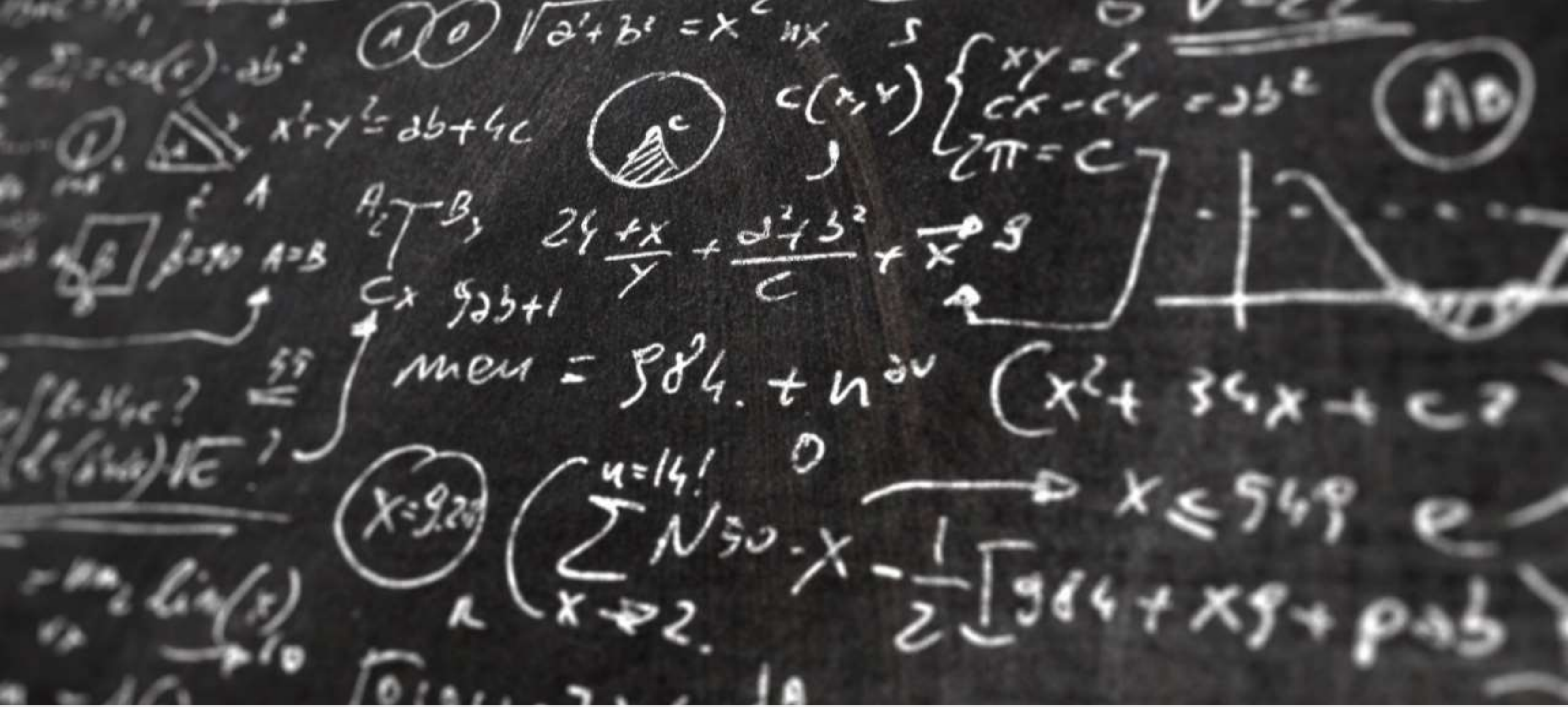


ASSESSMENT 4

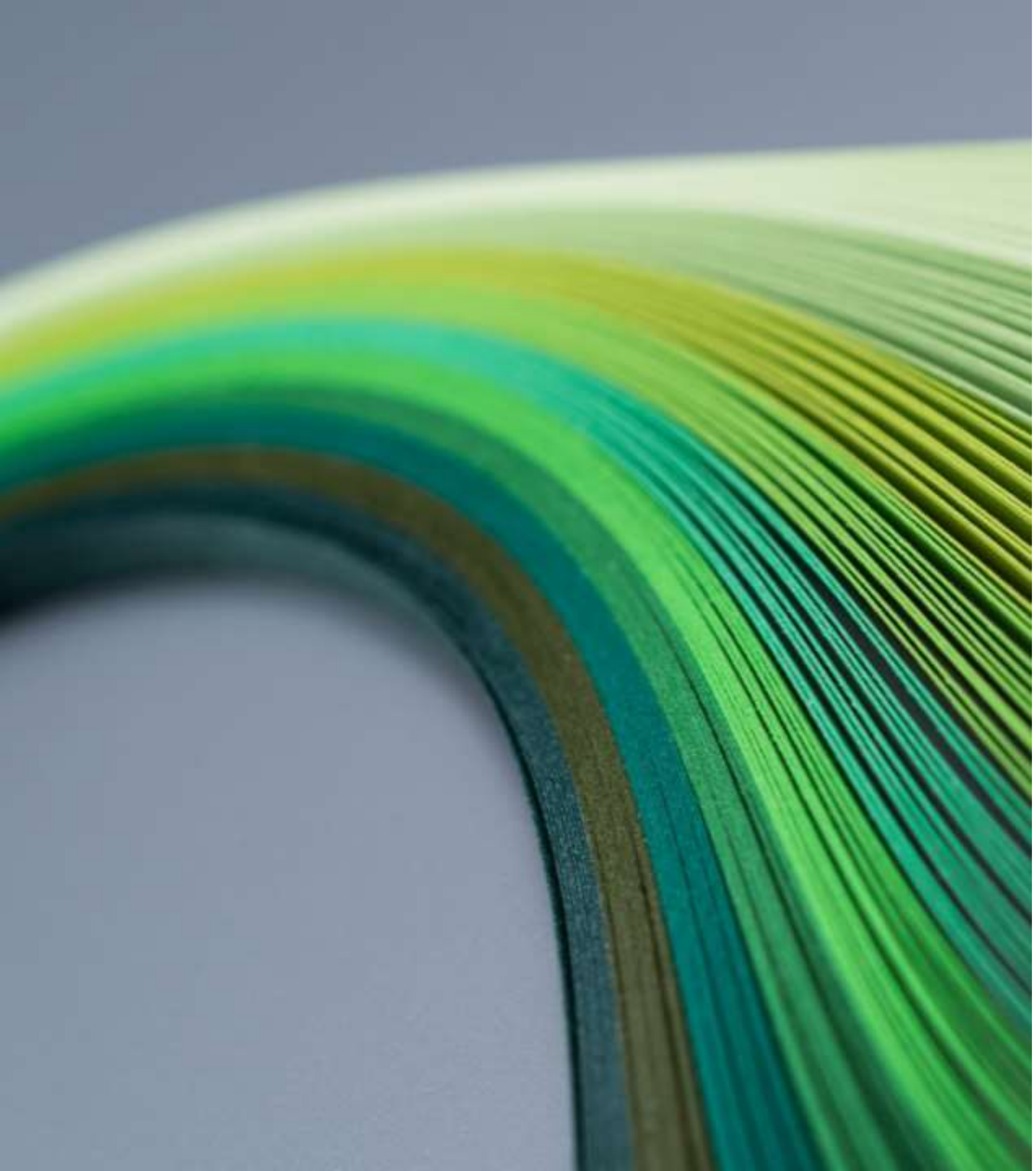
Asghar, Jawad, Nawar, Faris

OUTDOOR FABRICS: WATERPROOFING, BREATHABILITY, AND INDIGENOUS KNOWLEDGE

Outdoor fabrics protect against **rain, wind, and cold**.

Balance of **waterproofing** (keeping water out) and **breathability** (allowing sweat to escape) is crucial.

Comfort, safety, and performance in outdoor activities depend on materials.



NYLON: STRENGTH AND COATINGS

- **Properties:** lightweight, strong, abrasion-resistant.
- Widely used in **tents and rain jackets**.
- Made waterproof using **polyurethane (PU) or silicone coatings**.
- Trade-off: coatings reduce breathability.
- Environmental issue: petroleum-based → emerging **bio-nylon and recycled nylon**

GORE-TEX: WATERPROOF AND BREATHABLE MEMBRANES

- **Microporous ePTFE membrane** → pores smaller than water droplets, larger than vapor molecules.
- Provides both **waterproofing and breathability**.
- Common in **jackets, boots, mountaineering gear**.
- Limitations: expensive, needs regular care, past use of harmful PFCs.
- Now shifting to **PFC-free membranes** for sustainability

RECYCLED PET AND INDIGENOUS KNOWLEDGE

Recycled PET (rPET):

Made from plastic bottles → fibres → fabrics.

Reduces waste and carbon footprint.

Requires coatings/laminates for waterproofing.

Slightly less durable but eco-friendly.

Indigenous Knowledge:

Arctic peoples: **seal and caribou skins** for waterproof, breathable clothing.

Māori: **harakeke (flax) cloaks** resisting rain, allowing airflow.

Early, sustainable solutions inspire modern innovation.

CONCLUSION AND FUTURE DIRECTIONS

Nylon → affordable, strong, but less breathable.

Gore-Tex → advanced, waterproof + breathable, but costly.

Recycled PET → sustainable, reduces waste, slightly less durable.

Indigenous Knowledge → foundation for sustainable design.

Future: **bio-based fibres, PFC-free waterproofing, circular recycling systems**

HELMET SHELLS AND LINERS:

- **Introduction to safety and production of helmets like hard hats for work and sport.**
- This will focus on the production and material science behind helmet shells and liners.

Main points:

- Materials
- Cost
- Production
- Usability

MATERIAL (SHELL)

- There are many materials which can be used to make the shell, mainly coming down to cost and usage as high production of these hats are needed to due jobs and hobbies.
- **Main material**
- Polycarbonate (PC)
- Carbon fiber
- Fiberglass

materials like fiberglass and carbon fiber provided but having these materials would cause the helmets to be useful for jobs mainly construction but is too expensive for average users so most use polycarbonate (PC) as the main material for shells/

MATERIAL (LINER)

In the helmet outside of protection, comfort is a big factor in use as having a heavy uncomfortable would cause the product to be safe but wear down the user.

Main points

Expanded Polystyrene (EPS) foam

Effective ventilation channels within the liner and through the shell allow for consistent airflow, helping to regulate temperature and manage moisture, thereby ensuring the wearer remains focused, comfortable, and protected this is why EPS is used as it is cheap and does a perfect job.

CONCLUSION

- While having the best production of safety equipment it is not always needed as having high cost weighs down production and using cheaper materials for less dangerous jobs are perfectly fine in most cases like swapping carbon fiber for Polycarbonate.

MATERIALS FOR SPORT AND OUTDOOR EQUIPMENT: BIKE FRAME, RIMS AND FORKS

- Bicycles need materials that are strong, lightweight, and durable. The choice of material directly affects safety, performance, and how long the bike lasts. In this presentation, I'll compare different materials and explain why engineers choose them
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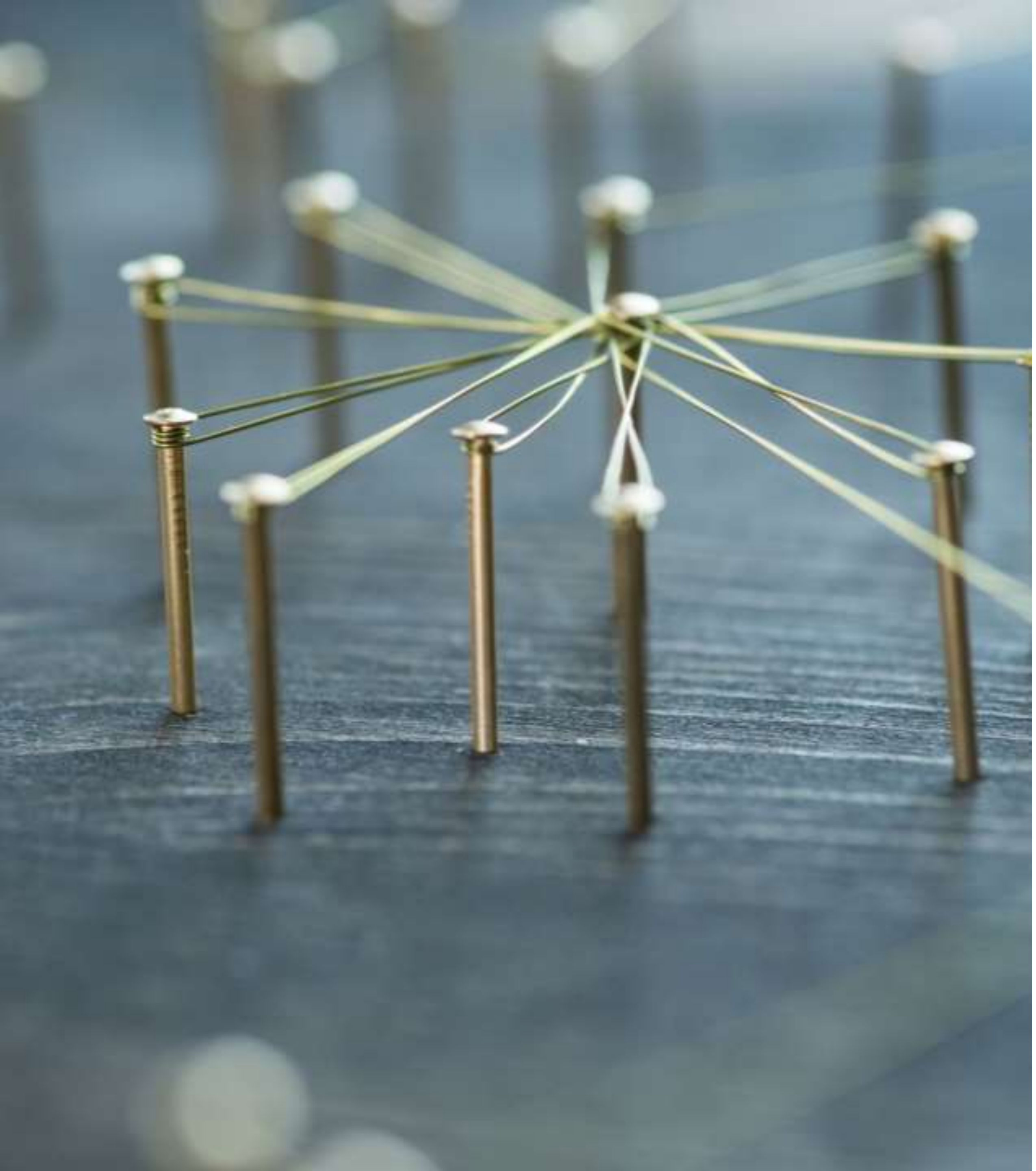

STEEL

- Steel was the traditional choice for bike frames. It has a body-centred cubic, or BCC structure, in ferrite and a face-centred cubic, or FCC, structure in austenite. Its microstructure can include ferrite, pearlite, or martensite, which changes its strength. Steel is strong and tough but heavy at about 7.8 grams per cubic centimetre. It resists fatigue well but needs coatings to stop rust.
-

ALUMINIUM ALLOYS

- Aluminium has an FCC atomic structure, which makes it ductile and corrosion resistant. It’s much lighter than steel, with a density of 2.7 grams per cubic centimetre. By adding elements like magnesium or zinc, engineers increase its strength. Heat treatment creates fine precipitates in the microstructure, which strengthen the alloy. Aluminium is excellent for light, stiff bikes, but its fatigue life is shorter.
-

CARBON FIBRE COMPOSITES

- Carbon fibre has a graphitic atomic structure. Strong covalent bonds hold the carbon atoms in layers, giving it incredible tensile strength. When fibres are combined with a polymer resin, we get a composite material. Its properties are anisotropic, meaning strength depends on fibre direction. This makes it very light and stiff, but also brittle and expensive. It can also be hard to recycle
-

SUSTAINABILITY & INDIGENOUS KNOWLEDGE

- Sustainability is a growing issue. Steel and aluminium are easy to recycle, while carbon fibre is more difficult, though new recycling methods are being developed. Indigenous Australian knowledge teaches us to value local, renewable, and long-lasting materials, and to minimise waste. These traditional principles align with modern ideas like repairability and respect for resources."

MATERIALS SCIENCE PRINCIPLES

- The strength-to-weight ratio is one of the most important factors in bicycle design. Fatigue resistance is also critical, because bicycles are exposed to constant cycling stresses. Corrosion resistance makes sure the frame lasts outdoors. Finally, microstructure — like grain size in metals or fibre orientation in composites — plays a huge role in determining strength and performance.
-

CONCLUSION

- In conclusion, bicycles rely on materials carefully chosen for their strength, weight, and durability. Aluminium is common for mass-market bicycles, while carbon fibre dominates racing bikes. Titanium and steel still play important roles. By looking at atomic structure, we can understand why these materials behave the way they do. Finally, Indigenous knowledge reminds us to use materials sustainably and with respect for the environment
-

PERFORMANCE MEETS SUSTAINABILITY: SURFBOARDS AND PADDLES

Water sports gear must be lightweight, strong, and water-resistant

Material choice affects speed, control, and durability

Sustainability is now a key concern in design and manufacturing

WHAT'S INSIDE A SURFBOARD?

- **Core Materials:**
- PU Foam: cheap, mouldable, non-recyclable
- EPS Foam: lighter, recyclable, used with epoxy resin
- **Outer Layers:**
- Fibreglass cloth: adds stiffness and strength
- Epoxy resin: stronger and less toxic than polyester resin

WHAT MAKES A PADDLE EFFICIENT?

Shaft & Blade Materials:

Fibreglass: flexible and affordable

Carbon Fibre: ultra-light, stiff, brittle

Aluminium: strong, heavy, recyclable

Bamboo: renewable, flexible, aesthetic

Grip Materials:

EVA foam and rubber: comfort and slip resistanc

THE ENVIRONMENTAL COST OF PERFORMANCE

- **Problems:**

- Carbon fibre and fibreglass: non-recyclable, high emissions
- PU foam: petroleum-based, degrades over time

- **Solutions:**

- Bio-resins: lower toxicity
- Bamboo: biodegradable and renewable

- Recycled foams: reduce landfill waste

CONCLUSION/THE FUTURE OF SURFBOARDS AND PADDLES

MATERIAL CHOICE = PERFORMANCE + SUSTAINABILITY

TRADITIONAL MATERIALS WORK, BUT COME AT A COST

ECO-FRIENDLY OPTIONS ARE IMPROVING—BIO-RESINS, BAMBOO, RECYCLED FOAMS

ENGINEERS MUST BALANCE SPEED, STRENGTH, AND ENVIRONMENTAL IMPACT