

# Modular Course B: Creative Design in shoe Industry

## Unit B – CREATIVE DESIGN

Lecture LB3.3 – Materials selection for  
design of sustainable F&L Goods



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T2.2 – Development of modular  
courses and training  
material.

D2.2 – Modular Course in  
Creative Design

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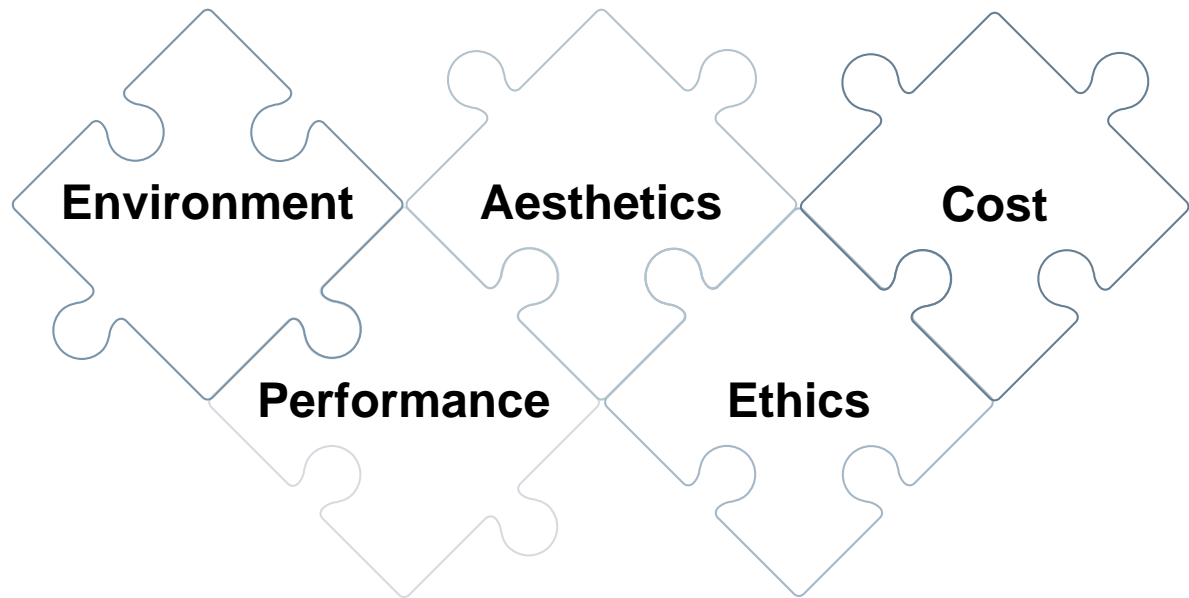
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# Introduction: Why Material Selection Matters

- Materials define functionality, aesthetics, and sustainability of F&L products.
- Decisions made at the early design stage influence most of the product's environmental footprint.
- Sustainable material choice reduces waste,

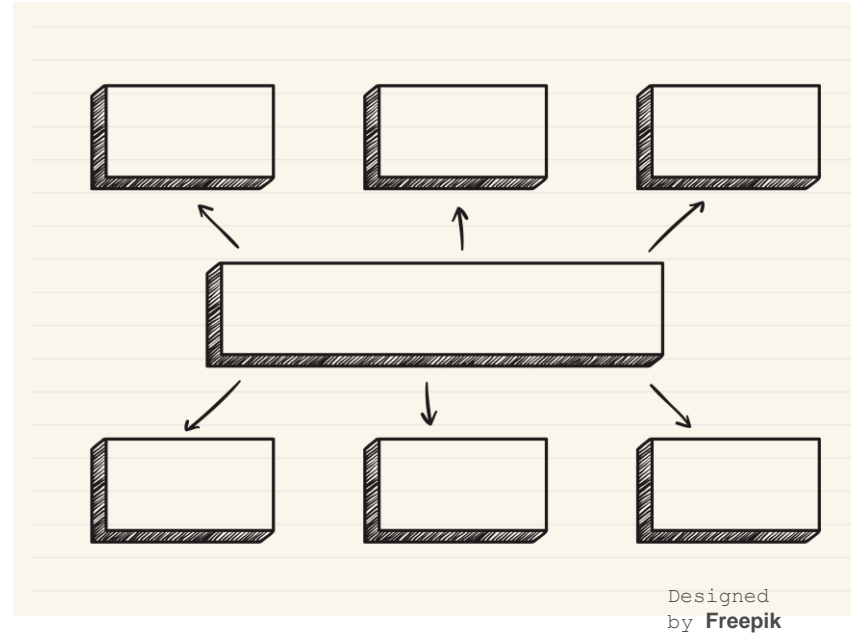


# Criteria for Sustainable Material Selection



- **Environment:** carbon & water footprint, toxicity, end-of-life (recyclability/biodegradability).
- **Performance:** durability, flexibility, comfort, abrasion/slip resistance.
- **Aesthetics:** color/finish/handfeel, brand fit, trend alignment.
- **Cost:** material price, processing cost, MOQ/lead

# Frameworks for Systematic Material Selection



- **Material Selection Matrix (Ashby approach):**

Compare options against weighted criteria (performance, cost, environment, aesthetics, ethics).

- **Design Canvas for Materials:**

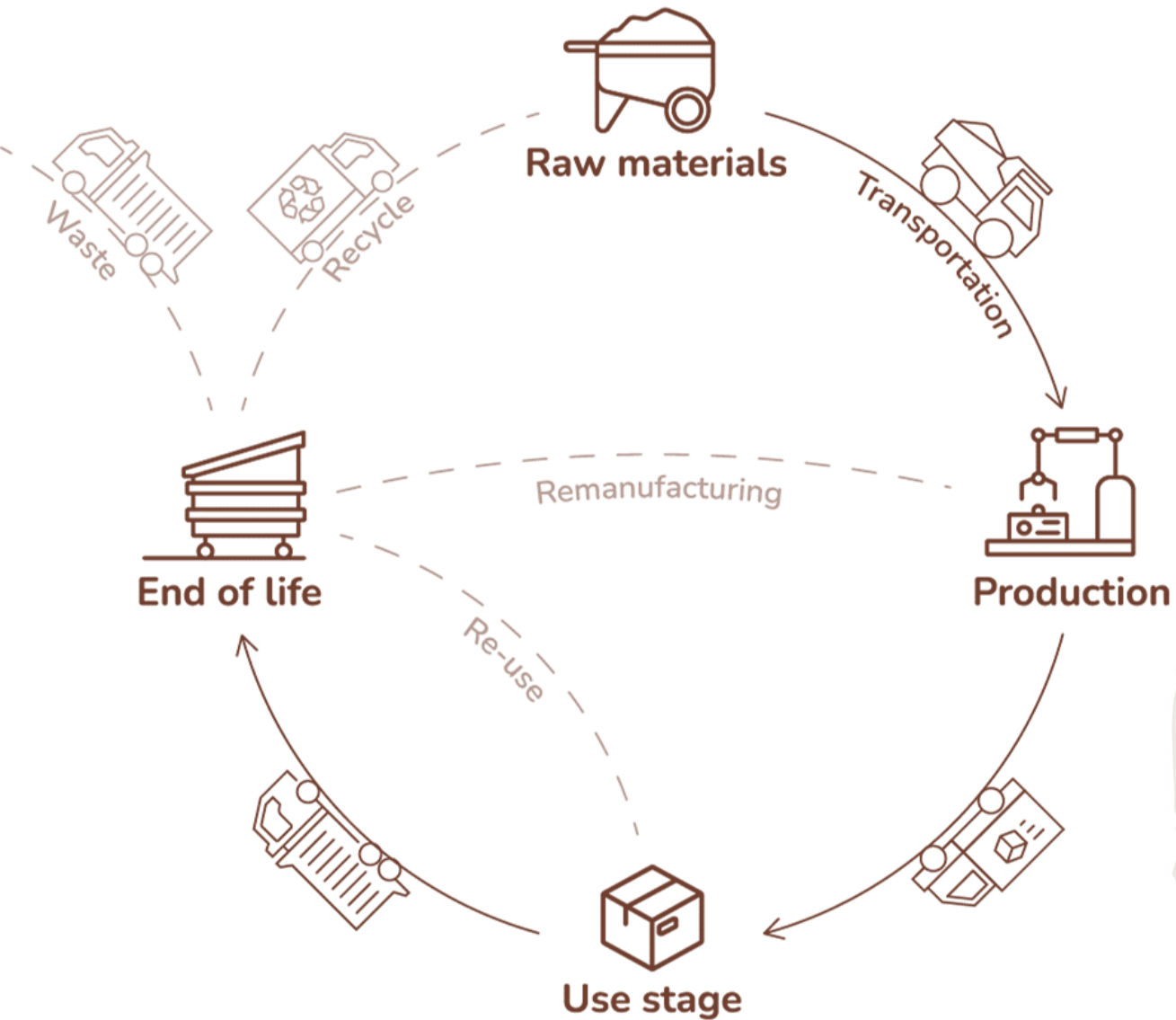
Visual tool to map sustainability trade-offs and

- **Databases & Libraries:**

Access material data from sources like Material ConneXion, Matmatch, or sustainable textile databases.

- **Integration with Design Thinking:**

Embed material decisions in early Ideate → Prototype



## Environmental Criteria in Material Selection

- 🌍 **Carbon footprint:** energy intensity & greenhouse gas emissions.
- 💧 **Water footprint:** irrigation, dyeing, tanning water use.
- ☠️ **Toxicity & chemicals:** restricted substances (RSLs, REACH, OEKO-TEX).
- ♻️ **End-of-life:** recyclability, biodegradability, compostability.
- ♻️ **Circularity potential:** reuse, repair,

# Environmental Criteria: End-of-Life Pathways

- **Biodegradable materials:** naturally decompose (e.g., organic cotton, natural rubber, mushroom leather).
- **Recyclable materials:** can be reprocessed into new products (e.g., PET bottles → polyester).
- **Closed-loop vs. open-loop recycling:** keeping materials in the footwear/leather cycle vs. downcycling.
- **Challenges:** contamination, mixed-material assemblies, lack of infrastructure.
- **Design for disassembly:** enabling material separation for recycling.





# Functional Criteria in Material

- **Durability & wear resistance:** abrasion, flexing, UV exposure.
- **Comfort:** breathability, moisture management, weight.
- **Flexibility & resilience:** cushioning, recovery, shock absorption.
- **Safety:** slip resistance, insulation, thermal properties.
- **Adaptability:** suitability

# Certifications Supporting Sustainable Materials

- **EU Ecolabel** – holistic environmental and durability criteria.
- **GRS (Global Recycled Standard)** – traceability & recycled content.
- **OEKO-TEX®** – harmful substance testing & human ecology.
- **Leather Working Group (LWG)** – responsible leather production.
- **GOTS (Global Organic Textile Standard)** – organic fibre certification.
- **Bluesign®** – safe chemicals and responsible textile production.



→□ *These are only illustrative examples. For a comprehensive analysis of sustainability standards and ecolabels in the **textile sector**, see:*  
Plakantonaki, S. et al. (2023). ***A Review of Sustainability Standards and Ecolabeling in the Textile Industry.*** Sustainability,

# Leather and Sustainable Alternatives

- **Traditional leather:** durable but resource- and chemical-intensive.
- **Environmental concerns:** tanning (chromium, water use, sludge waste).
- **Chrome-free & eco-tanned leathers:** Zeology, BioLeather, Bionature.



- **Bio-based leathers:** from pineapple leaves, mushroom mycelium, cocoa waste.
- **Vegan leathers:** PU and alternatives with reduced toxicity.

# Eco- Innovations in Tanning Processes

- **Zeology tanning:** chrome-free, heavy-metal-free, aldehyde-free.
- **Plant-based tanning:** using vegetable tannins, reduced toxicity.
- **Water & energy reduction:** closed-loop tanning systems.
- **Waste valorisation:** reusing sludge and by-products.
- **Performance**



# Linking Ashby's Method with the 5 Sustainability Pillars

Ashby Method Step	Mapped Sustainability Pillars	Examples in F&L Context
<b>1. Define Function &amp; Constraints</b>	<b>Performance</b> (must-meet specs), <b>Cost</b> (budget limits)	Minimum abrasion resistance, flexibility for sneakers; cost ceiling per pair.
<b>2. Set Objectives</b>	<b>Environment</b> (minimise impact), <b>Ethics &amp; Social</b> (fair sourcing)	Reduce CO <sub>2</sub> / water footprint; ensure worker safety in tanning/dyeing.
<b>3. Screen Materials</b>	<b>Environment</b> (exclude high-impact), <b>Ethics</b> (exclude non-compliant)	Exclude chrome-tanned leather (CrVI risk), non-certified cotton.
<b>4. Rank Candidates</b>	<b>Performance, Cost, Aesthetics</b> (comparative weighting)	Rank organic cotton vs. recycled polyester: breathability, price, look.
Performance & Cost → constraints + ranking. Environment & Ethics → objectives + screening. <b>5. Apply Trade-offs &amp; Decision</b> Aesthetics → ranking + trade-offs	<b>All 5 pillars balanced</b>	Choose Zeology-tanned leather (higher cost, but lower environmental/social

# Roadmap: Selecting Leather

## Define Function & Constraints

- Application: upper, lining, sole insert, bag panel.
- Constraints: thickness, strength, flexibility, cost.

## Set Objectives

- Minimize carbon & water footprint.
- Avoid hazardous chemicals.
  - LWG-rated tannery; traceability to slaughterhouse.
- Worker safety.
- Animal welfare policies; regional sourcing to reduce transport.

## Screen Materials

Exclude non-compliant leathers (chromium VI risk, no certification).

## Trade-Offs & Decision

Aesthetic needs, consumer acceptance, price sensitivity vs. environmental, ethical & social concerns.

## Rank Candidates

- Use eco-indices (e.g., environmental impact per unit performance).
- Compare chrome-tanned vs. chrome-free vs. bio-leathers.

# Case example: Leather Options

## Scenario:

A footwear brand must choose leather for a new sneaker line.

Options:

- **Option A:** Chrome-tanned leather (traditional).
- **Option B:** Zeology chrome-free leather (innovative).

Comparison under 5 Criteria:

Possible quantitative scoring & weighting of criteria

Criteria	Chrome-Tanned Leather	Zeology Chrome-Free Leather
Environment	✗ High wastewater & chemical load	✓ Reduced impact, no heavy metals
Performance	✓ Durable, flexible, widely proven	✓ Comparable durability
Aesthetics	✓ Wide range of finishes	✓ Bright/light colours possible
Cost	✓ Lower cost, widely available	✗ Higher cost, limited supply
Ethics & Social	✗ Worker exposure to hazardous chemicals	✓ Safer for workers & consumers

# Roadmap: Selecting Textiles

## Define Function & Constraints

- Application: uppers, linings, laces, bag interiors.
- Constraints: strength, breathability, comfort, flexibility.

## Set Objectives

- Minimize CO<sub>2</sub>, water use, pesticide/chemical load.
- Reduce microplastic shedding (synthetics).
- Ensure traceability & eco-certifications (GOTS, OEKO-TEX).

## Screen Materials

- Exclude non-certified conventional cotton, non-recycled synthetics.
- Avoid blends difficult to recycle.

## Trade-Offs & Decision

- Balance durability vs. biodegradability.
- Aesthetics (look/feel) vs. recyclability.
- Cost & availability vs. eco-performance.

## Rank Candidates

- Compare organic cotton, recycled polyester, innovative fibres (Lyocell, Seacell, etc.).
- Use eco-indices: carbon/water

# Case Example: Organic Cotton vs. Recycled Polyester

## Scenario:

A footwear brand must choose leather for a new sneaker line.

Options:

- **Option A:** Chrome-tanned leather (traditional).
- **Option B:** Zeology chrome-free leather (innovative).

Comparison under 5 Criteria:

Criteria	Organic Cotton	Recycled Polyester (rPET)
<b>Environment</b>	✓ Lower pesticide & water pollution; biodegradable	✓ Reduced landfill waste & CO <sub>2</sub> vs. virgin PET; ✗ microplastic shedding
<b>Performance</b>	✗ Lower durability, prone to shrinkage	✓ High strength & abrasion resistance
<b>Aesthetics</b>	✓ Natural look/feel, breathable	✓ Versatile finishes; synthetic handfeel
<b>Design Decision:</b>	✗ Higher than conventional cotton	✓ Often lower than organic cotton; stable supply
<b>Pros &amp; Cons:</b>	✓ Supports organic farming & fair labor schemes	✓ Supports recycling systems; but dependent on collection infrastructure
<b>Recycled polyester</b>	✓ Best for eco-marketing, availability	✓ Best for durability, cost, and large-scale

# Roadmap: Selecting Polymers & Soles

## Define Function & Constraints

- Application: outsole, midsole, cushioning, reinforcement.
- Constraints: abrasion resistance, slip resistance, flexibility, lightweight.

## Set Objectives

- Minimize CO<sub>2</sub> emissions and fossil-fuel dependence.
- Prioritize recyclability and biodegradability.
- Reduce VOC emissions from production.

## Screen Materials

- Exclude PVC and high-toxicity compounds.
- Avoid complex blends that block recycling.

## Trade-Offs & Decision

- Comfort & cushioning vs. biodegradability.
- Cost & mass availability vs. innovation (bio-based soles).
- Consumer acceptance of "new feel" vs. traditional performance.

## Rank Candidates

- Compare EVA, TPU, natural rubber, bio-based polymers.
- Consider durability vs. eco-indices (carbon footprint per wear cycle).

# Case Example: EVA vs. Biodegradable Sole Polymer

## Scenario:

Sports footwear company considering materials for midsoles.

Options:

- **Option A:** Conventional EVA (Ethylene-Vinyl Acetate).
- **Option B:** Biodegradable polymer (e.g., Bio-EVA or PHA-based).

Comparison under 5 Criteria:

Criteria	Conventional EVA	Biodegradable Polymer
<b>Environment</b>	✗ Fossil-based, difficult to recycle	✓ Renewable, compostable, reduced fossil use
<b>Performance</b>	✓ Proven cushioning, resilience	✗ Still lower durability in sports use
<b>Aesthetics</b>	✓ Wide color & finish options	✓ Acceptable, but some limitations
<b>Cost</b>	✓ Low cost, widely available	✗ Higher cost, limited industrial scale
<b>Ethics &amp; Social</b>	✗ Petrochemical dependence	✓ Supports bio-based economy; safer production

- Trade-off?

# Roadmap: Selecting Components & Accessories

## Define Function & Constraints

- Application: adhesives, stitching threads, trims, reinforcements, buckles, zippers.
- Constraints: strength, durability, safety (no sharp edges, strong bonding).

## Set Objectives

- Minimize VOC emissions (adhesives).
  - Reduce hazardous substances (metal plating, coatings).
- Use recyclable or biodegradable components where possible.

## Screen Materials

- Exclude solvent-based adhesives with high VOCs.
- Avoid PVC trims or non-compliant metals.

## Trade-Offs & Decision

- Adhesion strength vs. eco-safety.
  - Durability vs. recyclability (e.g., metal vs. biopolymer accessories).
- Cost & ease of sourcing vs. innovation.

## Rank Candidates

- Compare water-based adhesives, recycled threads, eco-metals vs. conventional.
- Eco-indices: emissions per bonding strength, durability.

# Case Example: Organic vs. Water-based adhesive

## Scenario:

A footwear brand must choose adhesives for sneaker production.

Options:

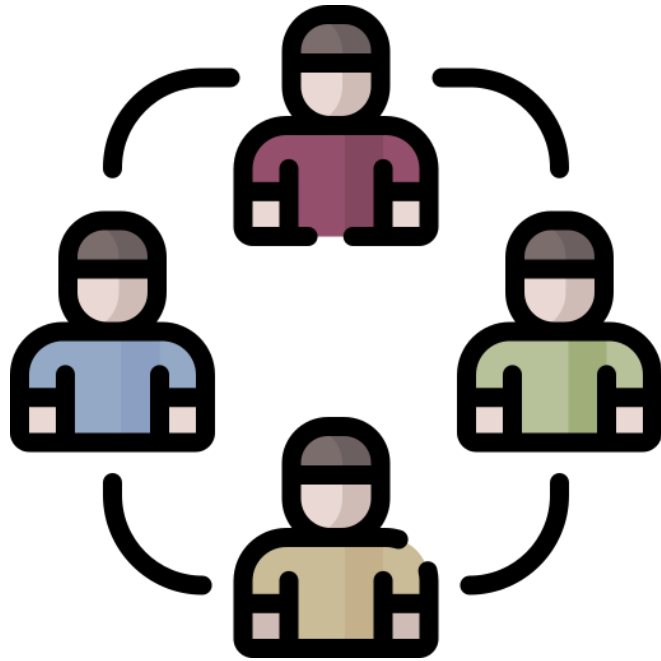
- **Option A:** Organic solvent-based adhesive.
- **Option B:** Water-based adhesive.

Comparison under 5 Criteria:

Criteria	Solvent-Based Adhesive	Water-Based Adhesive
Environment	✗ High VOC emissions, hazardous waste	✓ Lower emissions, safer disposal
Performance	✓ Strong bonding, proven reliability	⚠️ Adequate bonding but longer curing, limited in humid climates
Aesthetics	✓ No impact on look/finish	✓ No impact on look/finish
Cost	✓ Lower unit cost, widely available	✗ Slightly higher cost, process adaptation needed
Ethics & Social	✗ Worker exposure to VOCs	✓ Safer for workers, better compliance

- Trade-off ?

# Interactive Activity : Material Selection Challenge



## Instructions:

- Work in pairs/groups.
- Scenario: *You are designing a new eco-friendly sneaker.*
- Choose an **upper material** and a **sole material** from the options provided.
- Apply the **5-pillar criteria** (Environment, Performance, Aesthetics, Cost, Ethics & Social).
- Decide which combination best balances sustainability and functionality.

## Options Provided:

- Upper materials: Organic cotton, Recycled polyester, Mushroom leather.
- Sole materials: Conventional EVA, Recycled rubber, Bio-based polymer.

## Activity Format:

- 1.Think** - Each learner evaluates individually (2 min).

# Takeaway

- No single perfect material exists – every choice involves trade-offs.
- Use structured methods (Ashby + 5 pillars) to guide decision-making.
- Always balance performance, cost, aesthetics with environmental and social responsibility.
- Certifications and standards are tools, but critical reflection is essential.
- Design decisions at early stages have the greatest impact on sustainability.
- Innovation is key: explore bio-based, recycled, and circular solutions.

