Circular Ocean
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The Centre for Sustainable Design
University for the Creative Arts

Rhiannon Hunt

3D Printing Applications for Creating Products Made from Reclaimed Fishing Gear

Sustainable innovation 2016

www.circularocean.eu

Northern Periphery and Arctic Programme 2014–2020

EUROPEAN UNION
Investing in your future
European Regional Development Fund

Circular Ocean

In pursuit of innovative and sustainable solutions for marine plastic waste, the Circular Ocean project seeks to inspire enterprises and entrepreneurs to realise the hidden opportunities of discarded fishing nets and ropes in the Northern Periphery & Arctic (NPA) region.

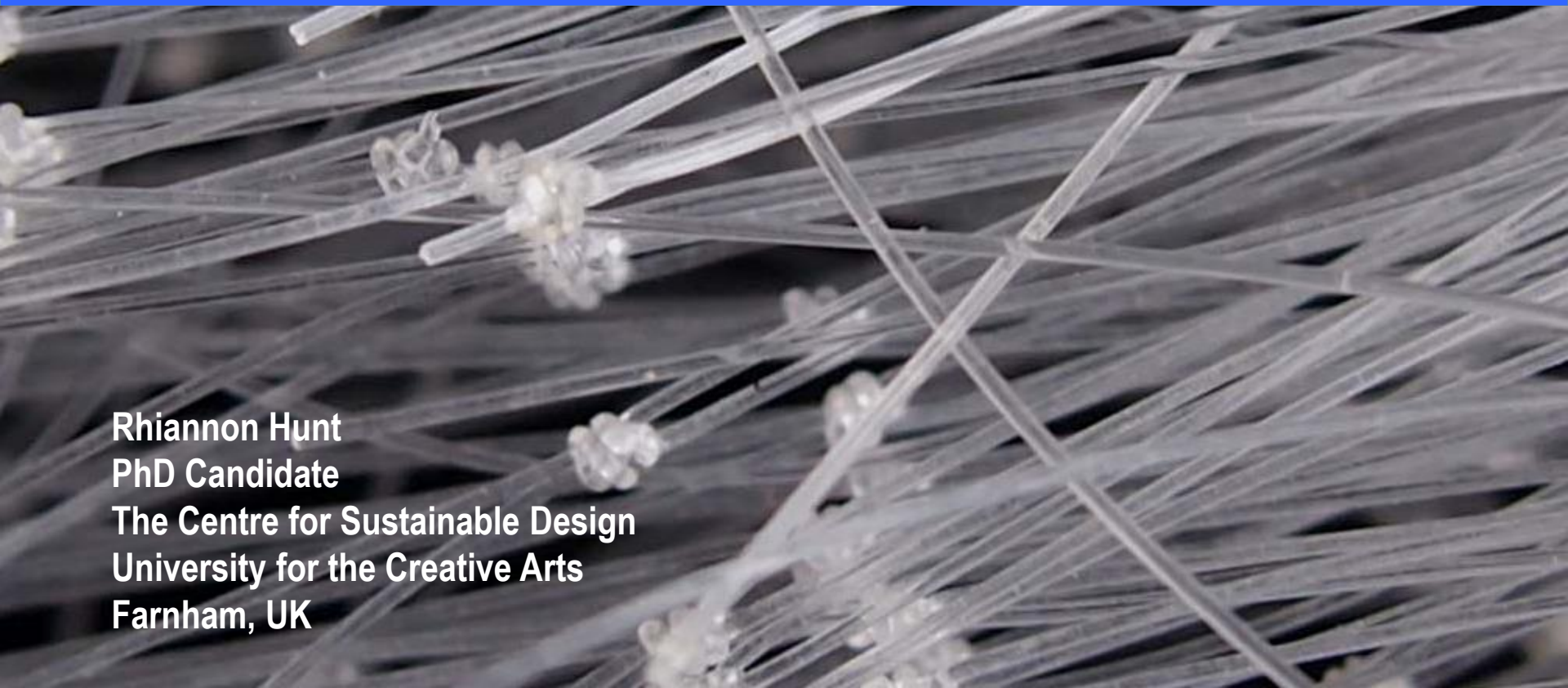
As increasing levels of marine litter is particularly pertinent to the NPA region, the Circular Ocean project will act as a catalyst to motivate and empower remote communities to develop sustainable and green business opportunities that will enhance income generation and retention within local regions.

Through transnational collaboration and eco-innovation, Circular Ocean will develop, share and test new sustainable solutions to incentivise the collection and reprocessing of discarded fishing nets and assist the movement towards a more circular economy.

Circular Ocean is led by the Environmental Research Institute, www.eri.ac.uk (Scotland), and is funded under the European Regional Development Fund (ERDF) Interreg VB Northern Periphery and Arctic (NPA) Programme http://www.interreg-npa.eu. It has partners in Ireland (Macroom E www.macroom-e.com), England (The Centre for Sustainable Design www.cfsd.org.uk), Greenland (Arctic Technology Centre www.artek.byg.dtu.dk), and Norway (Norwegian University of Science and Technology www.ntnu.edu).

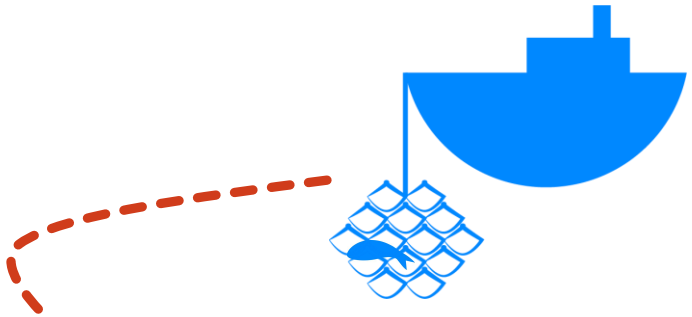
3D PRINTING APPLICATIONS FOR CREATING PRODUCTS MADE FROM RECLAIMED FISHING GEAR

SUSTAINABLE INNOVATION 2016



Rhiannon Hunt
PhD Candidate
The Centre for Sustainable Design
University for the Creative Arts
Farnham, UK

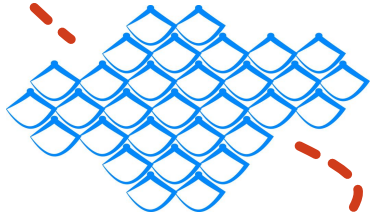
-THE PROBLEM-

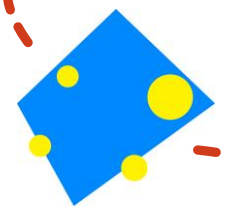


Nets are lost, abandoned or dumped at sea

Loss of material value for fishing communities

£ € $





‘Ghost nets’ continue to catch target and non-target species

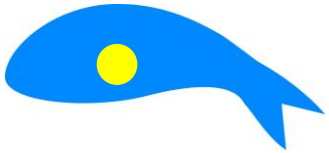
Chemical pollutants sorb onto net polymers

As they fragment, nets add to ocean plastic pollution

(Entanglement)

(Ingestion)

(Ingestion)



Fish kills

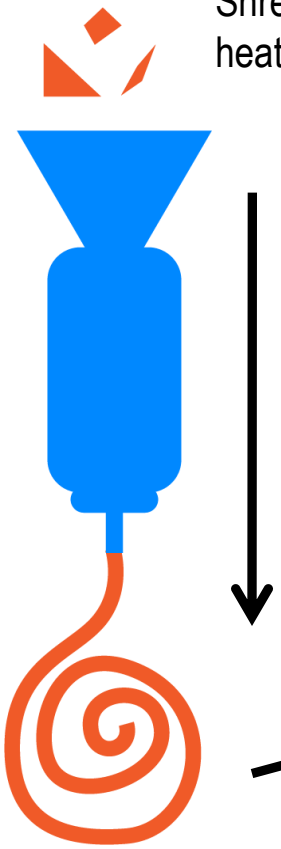
Contamination

Starvation

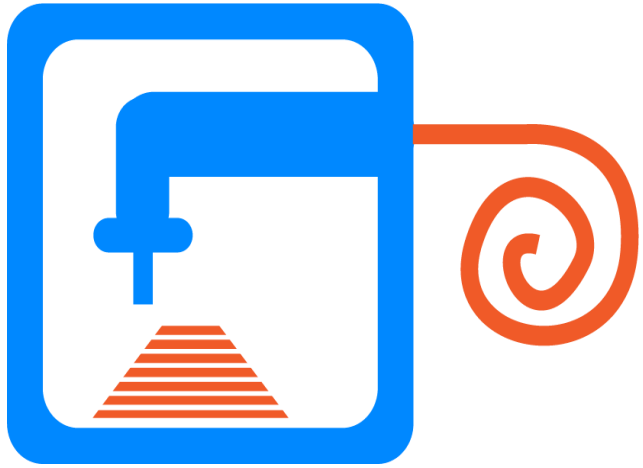
-THE SOLUTION?-

Waste fishing gear is collected, sorted, cleaned and shredded

Shredded material is heated and melt-extruded

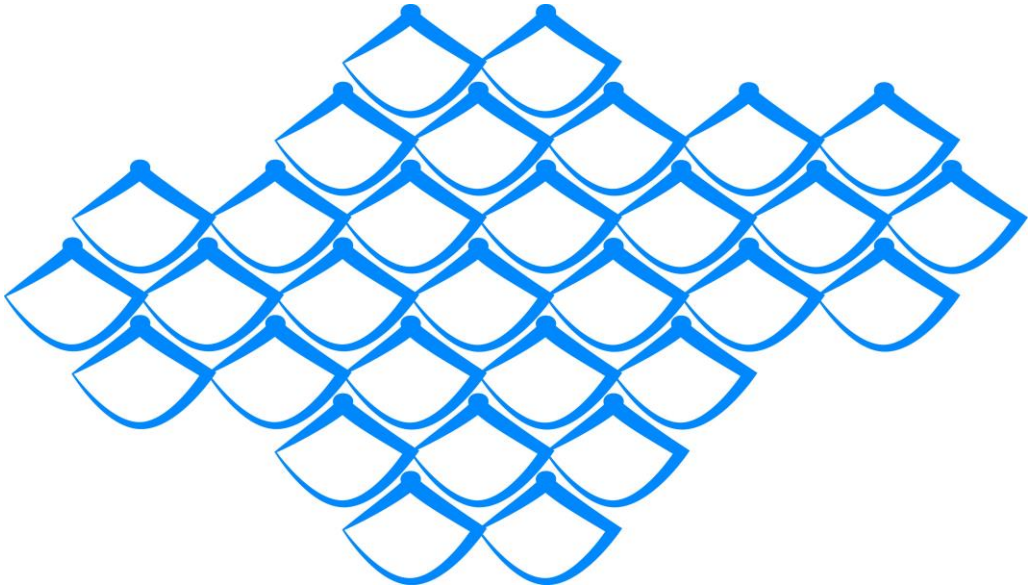


A spool of extruded filament is produced



Filament is 3D printed using a fused filament fabrication printer

-FISHING GEAR COMPOSITION-



- Thermoplastics
- High quality
- Mechanical strength
- Chemical resistance

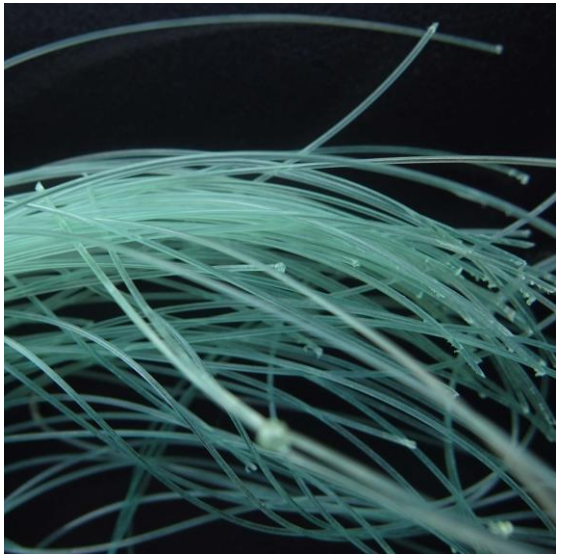
-FISHING GEAR COMPOSITION-

Polyethylene	Polypropylene	Polyester	Polyamide
• Moisture resistance • Chemical resistance • Impact resistance	• Moisture resistance • Chemical resistance • Fatigue resistance	• Moisture resistance • Chemical resistance • Durability	• Impact resistance • Chemical resistance • Tensile strength
• Poor UV resistance • Difficult to bond • Low melting point	• Poor UV resistance • Difficult to bond • Oxidative degradation	• Differential cooling rates can lead to warping	• High moisture pick-up • UV stabilisation required
• 3DP filament in development / DIY	• Limited 3DP filament availability / DIY	• 1.75mm & 3mm 3DP filament available	• 1.75mm & 3mm 3DP filament available
• Poor layer adhesion • Prone to warping • Burns above 80°C	• Prone to warping • Significant shrinkage during cooling	• Strength • High degree of clarity • No odours or fumes	• Strength • Interlayer adhesion • Prone to curling

-FISHING GEAR CONSTRUCTION-

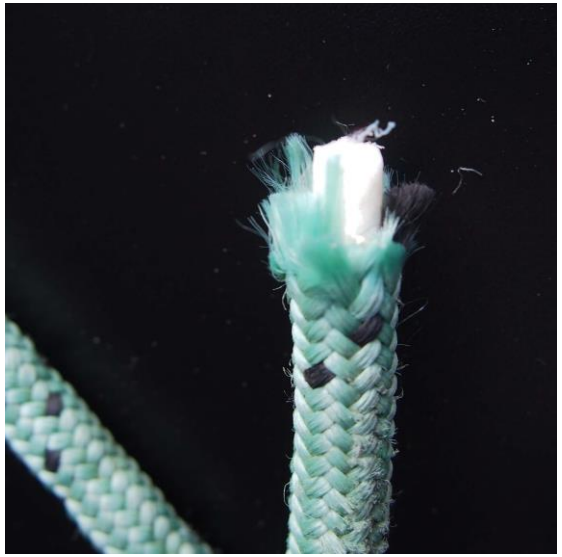
Single, twisted PE rope

Single, braided PE rope



Monofilament gillnet

-FISHING GEAR CONSTRUCTION-



Polyfoam and PE float-line

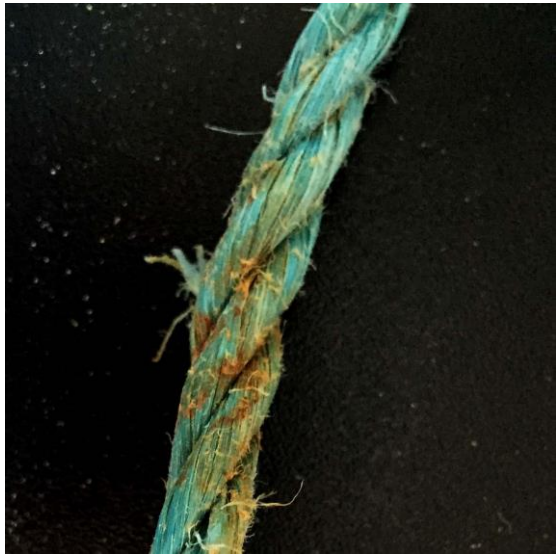
Braided PA stitched to PE rope

Adhesive tape on PE rope

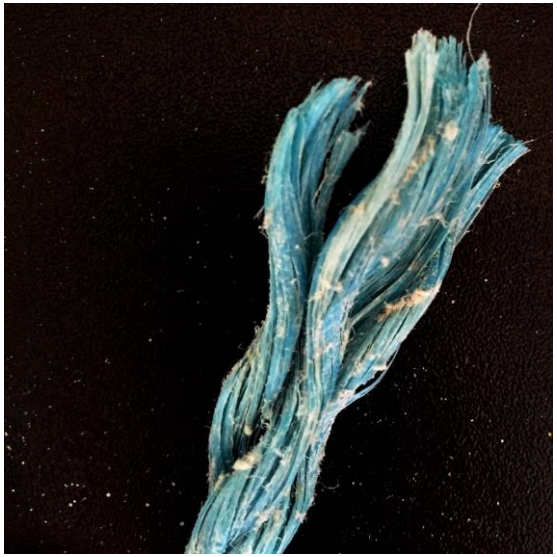
-FISHING GEAR CONDITION-

- Abrasion
- Absorption & adsorption of contaminants
- Ultra-violet degradation
- Chemical degradation

-FISHING GEAR CONTAMINATION-



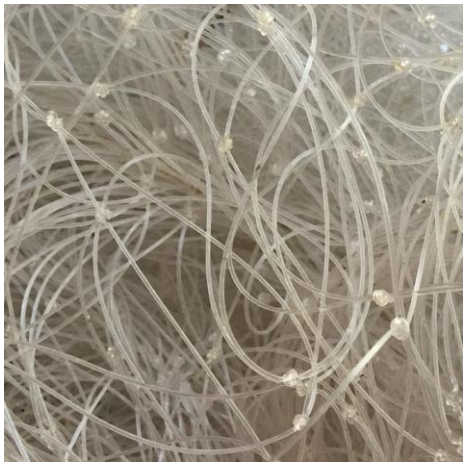
Suspected rust contamination



Salt and sand contamination

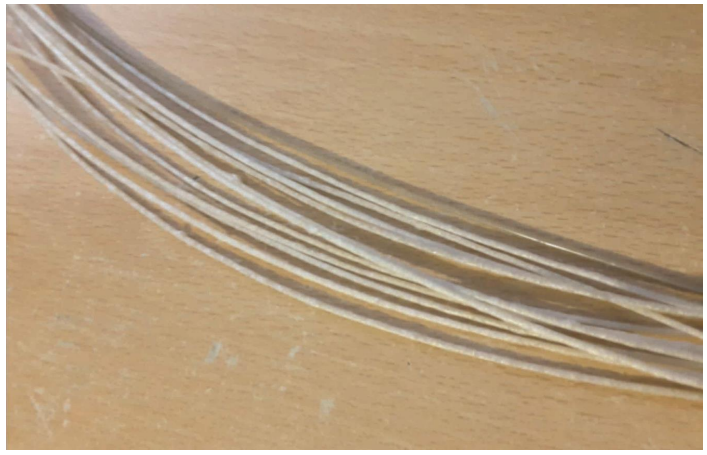
Suspected bio-fouling

-FISHING GEAR EXTRUSION TRIAL-



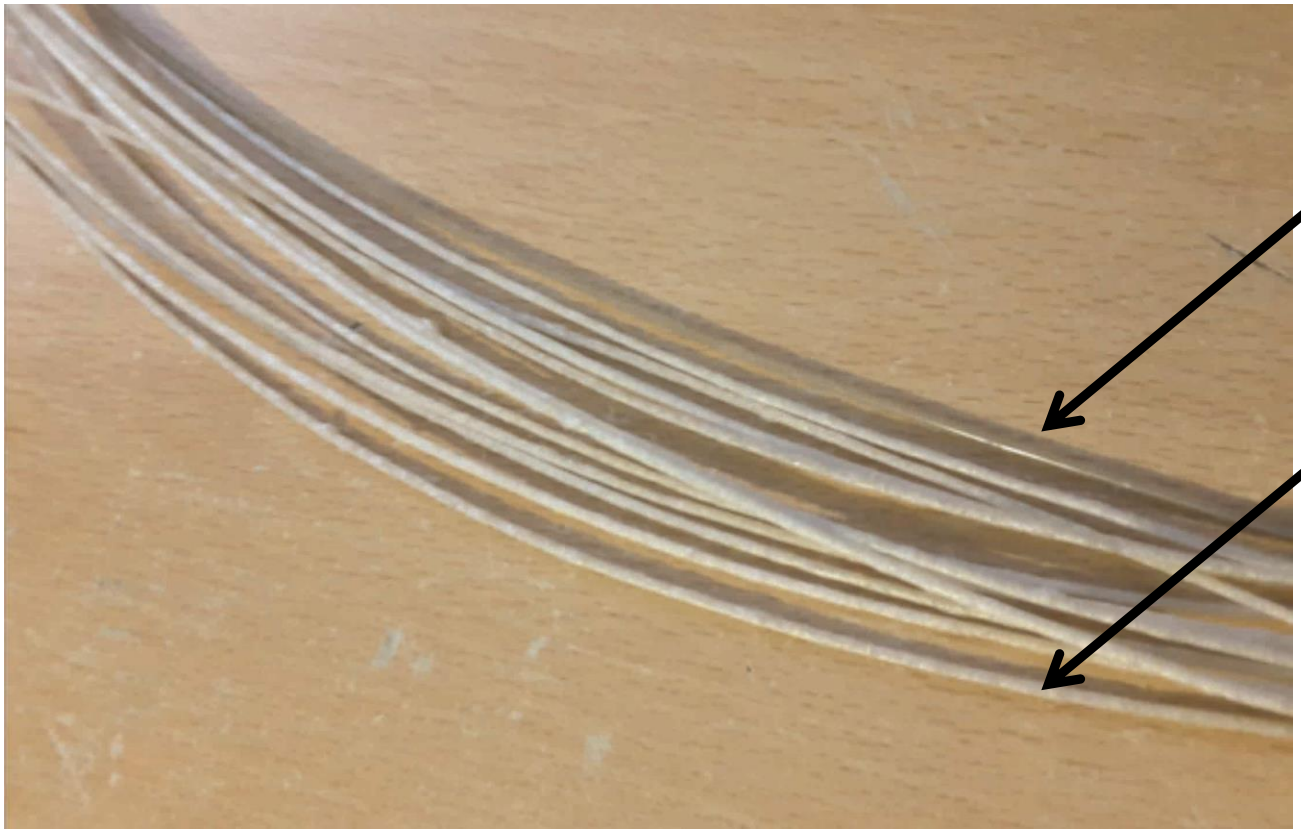
PA monofilament gillnet

Shredded PA <10mm



Extruded PA filament samples

-FISHING GEAR EXTRUSION TRIAL-



Slower, low temperature extrusion produced more consistent, high-quality filament

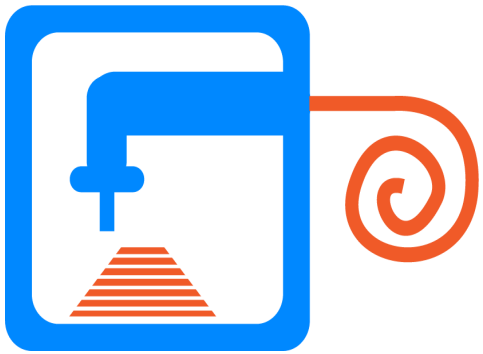
Bubbling due to high moisture content and high extrusion temperatures, creating steam

Salt contamination likely, however the extent and impact on filament quality is unknown

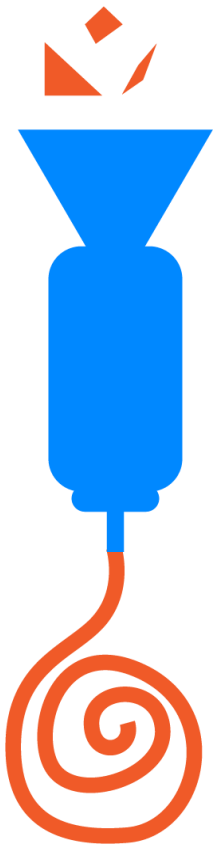
-FISHING GEAR EXTRUSION TRIAL-

Recommendations

- Polyamide monofilament gillnet is likely to be the easiest fishing gear to process and is likely to produce high quality 3D printing filament
- A mechanised shredding process is recommended as opposed to hand cutting the fishing gear ready for processing
- An industrial drying and pelletisation process is likely to produce higher quality filament, removing water content and ensuring a consistent composition and feed size
- Further testing to identify the level of salt contamination and it's impact on filament quality is needed
- Fused filament fabrication testing using a 3D printer to print products is needed



-3D PRINTING FILAMENT-



Clean, dry, pelletised polyamide fishing gear

Extrusion

Sale of filament

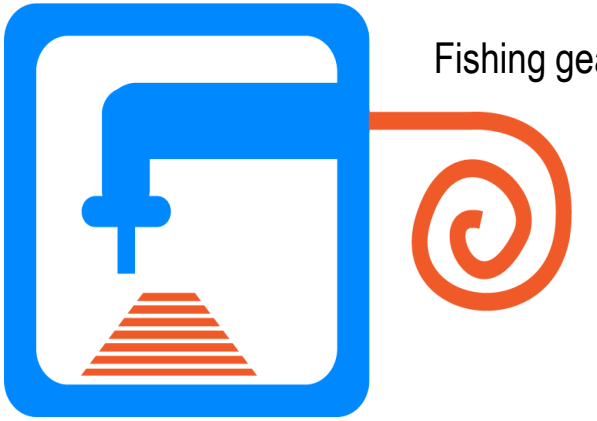
Positives

- Growing market for filament due to increasing popularity of fused filament fabrication (FFF) 3D printers
- Recycled filaments are now becoming available
- Potential for processing large quantities of fishing gear polymers into a valuable product, generating profits for local communities

Negatives

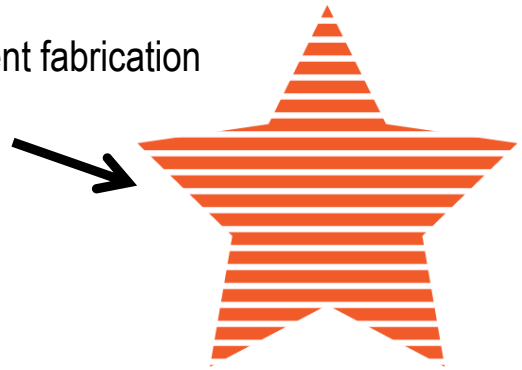
- Limited to particular fishing gear of the necessary polymer composition, quality and cleanliness
- Further testing needed to ensure recycled fishing gear filament produces quality 3D prints

-3D PRINTED PRODUCTS-



Fishing gear filament

Fused filament fabrication
3D printing



Sale of 3D printed product

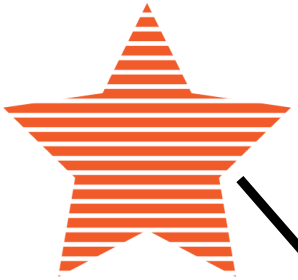
Positives

- Potential to add value through design and creativity

Negatives

- Limited to particular fishing gear of the necessary polymer composition, quality and cleanliness
- Further testing needed to ensure recycled fishing gear filament produces quality 3D prints
- Poor quality finish compared to other manufacturing processes (e.g. injection moulding)
- Limited by print-bed size and print speed
- Low volumes of fishing gear processed

-3D PRINTED PROTOTYPES-



3D printed prototype

Casting and injection moulding using fishing gear

Sale of injection moulded copies made from recycled fishing gear

Positives

- Potential to add value through design and creativity
- Makes the most of both 3D printing (flexibility, rapid prototyping) and injection moulding (quality, production speed)
- Potential to use a wider range of fishing gear polymers
- Potential for processing large quantities of fishing gear polymers into a valuable product, generating profits for local communities

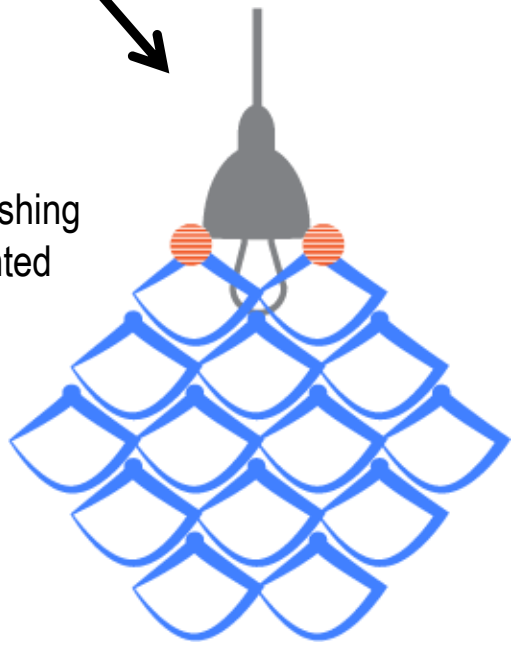
Negatives

- Set-up costs (equipment)

-3D PRINTED COMPONENTS-

3D printed components (e.g. clips)

Sale of products assembled from fishing nets using 3D printed components (e.g. lampshade)



Positives

- Potential to use any type of fishing gear polymer
- Potential for assembling large quantities of fishing gear into valuable products, generating profits for local communities
- Makes the most of 3D printing's flexibility to make custom components

Negatives

- Product designs are limited by the aesthetic of the existing fishing gear

-CONTACT-

+44 (0) 7591 748 544

rhiannon.hunt@gmail.com

@_rhiannonhunt


circular
ocean

www.circularocean.eu

Contact:
Dr Neil James
Environmental Research Institute
Castle Street
Thurso
KW14 7JD

Tel: +44 (0)1847 889 579
info@circularocean.eu
Neil.James@uhi.ac.uk

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