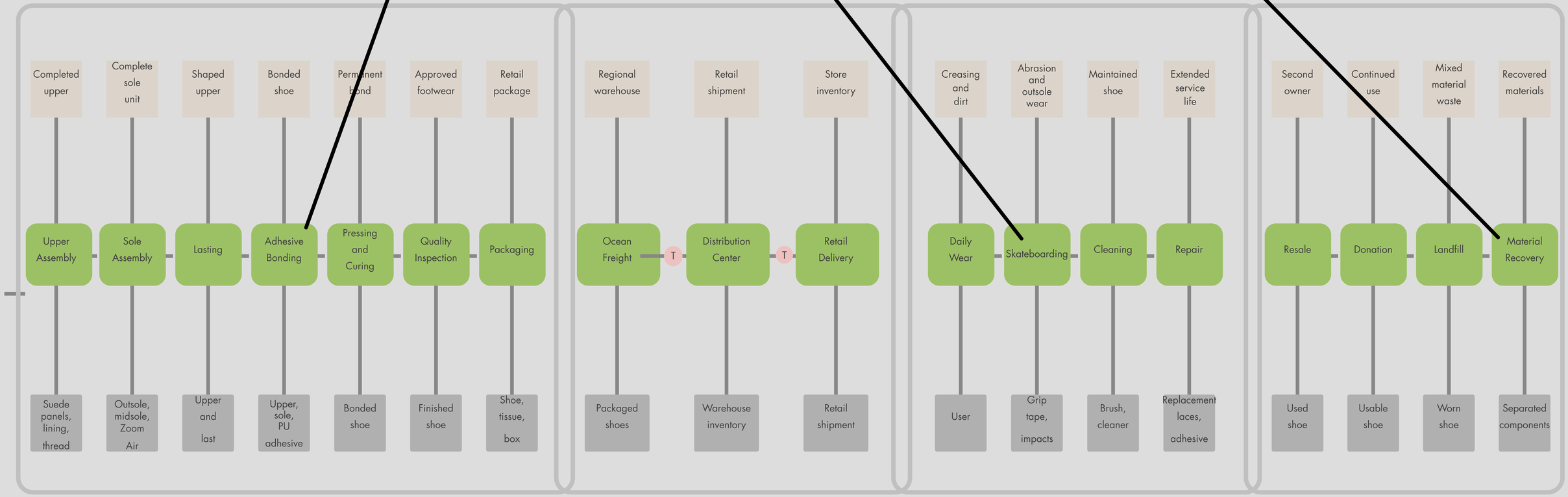
Localized damage dictates product lifespan.

- High-wear zones determine overall product lifespan.
- Localized wear causes premature product replacement.
- Most of the shoe remains functional after failure.

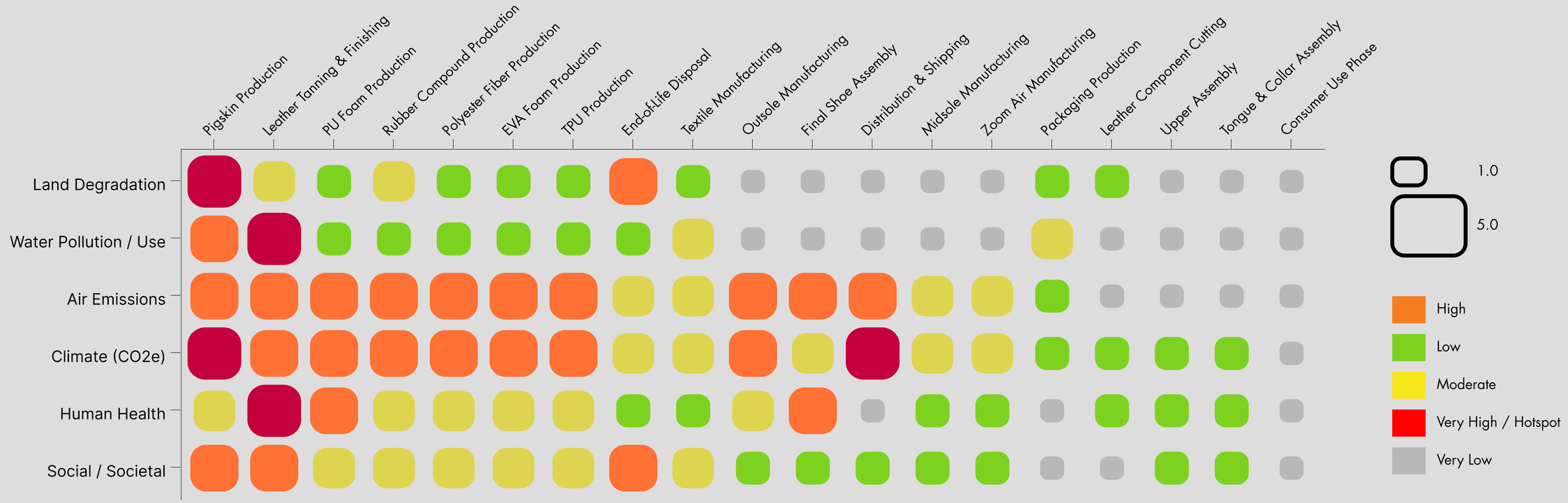
LIMITED MATERIAL RECOVERY

Multiple bonded layers prevent repair and recycling.

- Multiple material layers increase manufacturing complexity.
- Permanent adhesive bonding prevents material separation.
- High part count increases material and labor inputs



Impact Matrix



- Leather production is the largest environmental hotspot within the product.
- Synthetic material production contributes cumulative impacts throughout manufacturing.
- Environmental impacts are concentrated in material production rather than product assembly.

Lifecycle stage	Impact	share
Materials and processing	5.83 kg CO_2e	40.9%
Component manufacturing and assembly	7.57 kg CO_2e	53.1%
Packaging	0.22 kg CO_2e	1.5%
Distribution	0.30 kg CO_2e	2.1%
Use and maintenance	0.00 kg CO_2e	0.0%
End of life	0.33 kg CO_2e	2.3%
Total	**14.25 kg CO_2e**	**100%**

Okala score

- Functional unit: one pair used daily for one year
- Estimated total impact of 14.25 kg CO_2e





The Redesign



Redesign Knolling

- 14 total parts reduce overall construction complexity compared with the 35-part benchmark.
- The removable outer frame separates the highest-wear skate zones from the longer-life base shoe.
- Fewer permanently bonded layers improve repair, replacement, and end-of-life disassembly.

Redesign Bill Of Materials

Part Number	Material Group	Component	Part	Material / Material Category	Description	Quantity	Weight in g	Total Weight (g)	Weight in kg
F01	Corn Rubber	Frame	Main Outer Frame	Corn-filled natural-rubber compound, target 95 Shore A	Replaceable protective frame covering primary abrasion zones	2.0	345.0	690.1	0.6901
F02	Hemp / ECONYL Textile	Closure	Strap Core	60% hemp / 40% ECONYL® regenerated PA6 woven webbing	Woven textile core within the closure straps	2.0	0.3	0.6	0.0006
F03	Corn Rubber	Closure	Strap Overmold	Corn-filled natural-rubber compound, 95 Shore A	Rubber overmold protecting the strap core	2.0	2.5	5.0	0.0050
F04	TPU	Window	Transparent Air / Window Component	Transparent TPU	Transparent window / air component	2.0	0.08	0.16	0.00016
F05	Recycled Aluminum	Hardware	Aluminum Loops / Hardware	Recycled-content aluminum	Reinforced attachment loops and hardware	2.0	0.09	0.18	0.00018
B01	Corn Rubber	Sole	Base Shee Outsole	Corn-filled natural-rubber compound, target 85 Shore A	Base outsole for the core shoe	2.0	203.7	407.4	0.4074
B02	Hemp / ECONYL Textile	Upper	Engineered Knit Upper	65% hemp / 35% ECONYL® regenerated PA6	Near-net-shape knit forming the main upper	2.0	100.5	201.0	0.2010
B03	Hemp / ECONYL Textile	Lining	Inner Lining	70% hemp / 30% ECONYL® PA6 single jersey	Soft interior lining	2.0	46.0	92.0	0.0920
B04	Mushroom Suede	Upper	Toe Overlay	MuSkin® mushroom-derived suede alternative	Toe overlay replacing pig suede	2.0	1.9	3.9	0.0039
B05	Mushroom Suede	Upper	Heel Overlay	MuSkin® mushroom-derived suede alternative	Heel overlay replacing pig suede	2.0	2.0	4.1	0.0041
B06	Mushroom / Mycelium	Tongue	Tongue Assembly	MuSkin® outer + MycoFlex® mycelium foam + 70/30 hemp/PA6 jersey	Layered tongue with mycelium cushioning	2.0	2.6	5.1	0.0051
B07	Hemp / ECONYL Textile	Closure	Elastic Straps	Hemp / regenerated PA6 textile with natural-rubber elastic element	Elastic retention straps for the core shoe	2.0	0.9	1.8	0.0018
B08	Foam / Textile	Footbed	Insole / Sockliner	Existing Nike-style molded sockliner	Removable molded sockliner	2.0	22.4	44.9	0.0449
B09	Mycelium Foam	Padding	Heel Padding	MycoFlex® mycelium foam	Heel cushioning and padding	2.0	15.1	30.3	0.0303
TOTAL								**1486.54**	**1.48654**

- Part count is reduced from 35 to 14, simplifying the overall construction and material system.
- The permanent base shoe is significantly lighter than the benchmark, while the added mass is concentrated in the removable protective frame.
- The redesign shifts toward fewer, more targeted material families, using hemp/ECONYL textiles, mushroom and mycelium materials, natural-rubber-based compounds, TPU, and recycled aluminum.

Life Cycle Inventory

Process Step	Material Input	Energy Use	Waste & Emissions
Hemp Fiber Production	Hemp stalks, water, agricultural inputs	Cultivation equipment, harvesting, retting, decortication	Agricultural emissions, retting wastewater, fiber waste
ECONYL® PA6 Production	Recovered nylon waste, processing chemicals, water	Sorting, cleaning, depolymerization, repolymerization, melt spinning	Process emissions, wastewater, unusable contamination, production scrap
Engineered Textile Manufacturing	Hemp yarn, ECONYL® regenerated PA6 yarn	Yarn preparation, engineered knitting, finishing	Yarn waste, rejected knit sections, low cutting waste
MuSkin® Production	Fungal biomass, water, processing inputs	Cultivation, drying, stabilization, finishing	Organic residues, wastewater, trimming waste
MycoFlex® Foam Production	Mycelium, agricultural biomass feedstock, water	Controlled growth, drying, stabilization, forming	Organic waste, rejected foam pieces, process energy emissions
Corn-Filled Rubber Compound Production	Natural rubber, corn filler, curing agents, processing additives	Mixing, milling, compounding, vulcanization preparation	Rubber scrap, particulate matter, process emissions
TPU Production	Thermoplastic polyurethane resin	Polymer synthesis, extrusion, thermoforming	Manufacturing scrap, fossil-resource use, process emissions
Recycled Aluminum Production	Recovered aluminum scrap	Sorting, remelting, alloy adjustment	Furnace emissions, dross, metal scrap
Upper Manufacturing	Hemp / ECONYL® engineered knit textile	3D knitting, shaping, finishing	Yarn waste, rejected knit components
Inner Lining Manufacturing	Hemp / ECONYL® jersey textile	Knitting, cutting, sewing	Textile offcuts, fiber waste
MuSkin Component Cutting	MuSkin® sheets	Die cutting, trimming, forming	Mushroom-material offcuts, unusable scrap
Tongue Assembly	MuSkin®, MycoFlex® foam, hemp / PA6 jersey	Cutting, sewing, lamination	Textile and foam trim waste, rejected components
Sockliner / Insole Production	Existing molded sockliner material	Foam or polymer molding, trimming	Molded scrap, trim waste, process emissions
Base Outsole Manufacturing	Corn-filled natural-rubber compound	Compression molding, vulcanization, trimming	Rubber trim waste, curing emissions, rejected parts
Outer Frame Manufacturing	Corn-filled natural-rubber compound	Compression / injection molding, vulcanization, trimming	Rubber scrap, curing emissions, rejected frame sections
Strap Core Manufacturing	Hemp / ECONYL® woven webbing	Weaving, cutting, sewing	Textile offcuts, yarn waste
Strap Overmolding	Corn-filled natural-rubber compound, strap core	Rubber molding, heating, curing	Rubber flash, trim waste, curing emissions
TPU Window Manufacturing	Transparent TPU	Extrusion / molding, thermoforming, trimming	TPU scrap, rejected window components
Aluminum Hardware Forming	Recycled aluminum	Cutting, stamping / forming, finishing	Metal offcuts, finishing waste
Final Shoe Assembly	Upper, lining, outsole, overlays, tongue, straps, thread, water-based latex adhesive	Sewing, bonding, pressing, curing	Thread waste, adhesive residue, rejected assemblies
Frame Assembly	Rubber frame, strap core, strap overmold, TPU window, aluminum hardware	Molding, fastening, bonding / mechanical assembly	Rubber and TPU trim, rejected hardware, assembly waste
Packaging Production	Corrugated cardboard, tissue paper, inks	Paper production, corrugation, printing	Paper scrap, wastewater, energy use
Distribution & Shipping	Finished shoes, removable frames, packaging materials	Ocean freight, trucking, warehousing	CO_2 emissions, packaging damage waste
Consumer Use Phase	Shoe care products, replacement frame components	Walking, skateboarding, cleaning, maintenance	Rubber wear particles, cleaning waste, worn frame components
Frame Replacement	Replacement protective frame	Manufacturing and distribution of replacement frame	Worn rubber frame waste, packaging waste, transportation emissions
End-of-Life Recovery / Disposal	Rubber, hemp / PA6 textile, MuSkin®, mycelium foam, TPU, aluminum, adhesive	Collection, separation, recycling or disposal processing	Mixed-material waste, recycling losses, landfill / incineration emissions

- The removable outer frame becomes the largest environmental hotspot, driven by its high material mass and rubber molding / vulcanization processes.
- Hemp, MuSkin®, and MycoFlex® shift several upper components into lower-impact material pathways, reducing reliance on leather, PU foam, and conventional synthetic textiles.
- Impacts are concentrated into fewer components instead of being spread across many bonded materials, making the main redesign hotspots easier to identify and improve.

Re Design Process Tree



ReDesign Process Tree

REDUCED BONDING

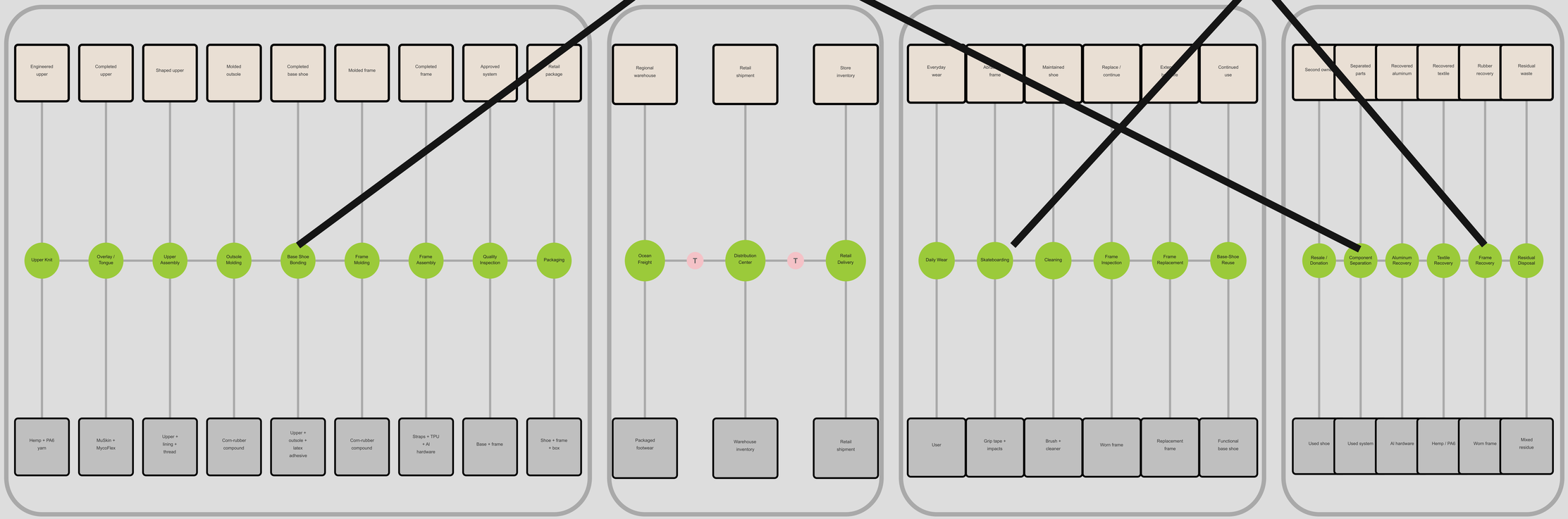
construction reduces permanent material bonding.

- Fewer adhesive bonded layers across the shoe
- Separable components improve repair and disassembly
- Reduced bonding simplifies end of life material recovery

REPLACEABLE WEAR SYSTEM

High abrasion areas are separated from the core.

- Outer frame absorbs the majority of skate abrasion
- • Worn frame can be replaced independently
- • Core shoe remains in use after frame replacement



New Hot Spots



- Engineered hemp blend shifts the upper toward lower impact material pathways compared with conventional synthetic fibers
- The outer frame becomes the largest remaining impact hotspot due to its material mass
- Impacts are concentrated into fewer components rather than spread across many bonded materials

Lifecycle stage	Impact	share
Materials and processing	3.75 kg CO_2e	43.5%
Component manufacturing and assembly	4.10 kg CO_2e	47.5%
Packaging	0.22 kg CO_2e	2.5%
Distribution	0.33 kg CO_2e	3.8%
Use and maintenance	0.00 kg CO_2e	0.0%
End of life	0.23 kg CO_2e	2.7%
Total	**8.63 kg CO_2e**	**100%**

Okala score

- Functional unit: one pair used daily for one year
- Estimated total impact of 8.63 kg CO_2e
- 39.4% lower than the 14.25 kg CO_2e benchmark

Okala Score Comparison

BENCHMARK
14.25 kg CO_2e

REDESIGN
8.63 kg CO_2e

IMPROVEMENT
39.4% estimated reduction in lifecycle carbon impact



The redesign reduces modeled carbon impact by approximately 5.62 kg CO_2e per pair.

Largest remaining impacts come from natural rubber production, molding, and vulcanization of the outsole and removable skate frame.