Tailoring Poisson's Ratio of a Fabric using Auxetic Structures

Breeshea Robinson
Supervisory Team: Anne Nortcliffe, Abdullahi Ahmed, Tasneem Sabir & Adil Imam
Canterbury Christ Church University, Wrexham University & Manchester Metropolitan University

Sporting Personal Protective Equipment (PPE) & Issues with It

PPE is used across all contact sports and widely used by all levels - amateur to professional and across all age groups

Poor Fit:
Most PPE is designed on a "one size fits all" or male-centric basis. Can lead to discomfort,, and even safety hazards with different body shapes.

Inadequate Protection:
Generic designs do not adequately protect specific areas vulnerable during certain sports for women (e.g., chest protection in contact sports).

Discomfort and Performance:
Ill-fitting or bulky PPE can cause chafing, overheating, and hinder athletic performance.

Evolution of Fabrics

Early Fabrics (Natural)
- From animal skins to plant fibres like cotton and wool, early clothing focused on basic protection and comfort.

Industrial Revolution
- Power looms and cotton gins revolutionised textile production, making fabrics more affordable and diverse.
- Sports adopted these materials for basic uniforms and early sports equipment (e.g., leather balls).

Synthetic Revolution
- Nylon, polyester, and other synthetics emerged, offering superior qualities like durability, moisture-wicking, and lightweight construction.
- Sportswear became more specialised for different activities (e.g., breathable running shirts, & water-resistant ski jackets).

Tech Fabrics
- Advanced materials like performance blends, seamless construction, and climate control technologies are pushing the boundaries of comfort, performance, and recovery in sports apparel.

3D Printing

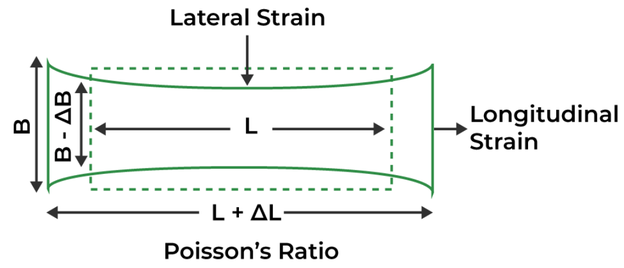
1980s:
- Lasers turn liquid resin into 3D objects (SLA).

1990s-2000s:
- FDM makes plastic prototypes from spools of filament.

2000s-Today:
- Affordable printers, new materials, and wider uses beyond prototypes.

Auxetic Structures

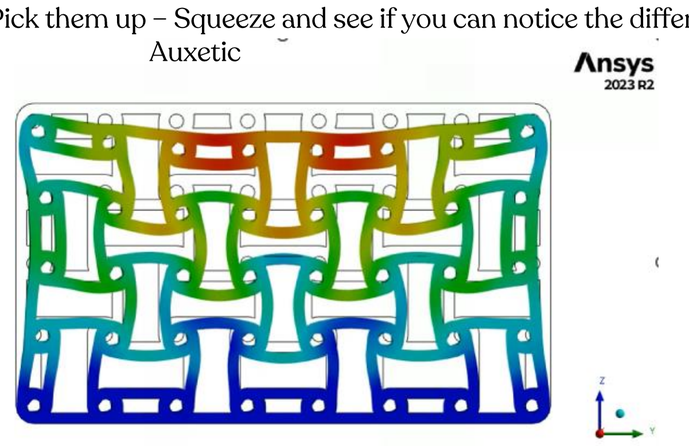
Negative Poisson's Ratio:
Describes the relationship between strain in different directions.
Auxetic Structures have a negative Poisson's ratio, defying the typical positive value for most materials.



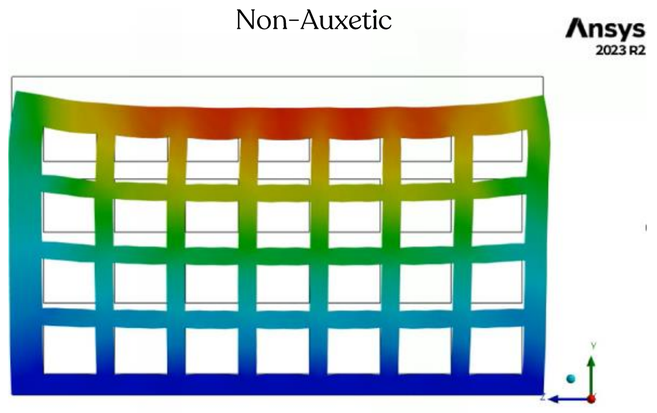
3D Printed Structures

Pick them up – Squeeze and see if you can notice the difference between an Auxetic and a Non-Auxetic Structure

Auxetic



Non-Auxetic



What we are trying to do:

The project aims to try and improve the performance of a sporting PPE by:
- Creating a PPE design that can be embedded into a fabric
- Optimising the fit of PPE/Clothing for all body types –making it more inclusive
- Providing a start on a database which would inform 3D printing of fabric in the future

How are we doing this:

- Tailoring the printing parameters for material – fabric combinations
- Finding potential applications to improve PPE fit
- Improving/Optimising adhesion between material and fabric
- Testing its impact on environment in terms of Micro/nano-plastics

Samples produced in this study

Feel free to stretch the fabric samples with and without the structures and notice any difference

Fabric

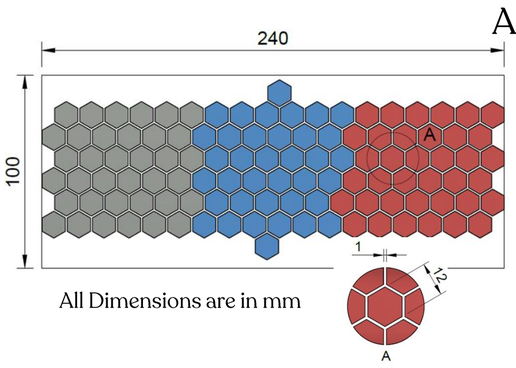
Fabric + Mesh

Please handle these samples with care

Fabric + Auxetic Soft TPU

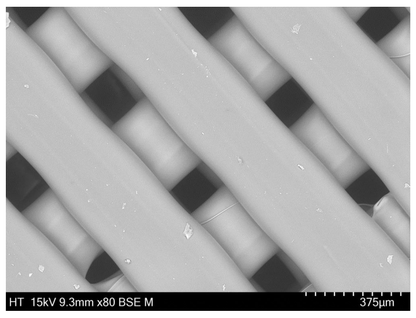
Fabric + Auxetic Hard TPU

Active research studies

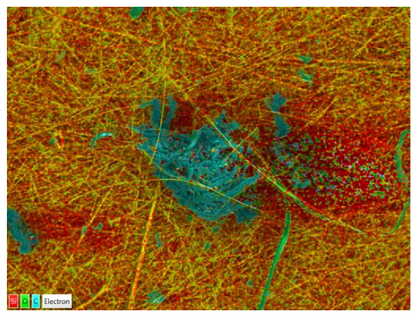


All Dimensions are in mm

Printing Setup on Fabric for testing



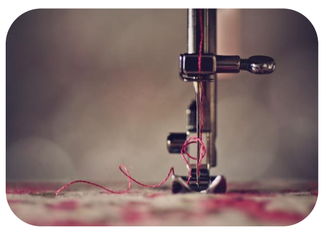
SEM Scan for Surface Finish



EDS to see Micro/Nano Plastics

Printing on Fabric for assessing adhesion, SEM Structural study and Environmental Impact

Applications and Future Work



Tailormade for purpose

Fit for any requirement

Sustainable

Contact Details

Breeshea Robinson – Breeshea.Robinson@canterbury.ac.uk
Adil Imam- Adil.Imam@canterbury.ac.uk

LinkedIn Profiles:

Outputs & References

For more information on the work being done and related information.

Please scan this QR Code